IOWA SOYBEAN
ASSOCIATION RESEARCH

2016 ANNUAL REPORT

ISA RESEARCH

IOWA SOYBEAN Association
Expanding Opportunities. Delivering Results.

1255 SW Prairie Trail Pkwy., Ankeny, IA 50023
515.251.8640 • iasoybeans.com

Partially funded by the soybean checkoff.

For more than 15 years, the Iowa Soybean Association Research teams have worked with farmers in their fields. The data captured from ISA's legacy work — coupled with active farmer engagement in annual projects — empowers farmers with information connected to their production systems, natural resources management and environmental quality. Since 2002, ISA has invested nearly ***$50 million in research*** projects by leveraging the soybean checkoff with federal, state and private funds. This supports ISA's mission to continuously improve the competitiveness of Iowa soybean farmers.

The maps on the following pages depict ISA's current and historical research activities across the state. In 2016, ISA research projects included 11 bioreactors, four saturated buffers, 33 conservation plans, 470 water monitoring sites, 79 field surveys, 448 guided stalk fields, 257 replicated strip trials and three watershed plans.

ELEVEN BIOREACTORS

FOUR SATURATED BUFFERS

33 CONSERVATION PLANS

470 WATER MONITORING SITES

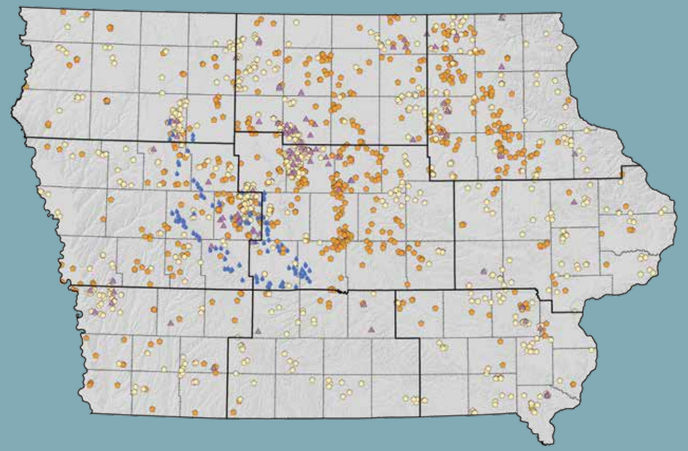
79 FIELD SURVEYS

448 GUIDED STALK FIELDS

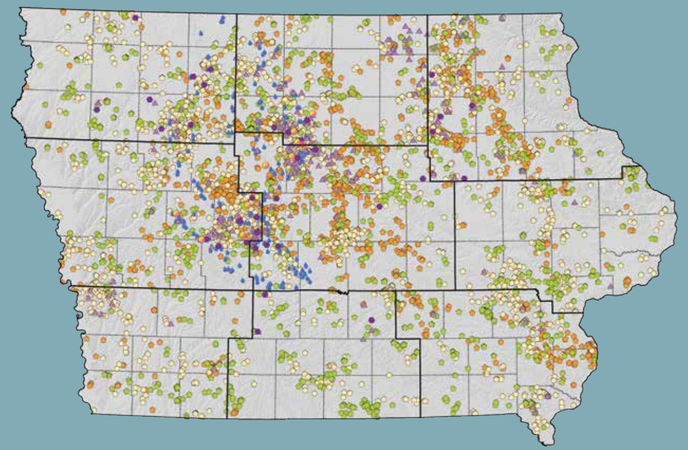
257 REPLICATED STRIP TRIALS

THREE WATERSHED PLANS

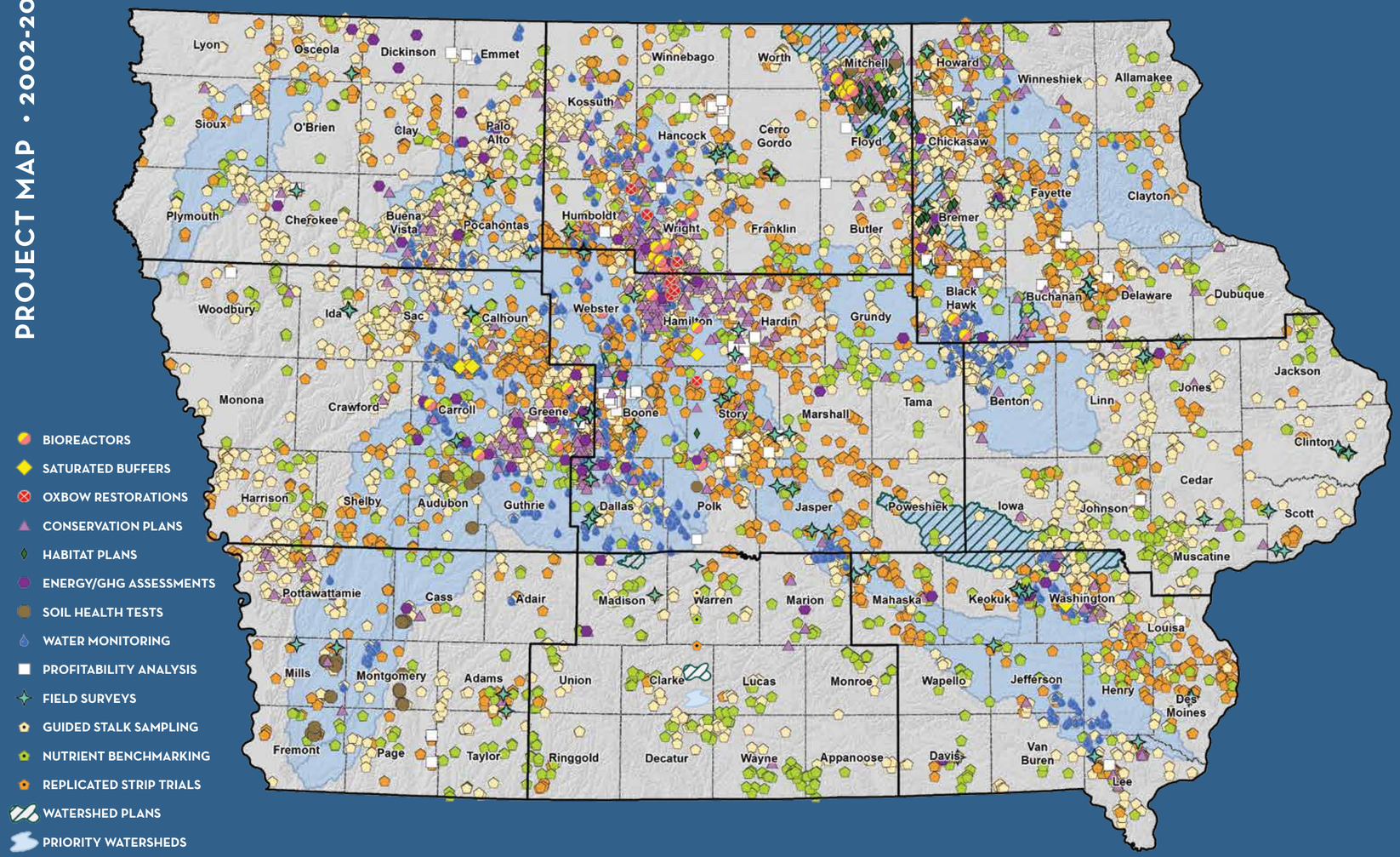
PROJECT MAP • 2002-2006



PROJECT MAP • 2006-2011



PROJECT MAP • 2002-2016



- BIOREACTORS
- SATURATED BUFFERS
- OXBOW RESTORATIONS
- CONSERVATION PLANS
- HABITAT PLANS
- ENERGY/GHG ASSESSMENTS
- SOIL HEALTH TESTS
- WATER MONITORING
- PROFITABILITY ANALYSIS
- FIELD SURVEYS
- GUIDED STALK SAMPLING
- NUTRIENT BENCHMARKING
- REPLICATED STRIP TRIALS
- WATERSHED PLANS
- PRIORITY WATERSHEDS

