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The **Agriculture and Natural Resources Crops Team** is a working group of more than 35 Iowa State University Extension and Outreach faculty and staff on the Iowa State University campus and in offices across Iowa. Members combine expertise in agronomy, climate, soil fertility, soil and water management, pest management (weeds, nematodes, plant diseases and insects), grain storage, farm management and agricultural engineering. Working as a team, these specialists **conduct research**, **solve production issues**, and **provide education** to farmers, agribusiness and the citizens of Iowa. For more information about the Crops Team including news articles, blog postings, and upcoming events, visit **crops.extension.iastate.edu**.

Students at the Field Extension Education Laboratory (FEEL) near Boone, Iowa view nitrogen deficiency symptoms with **John Sawyer**, Extension soil fertility specialist. *(Source: Brent Pringnitz)*

Mahdi Al-Kaisi, Extension soil and water management specialist, answers questions during the Northern Research and Demonstration Farm field day near Kanawha, Iowa. *(Source: Jody Korthaus)*

Meaghan Anderson, Extension field agronomist, discusses herbicide options when developing a weed resistance management plan during Weeds Week at Nashua, Iowa. *(Source: Virgil Schmitt)*

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Contents

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2020 Crop market outlook: Trade, tariffs, payments and the impact on farmers

Chad Hart, associate professor, Economics and Extension economist, Iowa State University

Objectives

- Explore the factors currently shaping crop markets.
- Examine the potential for trade agreements and trade disruptions.
- Indicate how government support has offset some of the trade damage.
- Discuss potential profitability and marketing opportunities.

2019 continues to be a challenging year, in many senses of the phrase. Crop harvest was significantly behind schedule, continuing the pattern in crop planting and development. Crop prices have stagnated, with conflicting signals buffeting the markets every few days. Crop supplies are still under question with the harvest delays. Yields and quality are concern points for merchandizers and users as they evaluate this year's crops. International demand and ethanol grind have faltered for a variety of reasons. And the weather pattern this harvest season has some eerie similarities to last year, which set up the flooding and saturated field issues last spring.

As with last year, the wet weather this autumn will create some additional flexibility in cropland as we look to planting next spring. The delays in harvest also translate in delays in fertilizer applications and tillage passes, moves that usually signal which crop will be on the land next spring. With less field work performed in the fall, farmers will have more time to consider crop options and to incorporate other market factors into their acreage decisions. Crop usage over the winter will likely have more sway on crop plantings next spring than usual.

One area of usage that has attracted negative attention is ethanol. The ongoing argument over the Renewable Fuels Standard and the proliferation of small refinery exemptions has highlighted a larger issue for the corn and ethanol industries. The weekly flow of corn estimated to move through the nation's ethanol plants hit its high water mark in 2018 and has taken a step since then. The deeper decline in 2019 indicates the shutdown of a few ethanol facilities and a slowdown at others. Some of that slowdown is related to plant maintenance as fall is the season many plant managers gear down production temporary for plant cleanup or refurbishment. A recent uptick in ethanol production is indicative of the plant maintenance storyline. But overall, corn usage for ethanol is at best steady and actually likely declining a bit. Transportation fuel use has been fairly stable over the past few years. While U.S. consumers are travelling more, they are using more fuel-efficient vehicles. With the E-10 market saturated, ethanol's growth depends on expanding blending percentages, which explains the drive for expansion of E-15. Combine that with a sizable reduction in ethanol exports, partially driven by trade disputes and partially by increased competition from sugarcane-based production, and you have a recipe for weaker ethanol production and corn usage.

Another issue for the ethanol industry has been the challenge of finding profitable margins. Corn prices are higher than they were last year, but gasoline prices are lower. So input costs have risen, while ethanol prices couldn't move to compensate without losing competitive balance to gasoline. Whereas five to ten years ago energy prices were highly volatile, currently energy markets are much more range-bound as global supplies have surged with alternative production strategies, such as fracking. In the past, the energy price volatility provided ethanol prices room to move with input/corn price changes. Now, that ability is constrained.

Another area of concern on the usage is exports. The trade war with China receives the largest headlines, but it is the broader international picture that interests me. For the soybean market, China has resumed its position as the major export market. It is an encouraging sign that the trade talks have progressed and Chinese statements about increased purchases are occurring. But the negative side of the story is this, Chinese purchases are still well below levels pre-trade war. Combine that with significant reductions in soybean sales to several other countries, including Mexico and the European Union, and you still have an international market in decline. As of mid-November, current export sales are running slightly behind last year. Besides the trade disputes, other factors that are restricting soybean exports are the abundance of soybeans worldwide (the last few global soybean crops have been the largest on record) and the relative strength of the U.S. dollar (making our soybeans cost relatively more than soybeans from competitors).

Those same export forces are hampering corn exports as well. Global corn (and overall feed) supplies are large. The dollar's strength has kicked in to limit U.S. corn's competitiveness in many markets. While there is no large trade dispute limiting exports, like with China in soybeans, there is an extensive broad-based reduction in U.S. corn demand around the world. Corn export sales are down nearly 50% from last year. Looking at the top 30 markets for U.S. corn last year, sales are down in 25 of them, including all of the top six markets.

These usage declines have the potential to influence farmers' land decisions next spring. Looking forward to 2020, there is a lot of land in flux for spring planting. While the weather forecast for this winter shows a continuation of the soggy conditions we have dealt for most of 2019, farmers will be prepping for the return of, at least some of, nearly 20 million acres that were prevented from being planted. That translates into an acreage boost, even with declining crop usage. Some early guesses on acreage have already been released. The USDA first projection for 2020 showed 4.5 million more acres for corn and 7.5 million more acres for soybeans. The major key to these projections centers on the likelihood of the "phase one" U.S.-China trade deal, the higher the probability of a deal, the higher the soybean acreage estimate. But both crops will see increased area, whether the markets are ready for that or not.

Futures prices for the 2020 crops are providing some incentive for acreage growth. For soybeans, current (mid-November) futures point to a 2019 season-average cash price estimate around $8.90 per bushel, roughly 10 cents below USDA current estimate. But for 2020, futures push that season-average estimate to nearly $9.25 per bushel, 40 cents better than USDA estimate. For corn, futures indicate a 2019 season-average cash price estimate of $3.60 per bushel, 25 cents below the current USDA estimate. For 2020, the futures-based estimate stands at $3.85 per bushel, 45 cents higher than USDA's forecast. So, overall, despite the many issues plaguing agriculture, the futures markets are providing a slightly better outlook for next year's crops.

Resources

Ag Decision Maker
www.extension.iastate.edu/agdm

Farm Bill Information
www.extension.iastate.edu/agdm/info/farmbill.html

Weekly export report – USDA
apps.fas.usda.gov/export-sales/esrd1.html

Cutting through the confusion: Online decision support tools for monitoring climate and weather

Justin Glisan, Ph.D. State Climatologist of Iowa, Iowa Department of Agriculture and Land Stewardship

Objectives

- Identify the best resources for localized agricultural decision support.
- Understand how online decision-support tools help stakeholders make better long-term choices.
- Understand how to use meteorological observations for agricultural guidance.
- Understand how changes in the frequency and intensity of precipitation events are impacting agricultural decisions across the state .

Weather and climate data provide farmers and stakeholders in the agricultural sector vital information and guidance, especially throughout the growing season. These data sets are particularly useful when they deliver real-time, quality observations as well as short-term and long-term climate outlooks. Obtaining this data can be a challenge since farmers are inundated with websites, expensive proprietary products and technologies that gather this information.

Quality meteorological observations are an integral part of monitoring current conditions and should be stored and made available after the fact. This is important in terms of constructing a long-term observation record, as location dependent trends are invaluable for numerous reasons, including drought and wetness monitoring. High frequency observations are also helpful in situations that may have legal implications, such as pesticide spraying and drift. There are numerous smart phone apps available that have GPS services and thus "this is where you are and these are the current conditions" capabilities. Many Midwestern states use high frequency observations to monitor low-level temperature inversions in real-time. These inversions can suspend pesticide droplets and cause secondary drift and crop/vegetation damage. Online graphical tools that alert stakeholders whether or not to spray in a given location due to current conditions and inversion probability are available.

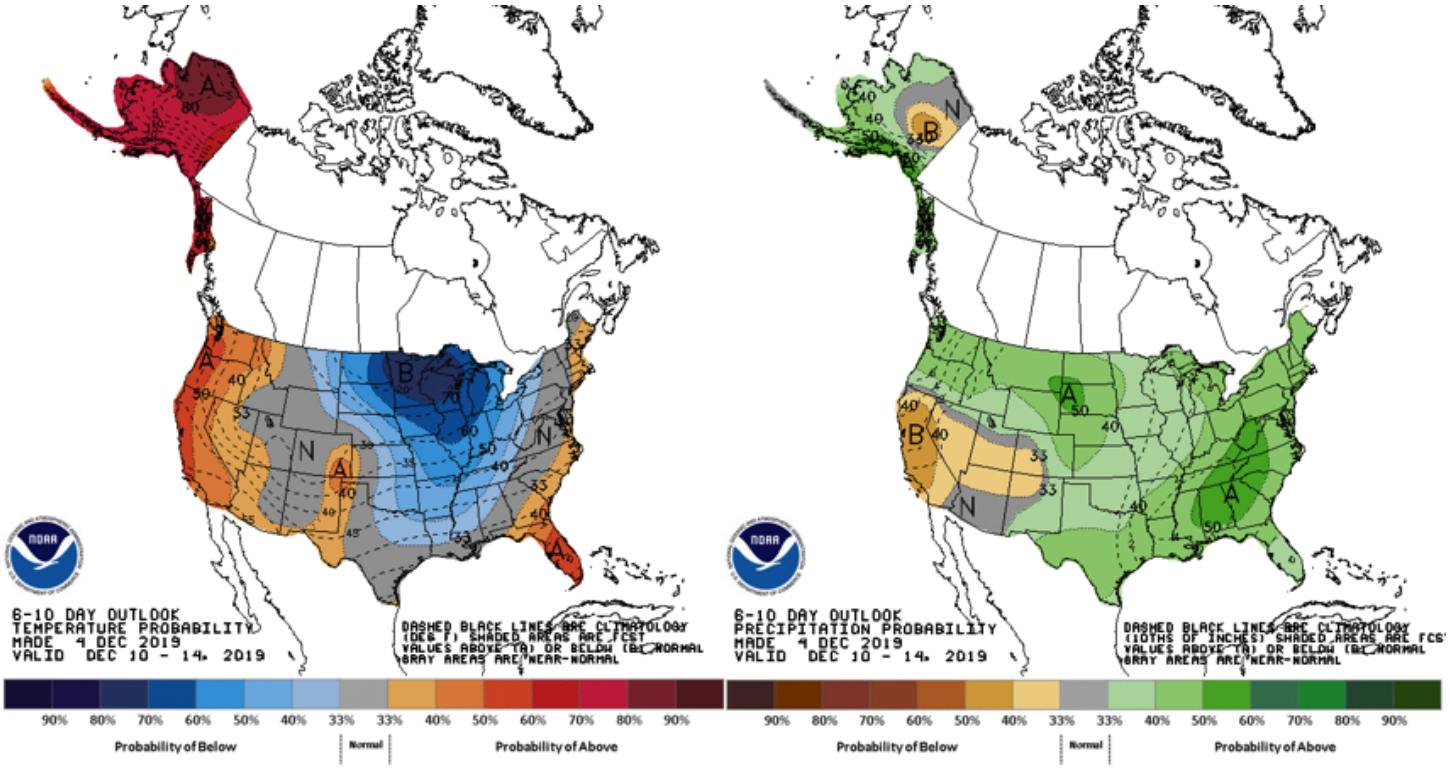

Figure 1. Climate Prediction Center 6-10 day (left) temperature and (right) precipitation outlooks.