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OUR STAFF

RESEARCH COORDINATION

ED ANDERSON, PH.D., *Senior Director of Research*
SUE DERSCHEID, *Research Executive Assistant*
DAVID KURTH, *Research Program Coordinator*

ANALYTICS

PETER KYVERYGA, PH.D., *Director*
SUZANNE FEY, *Data Analyst*
BRAD WIRT, *GIS Specialist/Analyst*
CHRIS WILKINS, *Database Administrator/GIS Specialist*

ON-FARM NETWORK®

SCOTT NELSON, *Director*
NATHAN PAUL, *Operations Manager – Cropping Systems*
RICH STESSMAN, *Operations Manager – Agronomic Research*
ANTHONY MARTIN, *Regional Agronomist*
BRETT MCARTOR, *Regional Agronomist*
STEVE MAY, *Resource Development*

ENVIRONMENTAL PROGRAMS AND SERVICES

ROGER WOLF, *Director*
TODD SUTPHIN, *Senior Operations Manager*
HEATH ELLISON, *Operations Manager – Agriculture and Natural Resources*
ADAM KIEL, *Operations Manager – Water Resources*
CHRIS HAY, PH.D., *Senior Environmental Scientist*
KEEGAN KULT, *Environmental Scientist*
TONY SEEMAN, *Environmental Research Coordinator*
THEO GUNTHER, *Resource Management Specialist*
DIANE ERCSE, *Watershed Coordinator/Resource Management Specialist*
KARL GESCH, *Watershed Coordinator/Resource Management Specialist*
DAVE GRAHAM, *Water Lab Technician*

IOWA SOYBEAN ASSOCIATION

RESEARCH PROGRAM: *Independent and Integrated*

Welcome to the inaugural ISA Research Annual Report. Since 2002, the Iowa Soybean Association (ISA) research team, initially encompassing the On-Farm Network and Environmental Programs and Services (EPS) teams, has helped farmers improve their competitiveness by increasing productivity, profitability and sustainability.

The team has embraced the vision of our farmer board by building recognized and independent, unbiased programs focused on agronomics and conservation. Their efforts have brought great value to farmers across the state and region, in addition to advancing the soybean industry.

In recent years, we have added collaborative projects that explore in-field and edge-of-field opportunities for improved nutrient management, soil health, crop productivity and water quality. These projects allow all of ISA Research to work together to help farmers.

In addition to a more collaborative approach in the field, we realized the need to leverage our research data sets to bring greater value to our farmer members, partners and stakeholders. This led to the formation of the Analytics team in 2013. The ISA Analytics team contributes scientifically robust research protocols and statistically significant data analysis in addition to the clear interpretation of results.

Since research partnership opportunities extend well beyond ISA, we have invested time and energy to align our programs with other checkoff funded research projects. These consist of programs at Iowa State University — including the Iowa Soybean Research Center — other Midwestern universities, regional soybean research programs like the North Central Soybean Research Program and national programs supported by the United Soybean Board.

I believe you will enjoy reading about the variety of projects conducted by our ISA research teams. All of us hope you will recognize how our integrated research programs synergize with our contracted university research to bring maximum return on checkoff investments. We also leverage other funds and partnerships to increase the value added to soybean checkoff dollars. This gets us closer to our goal of enhancing the competitiveness of Iowa's soybean farmers while improving the broader agriculture industry and urban society.

Ed Anderson, Ph.D.,
Senior Director of Research

ISA RESEARCH

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Expanding Opportunities. Delivering Results.