Along with observations, climate outlooks are also great assets for decision making. The Climate Prediction Center (CPC), a branch of the National Oceanic and Atmospheric Administration (NOAA), creates the main outlook information for the United States. These outlooks are based on the probability that temperature and precipitation will be above or below the 30-year climatological average. The most useful of these outlooks tend to be the short-term 6-10 and 8-14 day products. These outlooks provide good guidance in terms of shorter-term precipitation and temperature behavior using easy to understand graphical mapping. For example, precipitation outlooks use a color scale from brown to green; the darker the brown (green) the higher the probability, and hence confidence, that a location will be drier (wetter) than the climatological expectation. These products are updated daily around 2:00 PM ET. Many private companies also create more specific outlooks. These outlooks can add some value, though their methodologies may diverge, where CPC uses a suite of tools for a consistent product.

The Midwestern Regional Climate Center (MRCC) provides a suite of decision-support tools to help stakeholders and producers make better long-term decisions. The Useful to Usable (U2U) suite has a Corn GDD tool that tracks "real-time and historical GDD accumulations, assesses spring and fall frost risk and guides decisions related to planting, harvest and seed selection." This tool integrates the stages of corn development with location-specific weather and climate data for decision-support specifically tailored to production.

Resources

Climatology Bureau, Iowa Department of Agriculture and Land Stewardship
iowaagriculture.gov/climatology-bureau

Midwestern Regional Climate Center - Useful to Usable
mrcc.illinois.edu/U2U

Climate Prediction Center Outlooks
www.cpc.ncep.noaa.gov

Iowa Environmental Mesonet
mesonet.agron.iastate.edu

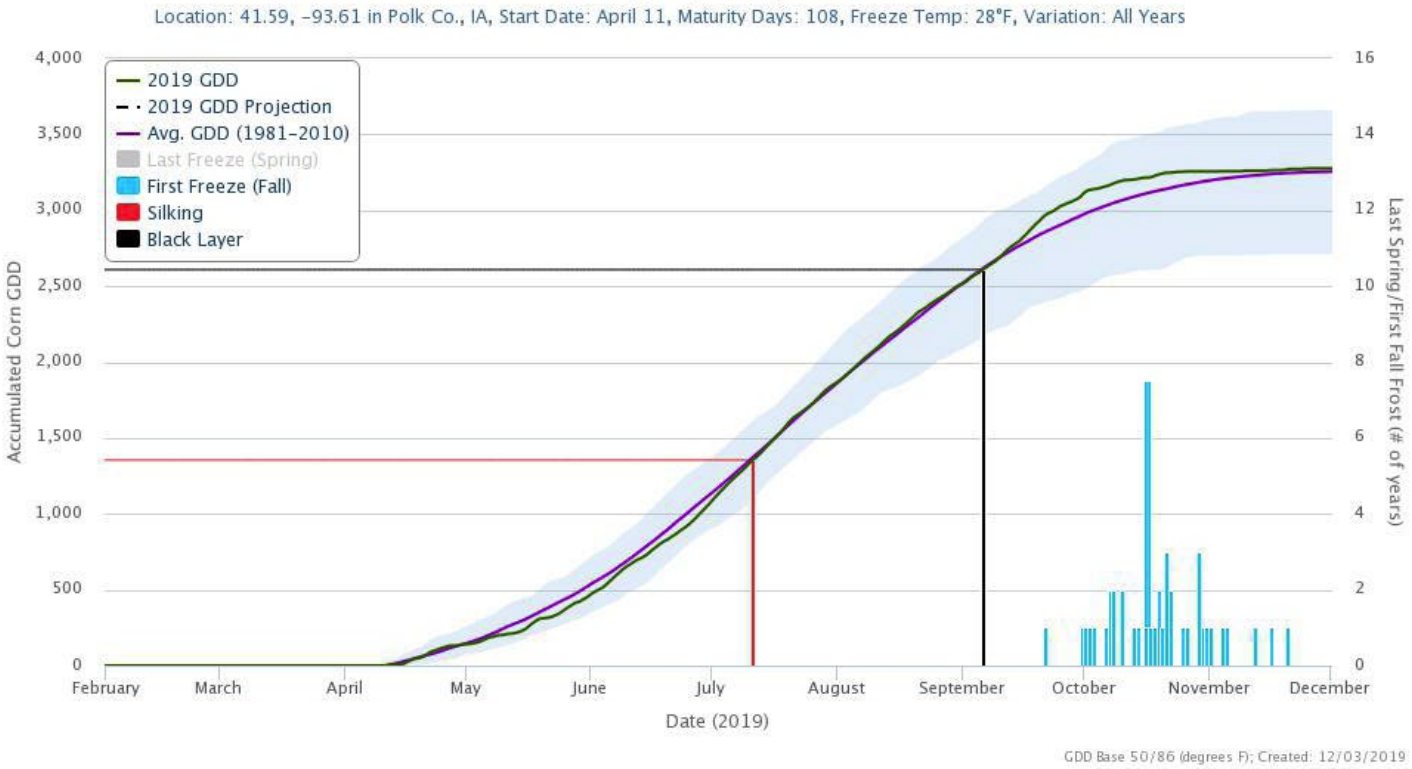

Figure 2. MRCC Useful to Usable Corn Growing Degree Day tool.

2019 Cropping year in review

Mark Licht, assistant professor, Agronomy and Extension cropping systems specialist, Iowa State University; **Sotirios Archontoulis,** associate professor, Agronomy and Extension cropping systems specialist, Iowa State University

Key points

- Yield response to late planting has not changed from previous research.
- Spring planting conditions and growing season weather dictate grain yield.
- Knowing initial grain moisture content for a given date is most important for predicting in-field grain dry down.

The 2019 growing season was a challenging year for many farmers in Iowa and across the Corn Belt. Six main events caused challenges throughout the growing season. First, April was much cooler than normal. Second, May and June had excess rainfall. Third, July and August were drier than normal. Fourth, September we noted for low radiation. And fifth, rain and cold weather set in for October and November. This was the most challenging growing season in the last 5 years. As a consequence, planting delays occurred, soil N mineralization was reduced, nitrate leaching was increased, grain fill was reduced, crop maturity was delayed, and harvest grain moisture was high. Yet with all the setback, crop yields were at good levels; estimated at 2% and 5% below 2018 for corn and soybean crops, respectively. This suggests that Iowa agriculture with modern cultivars, advanced farm equipment, and adaptive management practices can buffer against weather variability.

Resources

Integrated Crop Management - Crops
crops.extension.iastate.edu/crops

Corn Drydown Calculator
crops.extension.iastate.edu/facts/corn-drydown-calculator

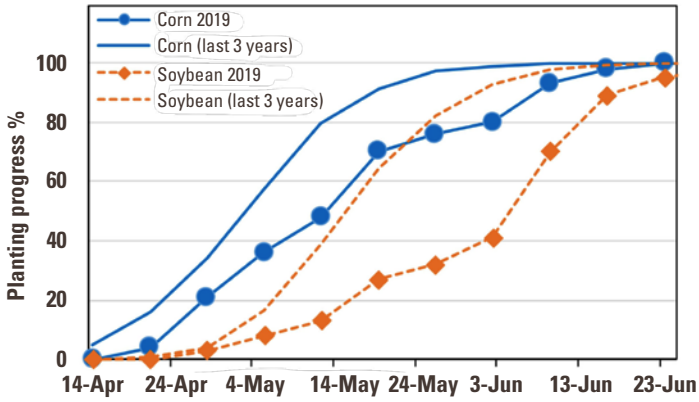

Figure 1. Corn and soybean planting progress in 2019 and in previous years (source: USDA-NASS).

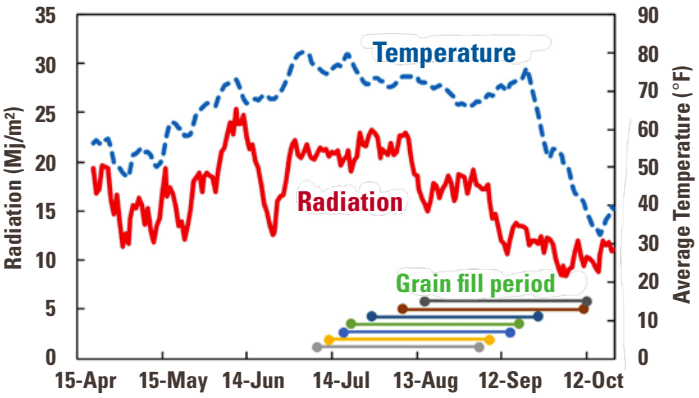

Figure 2. Average of temperature and radiation in central Iowa in 2019 with reference to the anticipated grain fill period for early to late corn planting dates. The analysis refers to a 111-d hybrid planted in central Iowa.

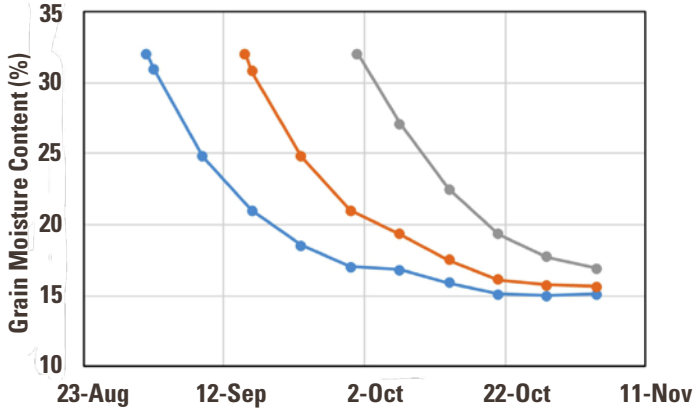

Figure 3. Corn grain moisture dry down in-field for the same hybrid that reached maturity at different dates as predicted by the Corn Grain Dry Down calculator (www.crops.extension.iastate.edu/facts/corn-drydown-calculator).

Hemp production in Iowa: What you need to know for 2020

Angela Rieck-Hinz and **R. Aaron Saeugling**, Extension field agronomists, Iowa State University;
Robin Pruisner, State Entomologist, Iowa Department of Agriculture and Land Stewardship

Objectives

- Attendees will be able to identify the current regulatory status of state of Iowa hemp rules.
- Attendees will be able to identify considerations for growing hemp on their farms.
- Attendees will be provided resources to interpret hemp growing practices.

Passage of the 2018 Farm Bill in December of 2018 and subsequent passage of Senate File 599 in Iowa have paved the road to the legalization of growing industrial hemp in Iowa. However, there are a few things you need to know before you plan to grow hemp in Iowa.

As of January 2020, growing and processing hemp in Iowa is not legal. While legislation was passed in May of 2019 to pave the way to grow industrial hemp in Iowa, many of those statute provisions are contingent upon the release of the rules being developed by the United States Department of Agriculture (USDA). Those rules were released on October 31, 2019. The state of Iowa may now develop a state hemp plan and submit it to the USDA for review. It is anticipated the "state plan" will be submitted by the end of 2019. The USDA will have 60 days to approve or deny "state plans".