THE ISA RESEARCH TEAMS work together to improve the productivity, profitability and environmental stewardship of all Iowa soybean farmers. The On-Farm Network implements farmer trials to test agronomic products and practices of cropping systems. The EPS team conducts environmental research and helps farmers install conservation and water quality practices. Using data collected from in-field and edge-of-field research, ISA Analytics interprets the results and develops decision-support tools benefiting farmers. The integration of the three teams has led to increased value and unbiased information for Iowa farmers, especially when combined with ISA checkoff-funded state and regional university research.

SOIL HEALTH: A ROLE FOR COVER CROPS

During the last few years, grower interest has increased in soil health and programs that promote and measure soil health improvements. Many farmers, working with ISA programs, have been eager to determine the effect of using various management systems on soil health.

ISA has conducted multiple cover crop studies to examine different measures of soil health. The first ISA project — completed this year — worked with 24 farmers in northeast and southwest Iowa who use cover crops. Samples were collected during two consecutive spring seasons at the same locations and then analyzed using the Haney soil health test.

Many effects of cover crops on production are small and difficult to quantify. Using the Haney test and repeating the sampling in two different Iowa landform regions, ISA researchers observed specific effects associated with rotation, cover crop growth and spring weather conditions. Since many of the measurements produced using the Haney test are more sensitive to management than traditional soil tests, gaining experience with the test results is important for developing knowledge of how to use the results to inform improved management decisions.

To build on this initial experience and small dataset, additional research trials were initiated through the ISA On-Farm Network to use this test with longer-term cover crop trials.

Beginning in the fall of 2016, 15 long-term multi-year cover crop trials were implemented in partnership with La Crosse Seed. Trials comparing cover crops versus no cover crop strips were established across the state using either a cereal rye or oat mix, pending crop rotation and the farmer's management preference. The trials were drilled, rather than flown on with an aerial applicator, to ensure establishment of the cover crop. Drilling also allows for accurate placement of cover crop strips in future years.

These trials will employ both the Haney soil health test and additional analysis from Midwest Labs to measure the effect of sustained use of a cover crop. These long-term trials will be helpful in understanding the small physical and chemical changes in soil properties that are difficult to observe without long-term commitment to the practice. Additional research will be conducted in partnership with Iowa State University to investigate the potential effect of cover crops on soybean cyst nematode (SCN) suppression.

While long-term trials are not expected to explain everything, they are comparable with other multi-state programs where the use of different soil tests to measure changes in soil health are being studied. Through cooperative research, these trials will help to determine if any of the small differences in soil measurements are observed consistently between locations. Also, the inclusion of these trial sites within the ISA research program network will provide locations to expand measurement and demonstration opportunities.

ISA researchers and cooperating farmers are just beginning to take these new measurements into the field to understand how they work as practical tools to help farmers improve their soil. Over the course of this study, ISA will accumulate thousands of soil samples from hundreds of cover-crop-treated acres to evaluate results at these sites.

By committing to these long-term studies, participating farmers are putting in place the opportunities to measure gradual changes over time and inform further improvements to the cropping system and the soils it relies upon.

DATA DRIVEN DECISION SUPPORT TOOLS

Together, corn and soybeans make up the Iowa row crop rotation. Technology allows farmers and researchers to collect more data about these crops than ever before, but without proper analyses, these data may not be as informative as farmers think.

With this in mind, the ISA research teams are trying to maximize the value of data collected by farmers for agronomic and environmental assessments in order to enhance decision making for their overall farming operation.

Online nitrogen risk app

To help farmers calculate the risk of late-season corn nitrogen deficiency, the ISA On-Farm Network and EPS teams developed an app using data collected from roughly 4,000 corn fields during the last 10 years as part of the annual nitrogen status survey with late-season aerial imagery.

The tool incorporates real-time, localized, May through June rainfall observations and allows farmers to estimate the risk of end-of-season deficiencies in corn nitrogen status (Fig. 1). A user can select a field location on the map, enter information about the previous crop, nitrogen timing, form and rate of application. The risk probabilities produced by the calculator can then be used to develop "what-if" projection scenarios that can aid decision making about in-season fertilization using daily, actual rainfall values.

Within-field profitability assessment

Production costs, grain prices and yield all affect profitability — but what about soil, management and weather?

To generate within field profitability maps, the research teams used historical yield, crop prices and the input cost data from 144 fields (550 site-years) across Iowa surveyed between 2006 and 2014. The time series profitability maps then were analyzed to identify how different cropping systems, soil properties and rainfall impact within-field profitability.

Analyses showed, for example, that within the Des Moines Lobe, profitability was affected by the presence of poorly drained pothole areas as well as by early season rainfall (Fig. 2. on page 13). The pothole areas were estimated to have a greater risk of negative profit, especially for corn fields with above average spring rainfall.

On the Iowan surface landform in eastern Iowa (Fig. 2, page 13), within-field profitability also was affected by soil drainage. But unlike in central Iowa, excessively drained areas tended to have lower profits and early season or spring rainfall had no effect on profitability.

Similar analyses will aid in the development of risk assessment tools that can help farmers target the least profitable areas within their fields and enable them to change specific management practices or cropping systems to reduce losses and improve profits.

Assessing the risk of excessive nitrate accumulation in tile water

As Iowa puts more emphasis on improving water quality, ISA is working in conjunction with Iowa State University (ISU) researchers to study the mechanisms, processes and associated risk of observed high nitrate concentrations in drainage tile water. The idea is to feed field observations into modern cropping systems modeling tools and predict conditions with a relatively high or low risk of excessive water nitrate concentration.

In 2016, the ISA staff worked with farmers to install soil sensing equipment in plots with and without cover crops. The equipment was installed in fields with a history of monitoring tile drainage water.

Hourly soil moisture and temperature data are collected year-round and additional measurements of soil mineral nitrogen, soil texture, soil total carbon, total organic nitrogen and cover crop biomass dry matter are collected during the growing season.

ISU researchers are helping to calibrate a crop systems model that simulates the whole cropping system, including numerous soil, hydrologic and plant processes simultaneously. Data from approximately 200 water monitoring sites surveyed during the last two years by ISA EPS will also be used in calibrating the cropping systems model and developing risk evaluation tools for farmers to use in the future (Fig. 3, page 14).