The state plan must include how states will implement licensing programs, including background checks, testing and inspection procedures, disposal procedures, a violations schedule and other parameters. The Iowa Department of Agriculture and Land Stewardship (IDALS) will be the regulatory agency in Iowa for hemp permitting. Finally, IDALS is required to post a notice in the biweekly Iowa Administrative Bulletin, stating that the state plan has been accepted and licensing can begin. NOTE: While it is anticipated that growing hemp in Iowa will be legalized for the 2020 growing season, it is impossible to predict with certainly when USDA will approve the state plan. Stay tuned for regulatory developments.

Agronomically, there are several questions you should consider before you plan to grow hemp. First, determine the ultimate end use of the crop you want to grow. Do you want to grow for seed, grain, fiber or CBD? Each "product" requires different planting, management, growing and harvest practices. If you want to grow hemp on a contract for some company, whether it be for seed, fiber or CBD, know what the company's needs are for the commodity. This can vary vastly by the end-use. Educate yourself and understand how practices in other states may or may not work within the scope of the Iowa climate and soils. Hemp grown in Colorado experiences a much drier climate than hot, humid Iowa.

Second, ask yourself "Do I have the appropriate equipment to plant and harvest a hemp crop?" Again, this will depend on what you are growing it for. Yes, you can use a corn planter, but you may need a drill. Third, do you have the appropriate soil conditions? Much like corn and soybean, hemp does better on more highly productive, well-drained soils. Fourth, what is your plan for weed, insect and pathogen control? There are no pesticides labeled for hemp so if you are growing for grain or fiber adequate field preparation is necessary for weed control. If you are growing for CBD you will be hand-weeding this crop as well as hand-rogueing the male plants as you do not want male plants in CBD production. Finally, do you have the appropriate grain storage and handling equipment? Spoilage of seed/grain can happen relatively quickly after harvest, within 4-6 hours, so grain needs to be dried in aeration bins or a very low temperature. Harvest of fiber may require retting or curing in the field. Reports say this can take 2-5 weeks. How does this fit into your existing fall tillage or manure application plans?

What should you know if approached by a company that wants you to grow hemp on your farm for their efforts? Do your homework! Read up on the company, its history, the management team, and its current financial situation. The hemp industry is a face-paced, evolving industry with both good and bad actors. It is highly suggested that you secure a contract in advance and consider getting some percentage of payment in escrow to assure you do come away with some payment for your efforts. There is case after case of people not being paid for their crop, whether that is fiber, grain, or CBD.

Resources

Iowa Department of Agriculture and Land Stewardship
iowaagriculture.gov/hemp

University of Wisconsin
fyi.extension.wisc.edu/hemp

University of Kentucky industrial hemp agronomic research
hemp.ca.uky.edu

Grain drying and storage 101

Kapil Arora, Brian Dougherty, Kris Kohl, Shawn Shouse, and **Kristina TeBockhorst,**
Extension agricultural and biosystems engineering field specialists, Iowa State University

Objectives

- Understand the principles of maintaining quality grain in storage.
- Understand the characteristics of different drying systems.
- Identify factors that affect grain drying rate and efficiency.
- Review good stored grain monitoring practices.

Grain in storage is affected by grain moisture content, grain temperature, initial grain quality, foreign matter and fines, and attack by mold and insects. Allowable storage time for good quality grain, an estimate of the time before deterioration would result in the loss of one quality grade, can be estimated from grain temperature and moisture content.

Grain drying occurs as grain comes into equilibrium with the temperature and relative humidity of surrounding air. This occurs in the field, and in drying systems without or with added heat.

Natural-air or low-temperature (NA/LT) drying relies heavily on adequate airflow rate and favorable ambient air conditions. Airflow rate is influenced by both grain depth and fan power. Successful NA/LT drying in Iowa requires a minimum airflow rate of 1 cfm/bu. Layer filling the bin can increase the NA/LT drying rate by increasing the airflow.

High-temperature grain dryers must remove or blend grain before it reaches full equilibrium with the heated air. Excessive heat can damage grain. Over-drying is avoided in column dryers by using shallow column width, and/or by blending grain in the drying column. Over-drying is avoided in bin dryers by using shallow batches or with stirring machines in deeper batches. High-temperature drying energy efficiency can be improved by recycling waste heat or by delaying grain cooling (dryeration).

Contact your ISU Extension and Outreach agricultural and biosystems engineering field specialist for more information and advice.

Stored grain best-managment practices

- ➔ Preserve the quality of grain during harvest and drying
- ➔ Dry the grain to suitable moisture content
- ➔ Screen the grain and/or core the bin to reduce fines accumulation
- ➔ Aerate to reduce temperature to 30-40 degrees going into winter
- ➔ Cover fans when not in use
- ➔ Check grain weekly while observing safety rules
- ➔ Have a backup plan for handling grain that has developed storage problems

Resources

Grain Drying, Handling and Storage Handbook
www-mwps.sws.iastate.edu/catalog/grain-handling-storage/grain-drying-handling-and-storage-handbook

Natural-Air Corn Drying in the Upper Midwest
extension.umn.edu/corn-harvest/natural-air-corn-drying

Learning modules
www.extension.iastate.edu/grain/training-modules

Post-harvest grain information
extension.umn.edu/corn/corn-harvest

Extension Agricultural and Biosystems Engineering Field Specialists
www.extension.iastate.edu/ag/agricultural-engineering

Table 1. Allowable storage time of corn (days).

Temperature ˚F	Moisture content					
	16%	18%	20%	22%	24%	26%
30	1,700	648	321	190	127	94
40	756	288	142	84	56	41
50	336	128	63	37	25	18
60	149	57	28	16	11	8
70	83	31	16	9	6	5

Source: Natural-Air Corn Drying in the Upper Midwest, University of Minnesota

Table 2. Equilibrium moisture content of shelled corn, % moisture, wet basis.

Temperature ˚F	Relative humidity				
	50%	60%	70%	80%	90%
20	14.8	16.1	17.6	19.4	22.2
30	13.9	15.2	16.7	18.6	21.1
40	13.1	14.5	16.0	17.9	20.5
50	12.5	13.8	15.4	17.3	20.2
60	11.9	13.3	14.8	16.8	19.7
70	11.4	12.7	14.3	16.3	19.3

Source: Natural-Air Corn Drying in the Upper Midwest, University of Minnesota

Effectively using cover crops for forage

Chris Clark, Denise Schwab and **Patrick Wall,** Extension beef field specialists, Iowa State University

Objectives

- Identify management considerations to better integrate row crop and cattle enterprises.
- Identify strategies and best management practices to effectively use cover crops for forage.
- Identify potential health and nutrition issues associated with grazing cover crops.
- Understand management strategies to overcome these issues.

Establishing cover crops following grain production is a proven tool to protect soil, reduce erosion, improve water quality and enhance soil quality. Variable late summer, fall and winter weather is a challenge to both establishment and grazing success. But extending the fall grazing season with cover crops can significantly reduce feed costs even if it is only for a few weeks.

A 2018 demonstration project was funded by the North Central Risk Management Extension Education grant where twenty producers who have fall grazed cover crops for two or more years were interviewed about their experiences. Cooperators ranged from 2 to 30 years of experience seeding cover crops with an average of 10 years. The project group averaged nearly 400 acres of cover crops seeded. Their comments contributed to this list of best management practices.

Figure 1. Grazing a cereal rye cover crop at the Allee Research Farm. *(Source: Rebecca Vittetoe)*

Planning and flexibility

Field and crop planning is further complicated when cover crops and grazing are added into the management scheme. Adjustments in cash crop selection, planting and management may be needed to extend the growing season for the cover crop to provide adequate forage for grazing. Grazing fields need access to water sources and adequate fencing, as well as access to other crop residue fields to balance the diet. Even the best plans are often impacted by Mother Nature, requiring flexibility when inadequate forage is available for the livestock.

Cover crop species

There are many cover crop species available, but most cooperators focused on winter cereal rye, oats, radish or turnips. They preferred the greater fall growth from oats without the need to terminate it in the spring, and the greater early spring growth from cereal rye for spring grazing. Radish and turnips were added to the mix to improve the protein value in the final forage, although seldom had enough growing days to take full advantage of the root/bulb component except in very favorable weather years.

Seeding method and timing

Drilling is the most effective seeding method but must be done following harvest which can significantly shorten the fall growing season. For producers that chop silage, seed can be drilled following silage harvest which is usually early enough to allow solid fall cover crop growth. Considering the lack of residue after silage harvest, the conservation benefits of cover crops in this scenario can also be great. Early seeding is critical, particularly for fall grazing. Aerial or broadcast seeding methods can be used to plant cover crop into standing crops but for a variety of reasons, results can be inconsistent. There is a need for ongoing research to evaluate the best techniques for seeding into standing crops.

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.

Grazing management

The lush, high moisture and high protein content of cover crops create grazing challenges. Cooperators overcome this by grazing cover crops in conjunction with crop residue, either in the same field or adjacent fields. Strip grazing provides high quality forage for a longer period than continuous grazing, however requires additional labor during a very busy time of year. Most cooperators continuously graze cover crop fields but with a higher stocking density, and then move to new fields as more are harvested.

Water and fencing

Grazing cover crops and corn stalk residue can be a very economical way to feed cattle and can help tremendously to reduce feed costs. Lack of water and fencing, however, can be significant challenges. It is important to have a reliable, permanent, legal fence around the perimeter of any grazed field. Temporary, electric fences can be used for interior fences to implement rotational or strip grazing. Water sources must offer a constant supply of fresh, clean water and must be manageable to combat freezing.

Balanced nutrition

It is often recommended to start grazing as soon as the cover crop is well rooted and can't be "plucked" from the soil, since the forage grows very rapidly. However there needs to be an adequate quantity of forage available in the field to support the livestock. Weather conditions may influence the level of nitrates and sulfur in the cover crops, and should be considered prior to grazing.

While grazing cover crops adds an additional level of management to the grain operation, cooperators readily attest that grazing usually offsets the costs and challenges of the cover crop while still providing the environmental benefits. Estimating that it costs $1.50/day to feed a beef cow, rough cowboy-math would indicate that $40/acre cover crop costs would be recouped by grazing 27 cow days.

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) can be used to help alleviate soil compaction and on a dry matter basis, are very nutritious feedstuffs. However, brassica plants can be extremely high in moisture, making their feed value much less on an as-fed basis. Brassicas are also naturally low in fiber and high in sulfur. The high sulfur content can put cattle at risk for developing sulfur toxicity or polioencephalomalacia (PEM). To mitigate risk for sulfur toxicity, plant brassicas as components of mixed stands with other species and limit additional sulfur consumption from water sources and supplemental feeds associated with higher sulfur levels such as distillers grains or corn gluten feed.

Resources

Iowa Beef Center
www.iowabeefcenter.org

Integrated Crop Management - Cover crops
crops.extension.iastate.edu/crops/covercrops

Best management practices for fall grazing cover crops
www.iowabeefcenter.org/information/FallGrazingCoverCropsBMPinfographic.pdf

Herbicide use may restrict grazing options for cover crops
store.extension.iastate.edu/product/14454

Managing cattle health issues when grazing cover crops
store.extension.iastate.edu/product/15455

Spring grazing cover crops
www.iowalearningfarms.org/files/page/files/16-0301_SpringGrazing_FINAL.pdf

Corn herbicides: Restrictions when planting, grazing or feeding cover crops
practicalfarmers.org/wp-content/uploads/2018/11/PFI-Corn-Herbicides.pdf

Soybean herbicides: Restrictions when planting, grazing or feeding cover crops
practicalfarmers.org/wp-content/uploads/2018/11/PFI-Soybean-Herbicides.pdf

Late planting, wet corn and the LP shortage

Charles R. Hurburgh, professor, Agricultural and Biosystems Engineering, Iowa State University

Key points

- Corn quality was substandard in 2020, due to late planting and delayed maturity.
- Wet corn had to be held in storage and in many cases still is in storage.
- Tactical aeration using cold dry air conditions enables the storage of wet grain without major spoilage, as long as grain temperatures are maintained uniformly cold.