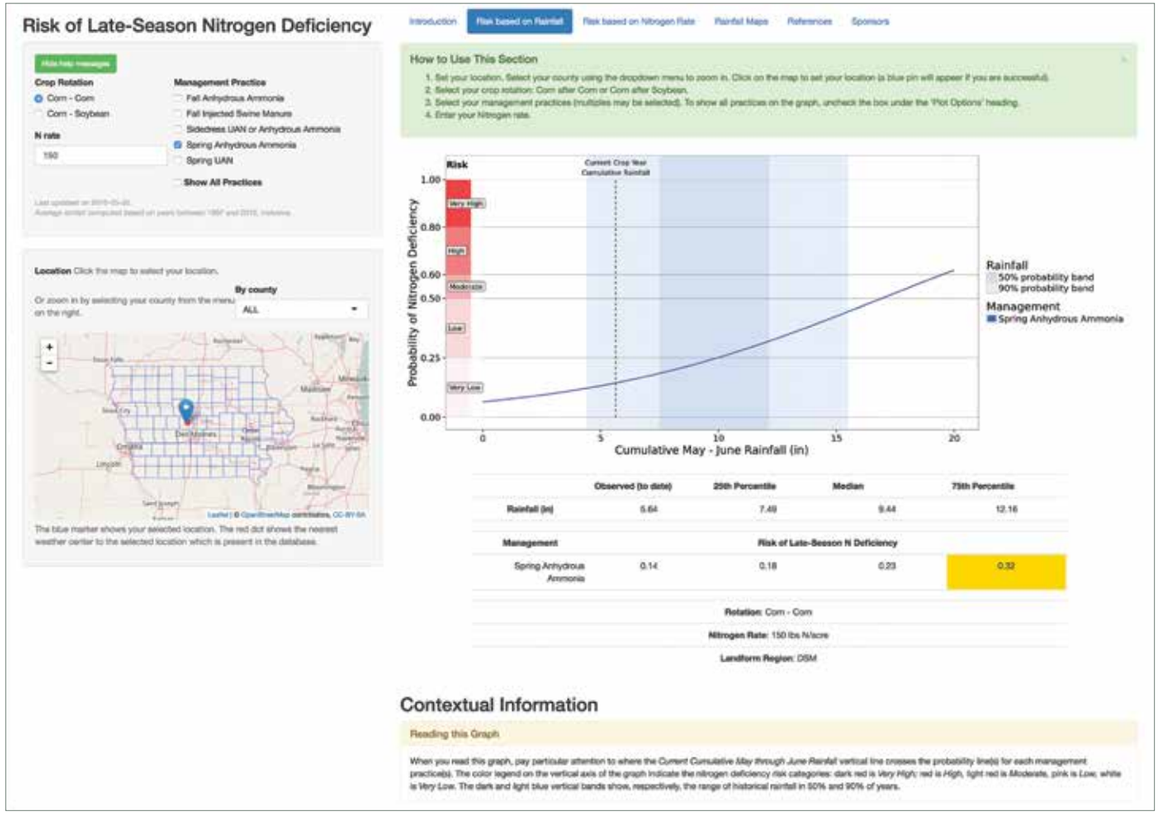


FIG. 1. A general overview of the on-line nitrogen risk app (calculator) developed from data collected in annual nitrogen status surveys of 4,000 corn fields sampled between 2006 and 2015. The scientific rationale behind the risk calculator was recently published in the Climate Risk Management Journal.