The late planting has caused corn moisture to be higher than normal. Since most farm dryers and some elevator dryers operate on propane gas (LP), the LP distribution backup caused wet corn to be held, either in storage, or in the field. With 18% of acres unharvested as of November 25, Iowa had relatively less wet corn waiting than states to the north and east. Elevator reports indicate the wet corn is around 20% moisture in central and western Iowa, up to 25% moisture or higher in northern and eastern Iowa.

The general corn quality in 2019 is below average, due to the record late planting and subsequent immaturity and incomplete grain fill. Immature corn has lower test weight, lower protein content, and poorer storability (resistance to mold invasion). Replanted corn and very late initial planting caused large variations in moisture content that were not fully evened out in high temperature dryers. Pockets of wet grain remain. Bin dryers with stirring machines are better at evening out moisture variations but have much lower throughput capacity than high temperature batch or continuous flow dryers. The drying season ended in mid November for low temperature and natural air dryers because the moisture evaporation capacity of cold air is low.

Immaturity has also made 2019 corn harder to dry. Elevators are reporting 5-10% increases in energy use per unit of moisture removed; soft texture makes corn hang on to the water tightly. This means the storage life (allowable storage time) is shorter than normal estimates. Elevators, regardless of fuel source, had drying backups with more moisture to remove, more energy required per unit of moisture, and in many cases higher yields than expected.

Maintaining uniformly cold grain temperature will be the key to ongoing holding of wet corn until it can be dried or sold. Conical piles, both covered and uncovered, are difficult to aerate uniformly, and therefore will experience more storage problems than bins or regularly shaped flat storages with good aeration systems.

Grain will cool by evaporation to nearly the dew point (temperature at which water will condense). Dew points have been low since mid November, which was very beneficial. The dew point is lower than the actual temperature unless the air is 100% relative humidity. Airflow rates typical for aeration of dry corn (0.1 cfm/bu or higher) are enough for cooling (not drying).

Corn can be stored at temperatures below freezing. The risk is having frozen chunks that either obstruct airflow or jam conveyors. Frozen corn should be as clean as possible. Periodic removal of grain from the center of bins will take out fines, keep the grain moving, provide a roughly level surface for even air distribution and provide a sample for temperature measurement if the bin does not have temperature cables or is too deep for surface probing alone. One load should be enough in medium farm bins, less in small bins and more in larger ones.

Table 1. Maximum storage time, in months, for corn and soybean*.

	Corn, soybean moisture content						
Temperature ˚F	13%, 11%	14%, 12%	15%, 13%	16%, 14%	17%, 15%	18%, 16%	24%, NA
40	150	61	29.0	15.0	9.4	6.1	1.3
50	84	34	16.0	8.9	5.3	3.4	0.5
60	47	19	9.2	5.0	3.0	1.9	0.3
70	26	11	5.2	2.8	1.7	1.1	0.2
80	15	6	2.9	1.6	0.9	0.9	0.06

* Based on 0.5% maximum dry matter loss–calculated on the basis of USDA research at Iowa State University. Corresponds to one grade number loss; 2-3% pts of total damaged seeds.

Pay attention to the weather forecasts and conditions. You do not want to rewarm the wet corn in a warm spell. Consider 35°F as the upper limit for grain temperatures, for wet corn. The dew point is the critical measurement to follow. On low humidity days, there can be low dew points even with moderate air temperatures. For example, 50 degree air with 40% relative humidity will have a dew point of 30°F. However, leaving fans running on mild days with higher humidity will be counterproductive to maintaining grain temperatures in the 30s or below.

Tarped piles that require fan operation to hold the tarp on the pile will face greater risks from rewarming. Weekly records of exiting air temperatures at each fan, or at the top with upflow aeration, will give indications of temperature stability in the grain mass but will not necessarily identify pockets of heating.

Dry wet corn or sell it as soon as you can, even if this means some extra handling. The longer that wet corn stays in a bin, even cold, the higher the risk of spoilage in some places, such as along a wall that gets warmed on sunny days. Storage life loss shows up in the spring with hot spots, blue eye mold and eventually serious spoilage.

Recent developments in inexpensive carbon dioxide (CO_2) monitoring have created the ability to monitor grain condition in a new way. Increases over time in CO_2 levels in either exiting air or headspace air is indicative of increased mold activity somewhere in a bin.

Corn remaining in the field over winter is not necessarily a large loss. In 2009, we had significant amounts of corn left in the field due to high moisture and insufficient drying capacity. The corn reached about 18% moisture, which was the long term equilibrium for winter air in Iowa. There were some mold issues, but not from fungi that produce mycotoxins. Test weights remained about the same as they were in the fall, which suggested that there was not large dry matter deterioration. Stalk lodging and snow cause field loss to the ground, which is a risk with leaving corn in the field.

The abnormally early cold temperatures are provided a significant benefit this year, in the holding of higher than normal moisture corn until it can be dried or used.

Resources

Iowa Grain Quality Initiative
www.extension.iastate.edu/grain

Wet corn and propane shortage
crops.extension.iastate.edu/blog/charles-r-hurburgh/wet-corn-and-propane-shortage

Cooling grain impacts on grain quality and shelf life
crops.extension.iastate.edu/blog/charles-r-hurburgh/cooling-grain-impacts-grain-quality-and-shelf-life

Crop quality in 2019: Another unusual year
crops.extension.iastate.edu/cropnews/2019/10/crop-quality-2019-another-unusual-year-0

Cover crops for improved manure management

Brian Dougherty, Extension agricultural engineering field specialist, Iowa State University

Objectives

- Understand the impacts of cover crops on drainage water quality.
- Review cereal rye cover crop nutrient uptake data.
- Evaluate the effects of manure application timing and cover crops on corn yield.

Cover crops have been shown to provide water quality benefits in Iowa. They also store and release nutrients in cropping systems. This can be particularly beneficial in systems that utilize manure, where application timing typically does not match up well with crop nutrient demand. Both cover crops and manure can help to improve soil health by increasing soil organic matter, improving porosity and aggregate stability, increasing nutrient cycling, and reducing soil bulk density.

A research trial was started in fall of 2015 at the Northeast Research and Demonstration Farm near Nashua, IA to evaluate the effects of manure application timing and cover crops on drainage water quality and yields. Nutrient uptake by a cereal rye cover crop following both corn and soybeans in rotation was also evaluated. Corn in corn-soybean rotations received either Early fall manure (EFM), Late fall manure (LFM), or Spring UAN sidedress (SU). Early fall manure was applied as soon as possible after crop harvest (early-mid October). Late fall manure was applied after soils had cooled to below 50°F (early-mid November). Spring UAN was applied 4 weeks after planting. Continuous corn plots received either LFM or Spring manure (SM). Nitrogen rates were 150 lb N/ac for corn in corn-soybean rotation and 200 lb N/ac in continuous corn. No manure was applied prior to soybeans. An Instinct® nitrification inhibitor (+I) treatment was included in continuous corn.

Water quality

Data from 2016 to 2018 shows that the cereal rye cover crop reduced nitrate-N concentrations in tile drainage in an early fall manure system. Table 1 shows 3-year average (2016-2018) nitrate-N concentrations in drainage water from corn-soybean rotation plots. Comparing treatments with a cover crop (EM150NT+R) and without a cover crop (EFM150NT) shows that the cover crop significantly reduced nitrate-N concentrations in subsurface drainage water in both corn and soybeans in an early fall manure system (Table 1).

In continuous corn plots, timing of manure application had no significant effect on nitrate-N concentrations in drainage water. The Instinct nitrification inhibitor also had no significant effect.

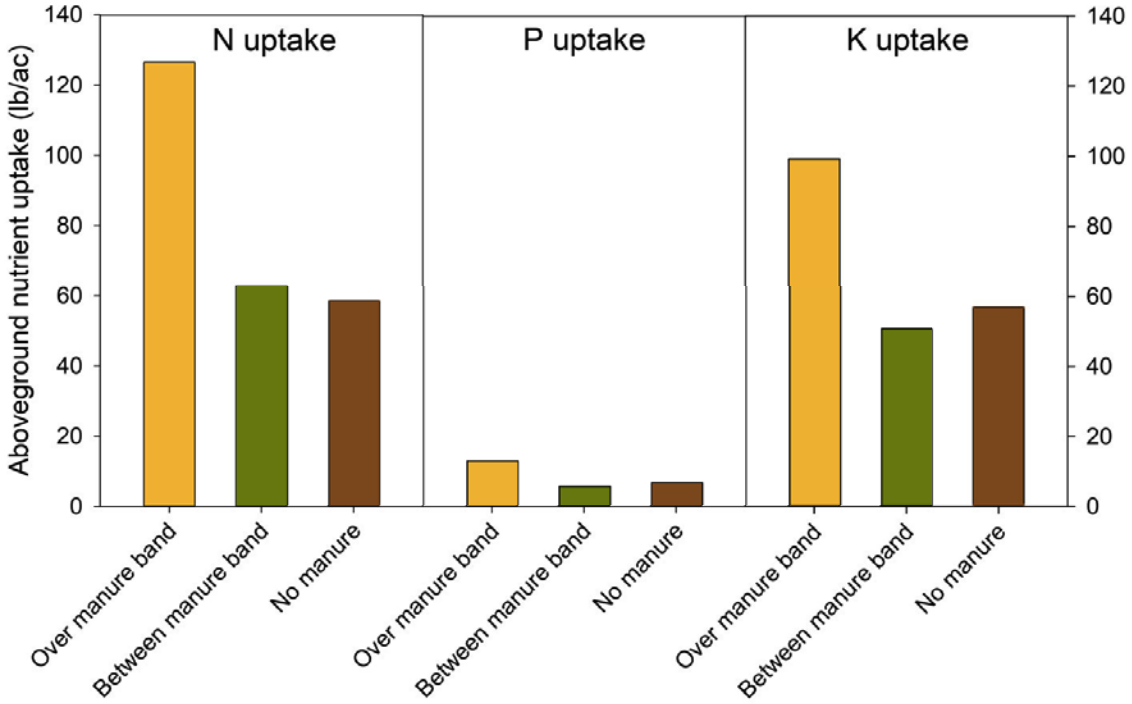

Figure 1. Cereal rye cover crop uptake of N, P, and K in aboveground biomass (lb/ac).

Cover crop nutrient uptake

Cover crop aboveground biomass samples were collected in the spring just prior to termination and analyzed for N, P, and K content. Figure 1 shows the 3-year average nutrient uptake in the above ground cereal rye biomass. There was significantly greater nutrient uptake directly over where manure had been injected compared to between the injection bands or where no manure was applied prior to soybeans. Averaging the N uptake from both in and between the manure injection bands across the 3-year study, the cover crop took up about 95 lb N/ac on plots receiving 150 lb N/ac from manure. Comparatively, the plots going to soybeans where no manure was applied took up about 58 lb N/ac. These results suggest that the cover crop took up significant residual soil N following soybean and likely took up N from the manure itself. Cover crop N uptake in a previous 8-year study on these same plots was only 13 lb/ac prior to soybeans and 21 lb/ac prior to corn in a spring UAN sidedress system.

Yields

The cereal rye cover crop had no effect on 3-year average corn yields in the corn-soybean rotation plots (Table 2). Delaying the timing of manure application from early fall to late fall resulted in a 40 bu/ac yield increase.

In continuous corn plots (Table 3) the Instinct nitrification inhibitor added to late fall manure resulted in a 17 bu/ac average yield increase (2017 and 2018 data only). Delaying the timing of manure application from late fall to spring resulted in a 38 bu/ac average yield increase in continuous corn.

Delaying manure application may conflict with other field operations and carries some risk due to weather uncertainty. However, the data shows potential for a significant yield advantage by shifting to spring rather than fall-applied manure. It is worthwhile for farmers to investigate ways to reduce nutrient losses with cover crops and shift manure application to later in the fall or spring on their own operations.

Resources

Integrated Crop Management - Cover crops
crops.extension.iastate.edu/crops/covercrops

Northeast Research Farm progress report
www.iastatedigitalpress.com/farmreports/article/id/475

Improving crop yields and water quality with manure management
bit.ly/waterqualitymanure

The Manure Scoop blog
themanurescoop.blogspot.com/2019/09/manure-application-timing.html

Table 1. Average nitrate-N concentrations in drainage water (mg/L) from 2016 to 2018. Treatments with the same letter within crop are not significantly different.

	Early fall manure, 150 lb N/acre, no-till	Early fall manure, 150 lb N/acre, no-till, rye cover crop	Late fall manure, 150 lb N/acre, no-till	Spring UAN sidedress, 150 lb N/acre
Corn	20.0a	11.7c	15.6b	11.9bc
Soybeans	9.2b	5.7a	9.7b	11.2b

Table 2. Three-year average corn yields from corn-soybean rotation plots (bu/ac). Treatments with the same letter are not significantly different.

	Early fall manure, 150 lb N/acre, no-till	Early fall manure, 150 lb N/acre, no-till, rye cover crop	Late fall manure, 150 lb N/acre, no-till	Spring UAN sidedress, 150 lb N/acre
Corn	162c	160c	202b	237a

Table 3. Three-yr average continuous corn yields (bu/ac). Treatments with the same letter are not significantly different.

	Late fall manure, 200 lb N/acre	Late fall manure, 200 lb N/acre, plus gypsum	Late fall manure, 200 lb N/acre, plus Instinct®	Spring manure, 200 lb N/acre
Continuous corn	188c	183c	205b*	227a

* 2017 and 2018 data only

Opportunities and cost share for conservation in Iowa

Jamie Benning, Water Quality Program Manager, Iowa State University

Objectives

- Participants will discuss different types of public and private incentive programs to encourage conservation practice adoption.
- Participants will explore the characteristics of several programs available to farmers and landowners in Iowa.
- Participants will learn steps for obtaining technical and financial assistance for conservation practices.

Many incentive programs exist to encourage voluntary conservation practice adoption. Some programs offer financial incentives to offset risks associated with installing a practice, adapting to a new management system, or to partially or completely reimburse for costs associated with practice construction and maintenance. Some programs also provide technical assistance that include practice selection, siting, and design services for farmers and landowners.

Most conservation programs are administered by one of five agencies, the Natural Resources Conservation Service (NRCS), Farm Service Agency (FSA), Iowa Department of Agriculture and Land Stewardship (IDALS), Iowa Department of Natural Resources (IDNR) and the Soil and Water Conservation District (SWCD). Offices for these agencies are co-located within the United States Department of Agriculture (USDA) Service Center in each of Iowa's 100 Soil and Water Conservation Districts. Conservation professionals employed by the federal, state, and local agencies within the center can assist farmers and landowners with their natural resource concerns and help them navigate programs and select practices that are best suited for achieving their conservation goals.

The following sections will highlight a selection of federal, state, and local programs and efforts that provide conservation focused financial and technical assistance for farmers and landowners. Each program has specific application requirements and priority practices that are eligible for funding. Local goals and natural resource concerns also influence practice rankings so that funds can be prioritized to geographic areas or resources with the highest need.

Federally funded programs administered by the NRCS and commonly used for soil and water management and improvement include:

Environmental Quality Incentives Program (EQIP) which funds conservation planning, conservation practice design and construction, and other conservation activities that address the broad categories of water quality, air quality, soil erosion, and wildlife habitat. Local leaders select natural resource concern sub-categories and recommend cost-effective practices that address resource concerns. The NRCS accepts EQIP applications continuously, however, sign-up cutoff dates are set throughout the year and it is important to submit applications by the cutoff dates to be considered for the application ranking process.

Conservation Stewardship Program (CSP) provides incentives for enhancements to existing conservation practices and systems with the goal of improving soil quality, water quality, water quantity, air quality, habitat quality, and energy conservation and efficiency. As with EQIP, applications are accepted throughout the year with specific cutoff dates set and announced locally for consideration and ranking.

Priority areas within the state are often selected for specialized programs such as the **Regional Conservation Partnership Program (RCPP)** and the **Mississippi River Basin Health Watersheds Initiative (MRBI)**. These programs focus conservation efforts in high-priority areas or address specific natural resource goals through partnerships with other conservation agencies and organizations.

The **Agricultural Conservation Easement Program (ACEP)** is focused on long-term protection of agricultural land including wetlands, grasslands, farms and ranches. ACEP provides funding for term and permanent easements to protect, restore, or enhance wetlands.

The **Farm Service Agency** administers the **Conservation Reserve Program (CRP)** that aims to protect highly erodible land by removing it from row crop production and planting perennial species that will hold soil in place, take up nutrients and provide wildlife habitat. For Continuous CRP signup, landowners enter in to 10-15 year contracts and receive a rental payment that is capped at 90% of county land rental rates for removing land from production for specific practices including waterways, filter strips, riparian buffers, and restored wetlands. Contracts accepted during the General CRP signup provides payments up to 85% of county land rates for land taken out of row crop production. Each application is ranked and priority is

given to contracts that will provide the highest level of environmental benefits for water quality, erosion reduction, wildlife habitat, and air quality.

IDALS administers state-funded programs at the state and SWCD district level to support conservation practice implementation. State cost share allocated to the SWCDs can be used for temporary in-field management practices such as no-till, strip-till, and cover crops and permanent practices including grade stabilization structures, grassed waterways, terraces, and windbreaks. Funding priorities and ranking criteria are set by local SWCD commissioners.

IDNR supports water quality and watershed improvement and protection projects through state and federal funding allocations. IDNR funds watershed planning to assist in setting goals and funding priorities and collaborates with IDALS, SWCDs, and other public and private partners to improve natural resources in priority watersheds across the state.

The **Water Quality Initiative (WQI) Program**, created to implement the goals of the Iowa Nutrient Reduction Strategy, is also administered by IDALS. Local SWCDs and other conservation organizations have regular opportunities to apply for watershed-scale and practice-focused projects to demonstrate and scale-up implementation of water quality improvement practices. Each project sets goals and identifies priority practices that are eligible for cost-share funds.

Since 2013 through WQI, IDALS has offered financial incentives to encourage adoption of in-field management practices on a statewide basis. Cover crops, no-till, strip-till, and nitrapyrin nitrification inhibitor incentives have been offered on a first-come, first-served basis through all 100 SWCDs. Cost-share is available on a limited number of acres and, if funds are limited, priority has been given to those new to using the in-field practices.

In Central Iowa, the South Skunk River Watershed Project, funded by WQI, is focused on providing technical and financial assistance to landowners interested in implementing edge-of-field nitrate reduction practices. Cost-share is available for saturated buffers and denitrifying bioreactors.

The alphabet soup of programs and practices can be overwhelming, especially to those new to conservation efforts. A phone call or visit to the USDA Service Center is a great first step in discussing the resource concern, selecting a practice or conservation system to address it and then identifying the right state, federal, or local program that fits the landowner's needs and goals.

Resources

Iowa State University Extension and Outreach Natural Resources Stewardship
naturalresources.extension.iastate.edu

USDA service center locator
offices.sc.egov.usda.gov/locator/app

South Skunk River Watershed Project
www.cleanwateriowa.org/south-skunk-river-watershed-project

Master Conservationist Program

Planting the seeds of conservation in Iowa

A collaborative program offered by **ISU Extension and Outreach**, **County Conservation Boards**, and **local conservation leaders** designed to equip Iowans with the knowledge and skills necessary to make informed decisions about natural resources and to become local leaders and educators.

- Structured into four modules.
- Blend of online and in-person curriculum.
- In-person sessions led by local conservation leaders, practitioners and experts.
- Technical information prepared and presented by Iowa State University researchers and educators.
- Course graduates awarded certificate and encouraged to continue building connections with conservation professionals and local conservationists.

Learn more about becoming a Master Conservationist
naturalresources.extension.iastate.edu/programs/master-conservationist

master conservationist

Nitrogen management in wet and variable growing seasons

John E. Sawyer, professor, Agronomy and Extension soil fertility specialist, Iowa State University

Key points

- Springtime precipitation can be used for guidance on when supplemental nitrogen application may be needed.
- Recommended nitrogen rates provide adequate nitrogen in the majority of years, but not every year.
- High yield environments do not mean high nitrogen fertilization rate requirement.
- High nitrogen fertilization rates do not stabilize corn yield across variable seasons.

We all recognize that growing seasons are different. Does this mean nitrogen (N) management has to change every year? Or are N management systems within current corn production resilient enough to work well across varying environments? The short answer to the second question is yes in most instances, with understanding that the extreme years of high N application need are the critical ones that need to be considered for differential management.

Figure 1 is an example that shows the variability in corn yield response to N fertilization across multiple years at two contrasting research sites in northern Iowa. The graphs give the yields with no N applied, with the highest rate in the study (240 lb N/acre), at the economic optimum rate each year (Y-EONR), and with the current MRTN rate for each location (Y-MRTN). The Sutherland site is on a Galva silty clay loam soil, with no tile drainage, and the Nashua site a Readlyn-Floyd-Kenyon loam soil complex, with tile drainage. Nitrogen was applied either spring preplant or early sidedress incorporated/injected urea or UAN solution. These graphs allow comparison of what a "uniform" rate like the MRTN can do for corn production across years versus the best possible (the calculated yearly EONR). At the Sutherland site, only in one year was the yield with the MRTN rate significantly less than the yearly optimal rate; at the Nashua site, lower yield four years. The Nashua site soil is well drained and receives more rainfall; therefore, more years where greater than the MRTN rate was needed. What this example comparison does not show are the years where the MRTN rate was more than required, but yields would be "protected" in those cases.

How can we adjust for those extreme high N-fertilization need years (typically "wet" years)? What we have promoted in recent years is using the rainfall total from March 1 to end of June in Southeast Iowa (17.8 inches) or April 1 to end of June in the Main area of Iowa (15.5 inches) as a trigger point. If rainfall exceeds those amounts during those time periods, then more than the MRTN rate is suggested. Why not just apply a high N rate every year? That would take care of any potential yield depression in high N rate need years, but across time would result in too much N most years, lower economic return, and more N for loss as nitrate in drainage water.

In-season (mid-to-late vegetative) N applications are options for adjusting to the season, but does not always improve N management compared to preplant N. Late applied N can put corn yield at risk, for example too little N applied initially or lack of precipitation before/after the mid-season application. An example of a large positive response to late N was a field-length trial (2005) where split N (UAN surface-dribbled) was applied at the V13 corn growth stage (60 lb N/acre had been applied early sidedress), rained 2+ inches after the V13 application – a 32 bu/acre yield increase. An example of a large negative response to late N was a trial at the Northwest Research Farm water quality site in 2017 where split N (urea surface-dribbled) was applied at the V10 stage (40 lb N/acre had been applied as starter N), a dry summer and with no or small rain events for a considerable time after the V10 application – a 22 bu/acre lower yield compared to preplant. These are examples of how precipitation variation can enhance or detract from attempted improved management in rainfed corn production.