WITHIN-FIELD PROFITABILITY ASSESSMENTS

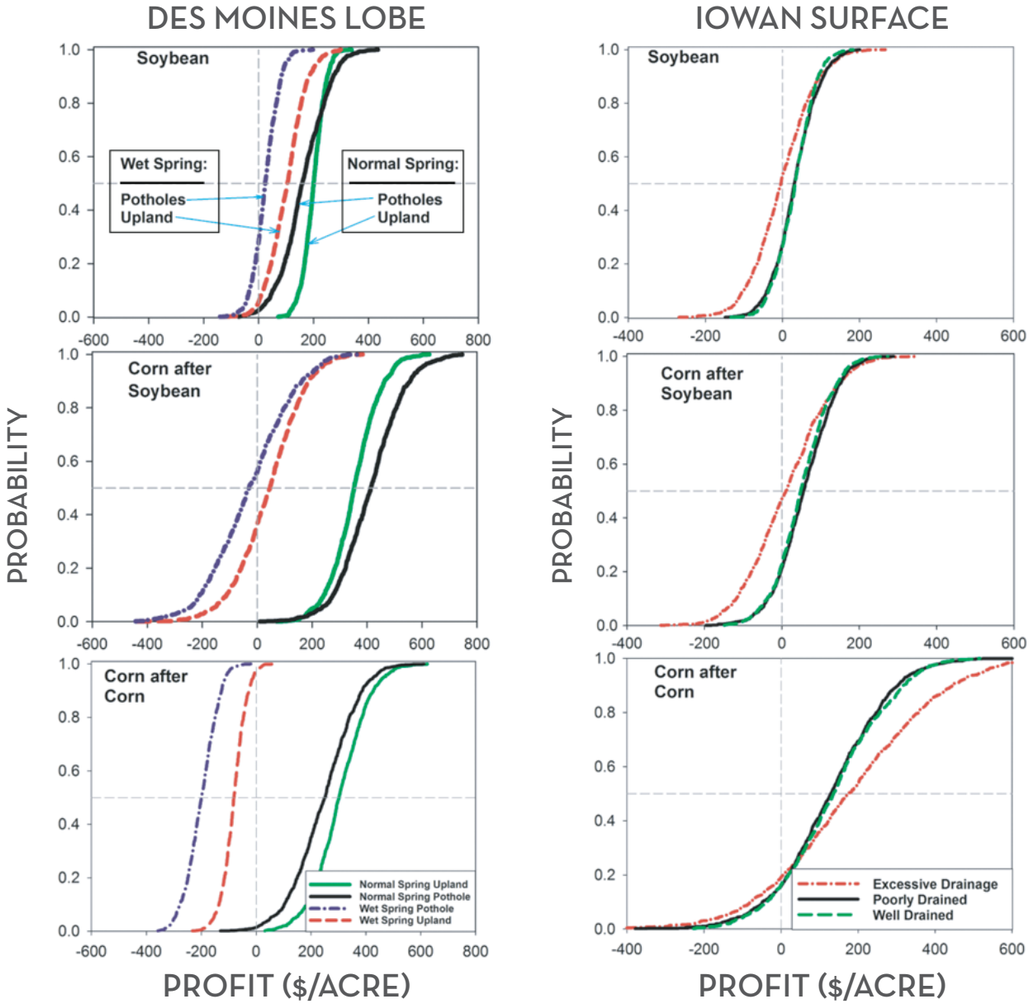


Fig. 2. Examples of quantifying the effect of poorly drained pothole areas and early season rainfall on field profitability in the Des Moines Lobe (left) and examples of quantifying the effect of drainage on profitability in Eastern Iowa (right). For any given comparison line, the probability of below break-even profit is estimated by drawing an imaginary horizontal line from the intersection of the zero line with the drainage category lines to where it crosses the probability values on the vertical axis. For example, the approximate probability of at or below break-even profit for corn after soybeans in Eastern Iowa, is 20 percent for the poorly drained areas and 50 percent for the excessively drained areas (middle graph, right side).

Modern modeling tools can be used simultaneously with on-farm observations to analyze information on soil, climate, crop and management for individual fields over time.