We have to supply adequate N to build the corn "yield" factory, so adequate N supply early in the season is important (70% or more of total N is taken up by silking). This can be accomplished by all preplant N application or split-sidedress. In either application system, excessively wet springtime conditions can cause loss of soil and fertilizer derived nitrate - thus a high N responsive year. Managing N by using recommended rates and adjusting for early-season excess moisture is the most viable way to deal with variable environments.

Resources

Nitrogen Use in Iowa Corn Production
store.extension.iastate.edu/Product/Nitrogen-Use-in-Iowa-Corn-Production

Corn Nitrogen Rate Calculator
cnrc.agron.iastate.edu

Iowa State University Soil Fertility
www.agronext.iastate.edu/soilfertility

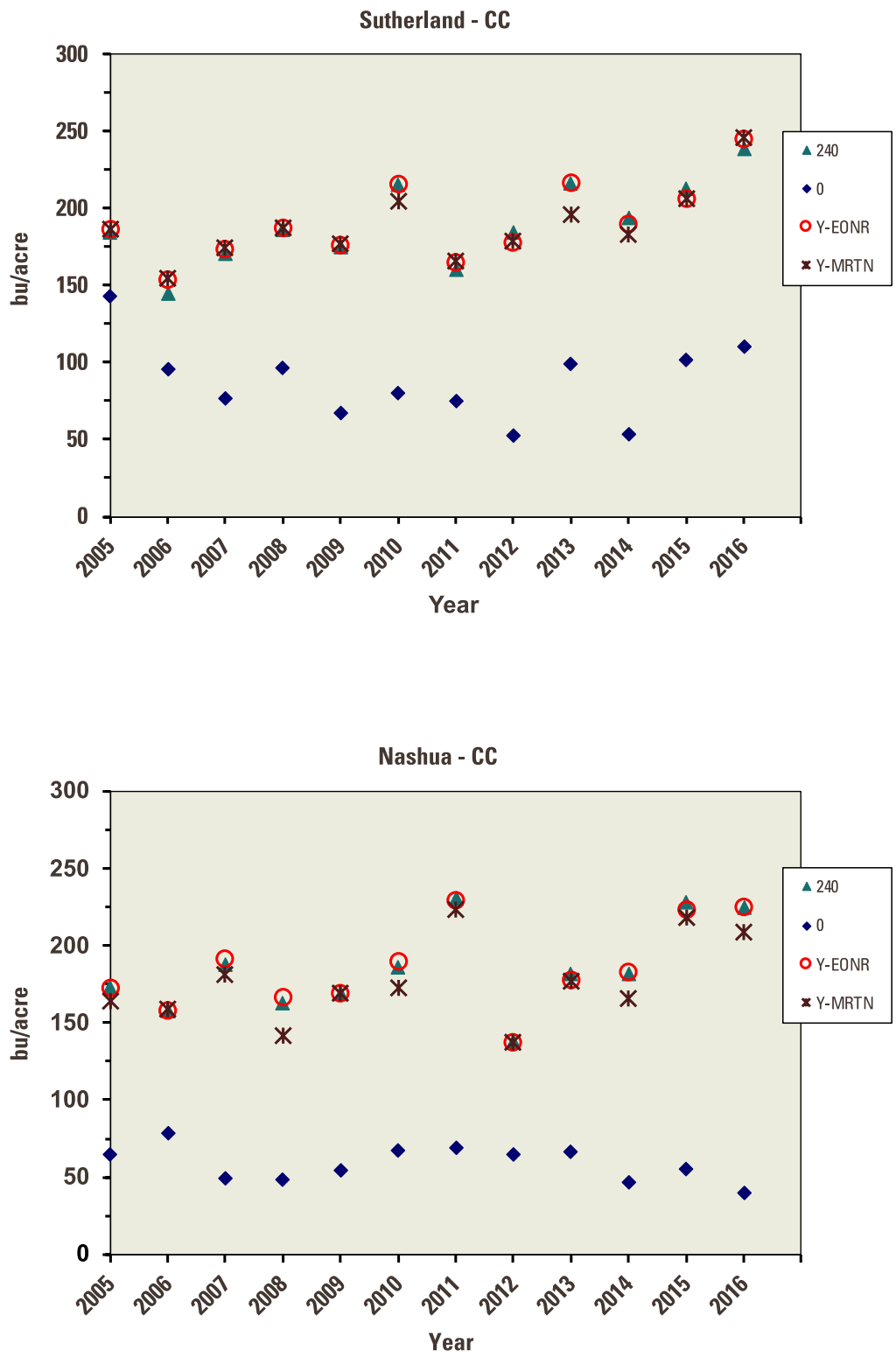

Figure 1. Examples of corn yields at two sites with no N applied, 240 lb N/acre (max in the study), at the yearly optimum EONR (Y-EONR), and with a constant MRTN (Y-MRTN) rate each year (MRTN rate of 188 lb N/acre, corn following corn). If the "star" symbol is below the dot, then the yield with the MRTN rate was less than the yield with that year-specific EONR rate.

Corn nitrogen rate calculator: The science that drives it

John E. Sawyer, professor, Agronomy and Extension soil fertility specialist, Iowa State University

Objectives

- What science and research underpins the Corn Nitrogen Rate Calculator (CNRC).
- Increased understanding of how nitrogen rates are determined in the CNRC.
- Economic implications for use of the CNRC.
- What it takes to keep nitrogen rates current.

The web-based Corn Nitrogen Rate Calculator uses an approach to recommended N rates called the Maximum Return To Nitrogen (MRTN). The economic return to N is determined for user defined N and corn prices, with the maximum return point determined as the MRTN rate. An under-utilized output is the Most Profitable N Rate Range, which is a range of N rates that provides nearly the same economic return to N application, but with different risks. Despite being first implemented in 2005 (14 years ago), there remains uncertainty and lack of knowledge of the CNRC/MRTN approach to rate guidance. Another source of uncertainty is that N rates are not yield-goal or yield-potential based.

The MRTN method follows an approach to N rate guidelines developed and implemented regionally in seven Corn Belt states (Concepts and Rationale for Regional Rate Guidelines for Corn). One key component of the MRTN rate and most profitable range is the direct use of recent N rate response trial data, that is, use of mathematical regression-fit models. This direct database use is unique, and perhaps the first time implemented, for a rate-based crop input. The N rate response trials are conducted and accumulated within each state. The approach to rate calculation is the same in each state, but the research data is unique, and hence the rate suggestions unique to each state. The same for decisions on implementation of sub-state regions. A second key component of the MRTN rate is determination from the yield increase (response) to N rate, not the yield level (not yield goal or potential). The response (increase in yield) is what pays for the N input (economic based on fertilizer price and corn price), and the maximum economic response from across the rate trials determines the MRTN rate and most profitable rate range. Sub-state regions use rate response trials specific to the individual regions. When a user of the CNRC inputs a state, and or a state region, then only response trials are used that fall within that state/region. This makes the recommended N rate not only specific to the region, but specific to the actual research and economic price parameters of interest.

A few important scientific concepts drive the CNRC and MRTN determination. First, it is a uniform approach developed across Midwest Corn Belt states. This is important as it is now well-documented how N rate recommendations are determined. No uncertainty about methods for rate determination, and a robust system that is easy to implement. Second, is a known database of recent N rate research trials. No uncertainty in the data used to drive the output and rate recommendations. Third, a well-defined economic basis for determining optimal N rates – yield response and economic payback. Fourth, a recognized uncertainty in rate selection – the Most Profitable N Rate Range. Nitrogen fertilization need and corn response is one of the most uncertain crop input decisions. The CNRC addresses part of the uncertainty by use of a recent and large N response database, but also a look at economic response across that database to help guide decisions on use of a rate more or less than the MRTN rate.

The direct incorporation of a research-based N response trial database is an important step forward in N rate guidance in corn. The database allows rate recommendations to be dynamic as they are derived across current climatic conditions, hybrids, soils, and management; and change as new research is incorporated into the databases. However, the downside is that unless rate trials are continually conducted, the database and hence recommendations become outdated. This is a challenge and a concern for the future of N rate recommendations for corn production, no matter the system. And something that needs researcher and stakeholder discussion to find a viable path forward.

Resources

Corn Nitrogen Rate Calculator
cnrc.agron.iastate.edu

Concepts and rationale for regional rate guidelines for corn
store.extension.iastate.edu/product/12240

Nitrogen use in Iowa Corn Production
store.extension.iastate.edu/Product/Nitrogen-Use-in-Iowa-Corn-Production

Iowa State University Soil Fertility
www.agronext.iastate.edu/soilfertility

Field crop pest management updates from 2019

Erin Hodgson, associate professor, Entomology and Extension entomologist, Iowa State University

Objectives

- Understand field crop pests of economic importance in Iowa.
- Realize the benefits to scouting and making threshold-based decisions.
- Recognize changes in pest susceptibility to management tactics.

The summer of 2019 produced a medley of field crop pests in Iowa. Some were regular species we see every year and a few surprises showed up. Overall, insect activity was delayed 7-10 days due to slowly accumulating heat units in the spring. Depending on your location within the states, the most common pest issues included: western and northern corn rootworm, Japanese beetle, corn earworm, soybean aphid, thistle caterpillar, soybean gall midge, and potato leafhopper. Below are summarized updates for the most prominent pests likely to be active in 2020.

Corn rootworm

Overall, activity of western and northern corn rootworm was up in 2019. Performance issues with Bt continue in Iowa for western corn rootworm. Field-evolved resistance has been confirmed for all available Bt traits in Iowa. Assume all continuous-cornfields have some level of Cry3Bb1 resistance.

Soybean aphid

Several new active ingredients will be available in 2020. Pyrethroid resistance was confirmed in Iowa in 2016; however, only a few fields have been noted so far. Regular scouting and treating based on the economic threshold will extend the efficacy of foliar insecticides.

Figure 1. Soybean gall midge.

Soybean gall midge

This new fly pest expanded range eastward in 2019. Fields adjacent to tree lines and early-planted fields experienced more severe plant injury. We detected three generations, with larvae feeding from V3-R6 growth stages. (Figure 1)

Potato leafhopper

This migratory pest of soybean and alfalfa was more intense in Iowa than in previous summers. Regular scouting of this mobile insect is important for timely management. Variety selection, early harvest, and/or using threshold tables will protect the quality and quantity of alfalfa.

Resources

Integrated Crop Management - Insects
crops.extension.iastate.edu/pests/insects

Iowa State University Soybean Entomology Research
www.ent.iastate.edu/soybeanresearch/content/extension

A new era of herbicide-resistant weeds

Bob Hartzler, professor, Agronomy and Extension weed specialist, Iowa State University;
Prashant Jha, associate professor, Agronomy and Extension weed specialist, Iowa State University

Objectives

- Recognize differences among types of herbicide resistance.
- Be able to develop herbicide programs with reduced resistance risks.
- Recognize the need for alternative management strategies.

For most Iowa farmers, the battle with herbicide-resistant weeds began in the early 1990's with the rise of HG 2 resistant waterhemp. Since that time, waterhemp has evolved resistance to Group 4, 5, 9, 14, 15 and 27 herbicides (Group 4 and 15 have not been identified in Iowa at this time). Selection of new resistances follows this pattern: one herbicide group is rendered ineffective on waterhemp due to resistance, so we move on to the 'next best' herbicide group. We use this herbicide heavily until waterhemp beats it, and then it's on to the next herbicide group. Unfortunately, we are running out of herbicide groups to move on to.

It is important to recognize that there are different types of resistance: target site- and non-target site- based. Target site-based resistance involves changes to the target site that prevents the herbicide from stopping the function of the target site. For example, group 2 resistance is due to a slight change in the ALS enzyme that prevents the herbicide from binding to ALS. Group 2, 9 and 14 resistant waterhemp, and some group 5 populations, are due to target site-based mechanisms.

The second type of resistance involves changes not related to the target site. An increased ability of a weed to metabolize/detoxify the herbicide before it reaches the target site is the most common non-target site resistance mechanism. For example, waterhemp resistant to Group 27 herbicides (Callisto, Armezon, Balance Flexx) is able to convert the herbicide to non-toxic compounds before it reaches the target site.

Why should you be concerned about how a resistant weed survives the herbicide? The good thing about target site-based resistance (if there is anything good about resistance) is that it only provides resistance to herbicides within the same herbicide group. Thus, if group 14 herbicides are used repeatedly in a field and select for weeds resistant to Flexstar, Cobra, Valor, Authority, etc., the resistant biotype will still be susceptible to other herbicide groups effective on waterhemp (e.g. dicamba, Liberty, 2,4-D). However, with non-target site-based resistance there is potential for the resistance mechanism to provide resistance to other, completely unrelated herbicide groups. It is said that non-target site-based resistance can provide resistance to herbicides that haven't even been discovered.

The first resistant mechanisms identified in waterhemp were target site-based (HG 2, 5, 9, 14), but more recent events (HG 4, 15, 27) are all non-target site-based. Early in 2019 researchers at Illinois and Arkansas reported waterhemp and Palmer amaranth resistant to group 15 herbicides (metolachlor, acetochlor, etc.). Of concern is that these group 15 resistant populations already possessed resistance to group 27 herbicides. It has not been determined whether the mechanism that provides resistance to group 27 herbicides is responsible for the new resistance, but it is possible. It is important to note that other group 27 resistant populations have been found not to be cross resistant to group 15 herbicides. However, the potential for this new type of resistance to render other herbicide groups ineffective poses a much greater threat to our production system than target site-based resistance.

The rapid increase in herbicide resistance is due to the dependence of our production system on herbicides for managing weeds. To continue with the current system we must to a better job managing weeds to reduce the selection of new resistant biotypes. The first step is to consider what biological trait allows a weed to survive within your fields. In the case of waterhemp, prolific seed production and prolonged emergence create a formidable foe. A high percentage of Iowa fields have been allowed to develop a large waterhemp seedbank. Not only does this make achieving acceptable control difficult, it drives the evolution of new resistant biotypes. Management programs must be developed that provide full-season control and drive down the size of the weed seedbank.

More efficient use of herbicides is also essential. Full rates of preemergence herbicides and layered residuals will provide control later into the season. When using layered residual applications, it requires 20-30% more product than when only applying the preemergence herbicide only at planting if you want to fully capture the benefit of the herbicide. Postemergence herbicides must be applied in a timely manner, targeting 2 to 3-inch weeds should be the goal for most products. In recent years weather patterns have made it difficult to apply postemergence products in a timely matter. This is one of the benefits of full-rates of preemergence herbicides, they extend the application window for postemergence products. Strike when the iron is hot – if there is a window of good weather for spraying

but weeds are only 1 to 2 inches in height, don't put it off until more weeds emerge. Inclusion of the layered residual with early post applications can extend control until the crop canopy develops.

Finally, evaluate your production system to determine how you can diversify weed management on your farm. Anything done to enhance development of the crop canopy will help suppress weeds and take pressure off the herbicides. Row spacing, seeding rates, and planting dates can be manipulated to help provide the crop an advantage over weeds. Cover crops can be used to help control weeds, but they must be managed in a way to maximize biomass production to provide significant weed suppression. Tillage is another tool that can be considered, both pre-plant and post-plant tillage. Alternative tactics to manage weeds are not as simple to incorporate on a farm as switching to a different herbicide, but as we move forward in this new era of resistant weeds they will become increasingly important.

Herbicide resistance is a symptom of our heavy reliance on herbicides, and herbicides alone will not solve this problem.

Resources

Integrated Crop Management - Weeds
crops.extension.iastate.edu/pests/weeds

Metabolism-based resistance – why the concern?
crops.extension.iastate.edu/blog/bob-hartzler/metabolism-based-resistance-why-concern

Palmer amaranth: Current status in Iowa

Bob Hartzler, professor, Agronomy and Extension weed specialist, Iowa State University

Objectives

- Understand why Palmer amaranth is considered a threat to Iowa crop production.
- Be able to differentiate Palmer amaranth from waterhemp and other pigweeds.
- Understand the importance of early detection of Palmer amaranth.

The *Amaranthus* genus (pigweeds) has more than 60 species globally, and many are serious agronomic weeds. In Iowa has eight native pigweeds, including waterhemp, redroot pigweed and smooth pigweed. Palmer amaranth is native to the southwestern United States, but in the 1050's expanded its range into the southeastern U.S., and more recently has moved into the Iowa and other states in the northern Corn Belt.

Palmer amaranth was first identified in Iowa in 2013 in Harrison County, and and later that year four additional infestations in other counties were confirmed. The 'main' introduction event occurred in 2016 with the planting of native seed mixes contaminated with Palmer amaranth seed. In 2016 the number of counties with known infestations increased from 5 to 49. Since 2016 numerous new infestations were identified, bringing the number of infested counties to 55. Known sources of introduction include transport of equipment, animal feed and grain contaminated with Palmer amaranth seed.

Palmer amaranth is closely related to waterhemp, Iowa's number one weed. Both species are dioecious, meaning there are separate male and female plants. This characteristic leads to tremendous variability within both species. The diversity within the species contributes to the ability of both species to evolve herbicide resistance. One of the primary differences in the two pigweeds is that Palmer amaranth has a more rapid growth rate and is more competitive with crops than waterhemp, thus escapes of Palmer amaranth pose a greater risk to crop yields.

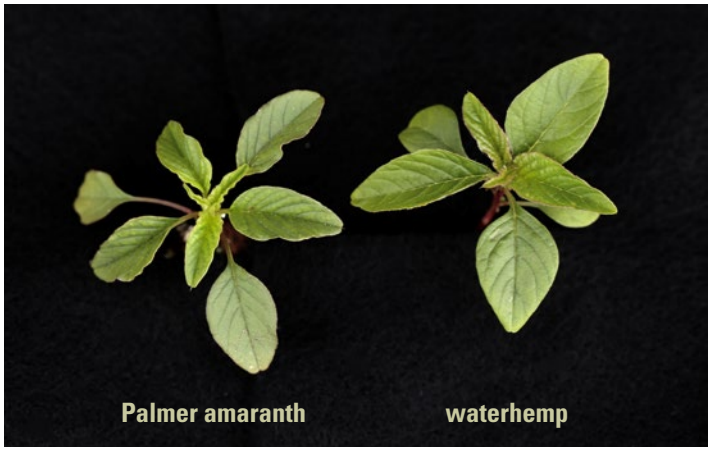

Figure 1. Seedlings of Palmer amaranth (L) and waterhemp (R) are difficult to differentiate.

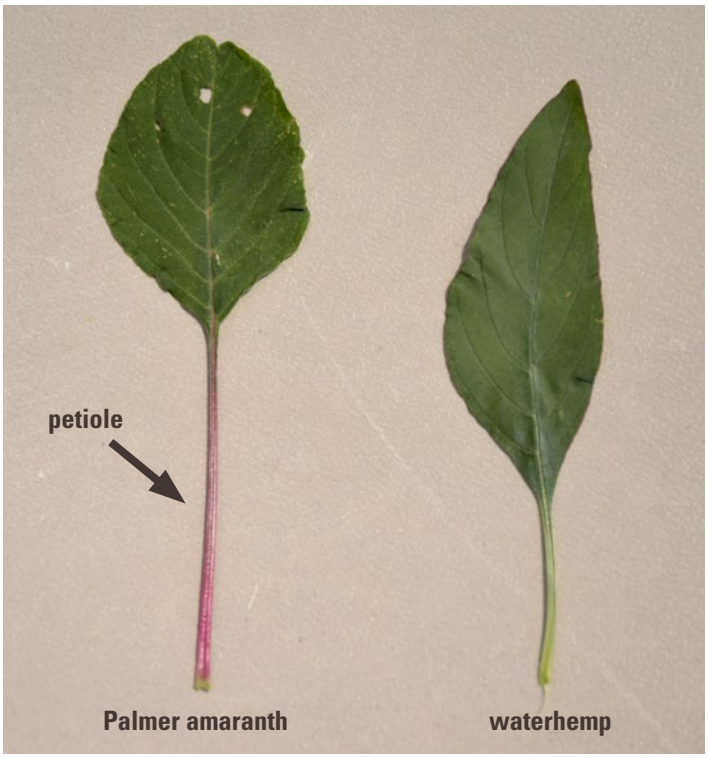

Figure 2. Leaves of Palmer amaranth (L) and waterhemp (R) showing long petiole on Palmer.

Palmer amaranth and waterhemp can be difficult to differentiate, especially early in the growing season. Unlike other pigweeds of Iowa crop fields, both waterhemp and Palmer amaranth lack hairs on the stems and leaves. In the vegetative stage, the most reliable trait are the long petioles found on Palmer amaranth leaves. Some, but not all, leaves on Palmer amaranth have petioles longer than the leaf blade. (Figure 2) The two pigweeds are relatively easy to tell apart when mature. Palmer amaranth typically has terminal branches on seedheads longer than 12 inches (Figure 3), and female flowers have long bracts giving the seedhead a spiky appearance, the bracts become sharp when mature. (Figure 4)

Figure 3. Palmer amaranth has seedheads longer than 12 inches.

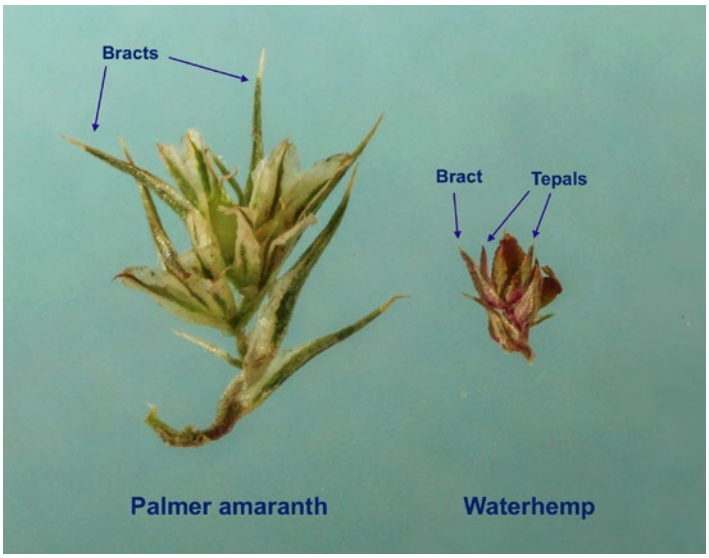

Figure 4. Large bracts on the flowers of Palmer amaranth give the seedheads a spiky appearance.

Fortunately, management programs that are effective on waterhemp will also control Palmer amaranth. Both pigweeds have extended periods of emergence, thus programs must be implemented that extend control late in the season. Both species will evolve resistance to any herbicide used repeatedly. Knowing what resistances are present in either species infesting your fields is essential in designing effective management programs. Iowa State University and Illinois offer resistance testing; closely evaluating performance of herbicide treatments can also help determine the presence of resistance.

Early detection and rapid response is a strategy used to manage invasive plants such as Palmer amaranth that are not widely established in a region. In the long run it is much cheaper to eradicate early infestations of a new weed rather than let it become a permanent component of the weed community. I am not aware of any infestations in Iowa that are beyond the point where Palmer amaranth has established to the point where eradication is not economically feasible. Farmers and commercial agronomists need to be on the lookout for pigweeds that don't look like our normal waterhemp. If in doubt, contact your local ISU field agronomist or contact hartzler@iastate.edu. If Palmer amaranth is found, it is worth the effort to go the extra mile to prevent seed production by escapes in the field. Since few fields have permanent Palmer amaranth seedbanks established, it should be feasible to eradicate infestations with a few years of vigilance.

Resources

Integrated Crop Management - Weeds
crops.extension.iastate.edu/pests/weeds

2019 Western Iowa Palmer amaranth tour
crops.extension.iastate.edu/blog/bob-hartzler/2019-western-iowa-palmer-amaranth-tour

Palmer amaranth identification
store.extension.iastate.edu/product/14794

Palmer amaranth: ID, biology, and management
crops.extension.iastate.edu/encyclopedia/palmer-amaranth-id-biology-and-management

Past pest problems and lessons learned

Paul Kassel, Extension field agronomist, Iowa State University

Objectives

- Review the origin of extended diapause, soybean aphid and other pest issues.
- Review the Extension response to new and emerging pest issues.
- Discuss the impact these issues have had on current pest management practices.

Various crop and pest problems have occurred in northwest Iowa since 1981. Some of these issues include drought in 1983, 1988, and 2012, Pursuit resistant waterhemp in 1995, white mold in 1996, corn brittle snap in 1998, the threat of Asian soybean rust in 2005, Sudden Death Syndrome in 2010, Goss's wilt in 2011, glyphosate resistant waterhemp in 2013, Palmer waterhemp in 2016, soybean gall midge in 2016, thistle caterpillar in 2019 and late planting in 2013, 2018 and 2019.

The following are some of the pest and agronomic issues where ISU Extension and Outreach was involved in the analysis of the problem and the development of management techniques.

Black cutworm

Black cutworm caused widespread stand reduction in corn in the spring of 1985. Several meetings were held to assess the cutworm damage and discuss black cutworm management. Field scouting, economic thresholds, insecticide selection and replant considerations were all factors that were discussed. Black cutworm is managed today by hybrid traits and insecticide seed treatments.

Figure 1. Black cutworm injury in corn, 1985.

Extended diapause

Reports of root injury from corn rootworm where corn followed soybean acres began to occur in the summer of 1985. Field visits confirmed the root injury. There was some skepticism by the university community regarding this change in the behavior of corn rootworm.

Field visits to extended diapause fields that had a diverse history in 1983 were used to confirm the change in rootworm behavior. Fields that had set-aside acres in 1983 were evaluated in the fall of 1985 for rootworm damage. Corn following set aside acres in 1983 did not have root injury. However, root injury from rootworm was evident where corn followed 1983 corn acres.

This represented a major change in rootworm management on corn/soybean rotation acres in terms of input expense and crop production risk. Research in the late 1980s and early 1990s indicated a low probability of corn yield reduction from extended diapause occurrence. However, the risk of yield loss, the risk of harvest difficulty and the unpredictability of the occurrence of extended diapause conditions caused many farmers to use soil applied insecticides at planting time. Corn rootworm traits also were used to manage this situation.

Figure 2. Aerial photo of corn root lodging from corn rootworm extended diapause, 1985.

Scepter carryover

Scepter herbicide saw widespread use in 1987. Many acres were treated with a preplant incorporated application of trifluralin and Scepter. The weed control performance of this combination was exceptional for this era. However, there was widespread carryover injury to the corn crop from the Scepter herbicide in 1988 and 1989. Winter meeting topics in 1989 included yield effects from the Scepter carryover, tillage options and crop rotation changes. Even though Scepter herbicide provided exceptional control for a soil applied product, post emergence application of Pursuit herbicide in 1989 and the Roundup Ready system in 1996 significantly changed the timing of herbicide application in soybean production.

Figure 3. Corn roots with injury symptoms from Scepter herbicide carryover, 1988.

Soybean aphid

Soybean aphids were first observed in northern Iowa in Hancock county in 2001. Low populations of soybean aphid could be observed in 2002 in numerous northwest Iowa fields. Soybean aphid infestations occurred in nearly all soybean acres in 2003 and created one of the largest pest infestations ever observed. Economic thresholds had not been developed and the potential yield damage was not well understood. Numerous meetings were held to educate farmers on soybean aphid management. Harvest results revealed the true effect of this pest as there were numerous 10 to 15 bushel per acre yield benefits from insecticide application.

Soybean aphid management continues to be a major crop activity in the summer months. Issues around synthetic pyrethroid resistance, the future of chlorpyrifos registration and new insecticide products assure that soybean aphid management will continue to be a major issue in the future.

Figure 4. Soybean aphids.

Dicamba

Dicamba applications to dicamba tolerant soybean varieties first occurred in 2017. Issues with off target movement of dicamba to non-dicamba tolerant soybean varieties began occur in mid-July 2017. Numerous field visits were conducted to assess and document the injury. Yield effects from the dicamba damage was not as severe as expected. Label changes to dicamba occurred to reduce the potential off target movement of the soybean dicamba products.

Figure 5. Dicamba injury symptoms in soybean.

Update on corn and soybean diseases

Daren Mueller, associate professor, Plant Pathology and Microbiology and Extension crop plant pathologist, Iowa State University; **Alison Robertson,** professor, Plant Pathology and Microbiology and Extension crop plant pathologist, Iowa State University

Objectives

- Recognize tar spot of corn and understand management options.
- Realize QoI fungicides are ineffective against soybean leaf diseases because the pathogens have developed resistance.
- Be aware of a new web-based resource for corn and soybean pest management information.

Tar spot of corn

Tar spot is now present throughout most of Iowa. The map below shows the counties in which tar spot was observed in 2019. While the severity of tar spot in each county was low, especially in the central and western parts of the state, it is still important to know that inoculum may be present in most Iowa counties going into 2020. We are still learning the best management options, but there are hybrid differences and some fungicides can suppress disease.

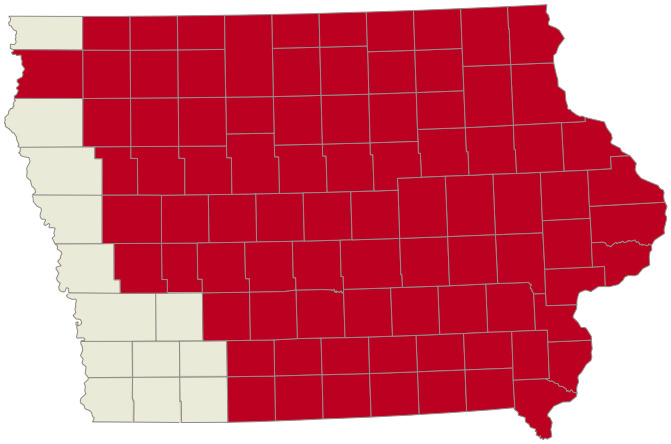

Figure 1. Iowa counties with obseved tar spot in corn, 2019.

Figure 2. Tar spot is recognized as small, irregular shaped, raised lesions scattered across the leaf. Photo by Adam Sisson.

Frogeye leaf spot

Fungicide-resistant strains of the pathogen that causes frogeye leaf spot was first found in Iowa in 2017. We conducted a state-wide survey of strains of the fungus in 2019 and found that EVERY isolate of the pathogen was resistant to the QoI (sometimes called strobilurins) fungicides. This confirms that the resistant strain of the pathogen is widespread in Iowa and this should affect your decision on which fungicides to use moving forward.

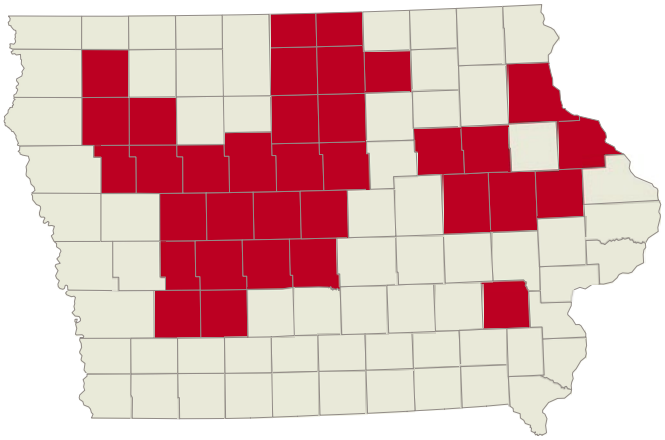

Figure 3. Iowa counties with with confirmed frogeye leaf spot resistance to QoI fungicides, 2019.

Crop Protection Network

Started in 2015, the CPN now serves as the infrastructure for corn, soybean, and small grain Extension outputs from a diverse set of collaborators across the United States. This network is primarily made up of individuals in land grant universities in the United States and closely related organizations in Canada, but includes other entities that contribute to agricultural Extension. Be sure to visit www.cropprotectionnetwork.org for resources on tar spot of corn, frogeye leaf spot of soybean, and fungicide efficacy information

Resources

Integrated Crop Management - Crop Diseases
crops.extension.iastate.edu/pests/diseases

Crop Protection Network
www.cropprotectionnetwork.org

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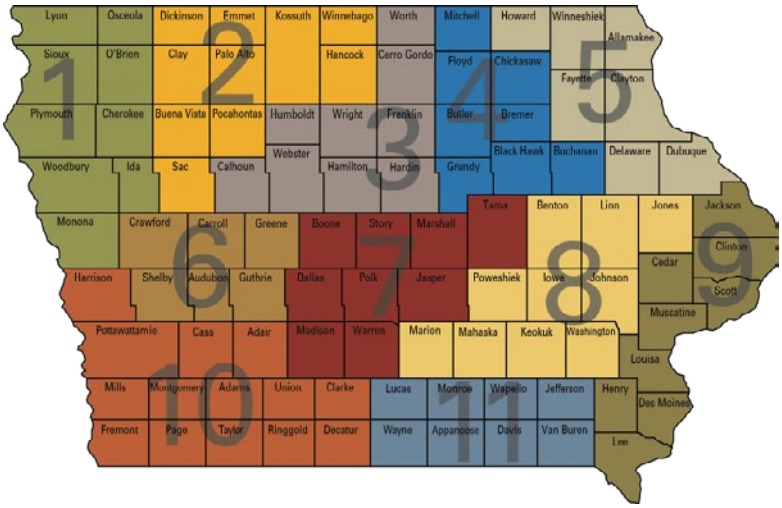
Extension and Outreach

Agriculture and Natural Resources

Field Agronomists

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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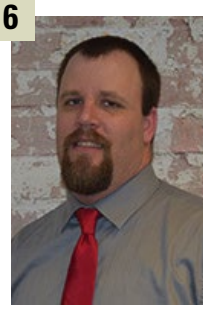

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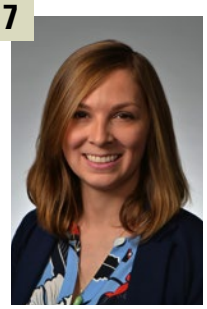

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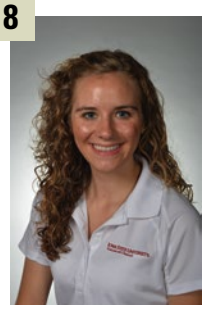

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