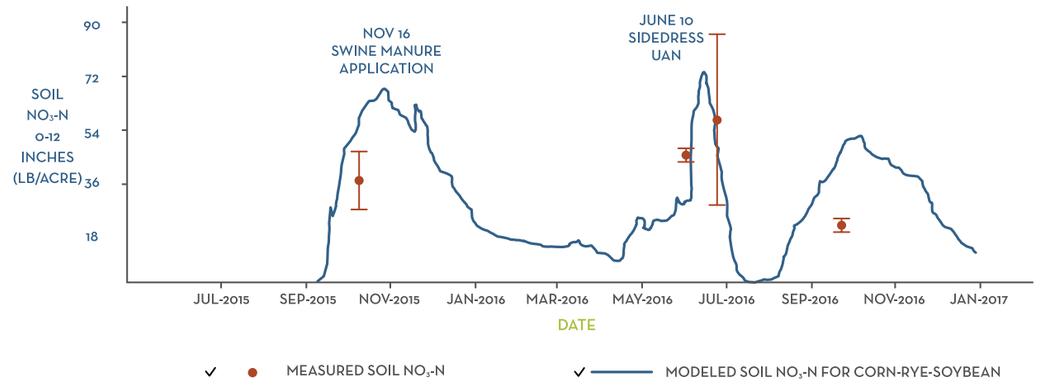
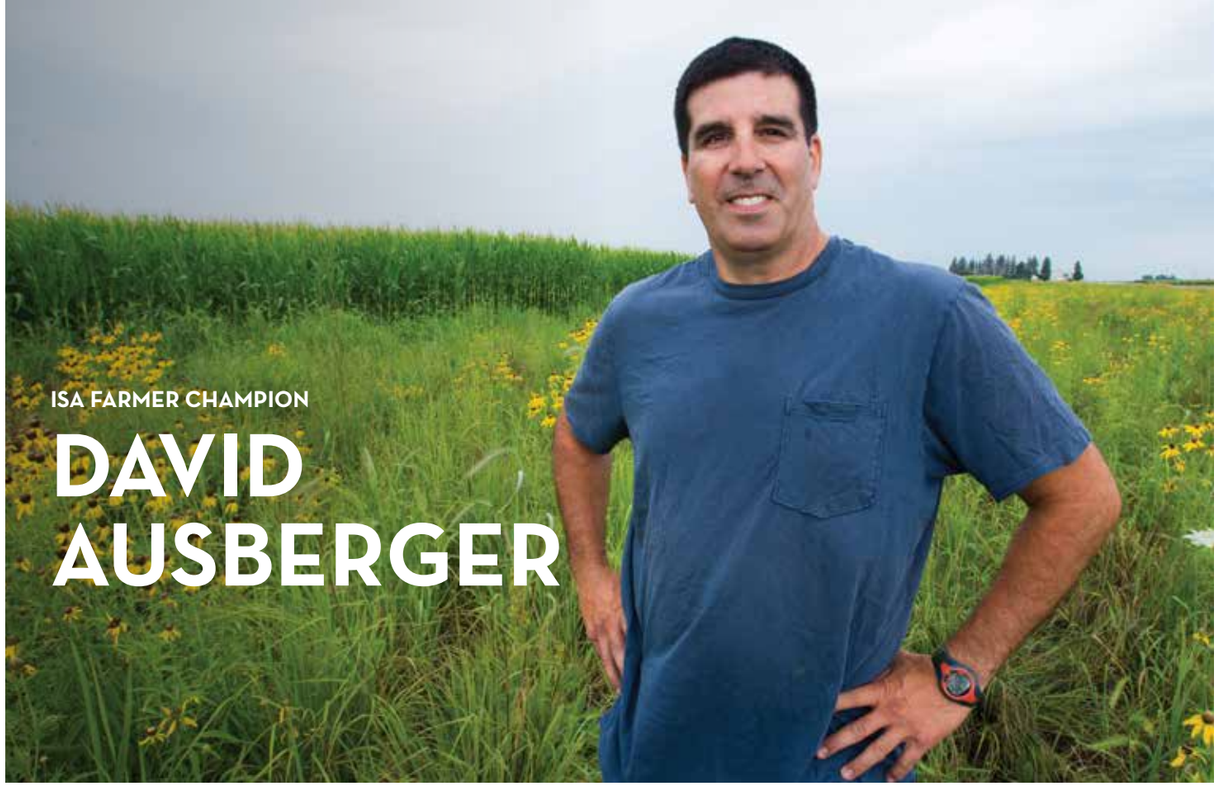


Fig. 3. The Agricultural Production System sIMulator model (APSIM) output with observed and predicted soil nitrate (lb/acre) values for a field with winter rye planted after soybean. The vertical bars are 90 percent confident intervals for the observed averages. During model calibration, the predicted values are compared to the observed nitrate values. The predicted values show variation in soil nitrate that may help to identify the risk of nitrate loss.



CONFIDENT IN ISA CONCLUSIONS

Long before Jefferson farmer David Ausberger got involved with the ISA Research and conservation programs, his father instilled in him the values of taking care of the land.

"Dad started me on conservation when he was younger than I am now," Ausberger said. "That's how we've always done it."

It wasn't until Ausberger got involved with water quality work through the West Buttrick Creek Watershed Project, that he was introduced to the ISA Research team.

"At first I thought I was doing it to help them out, but I soon realized I was getting the good out of it," Ausberger said. "Now with the database, I can see other people are getting good out of it and applying it to their operations."

One of the greatest benefits Ausberger sees from working with ISA Research is how different it is. Unlike university or other research, results collected by ISA come from farmers' own fields, farmers' own equipment and their own management practices. Collecting farmer-specific data is critically important to improving his or her decision-making ability.

Although he started working with ISA to write a nutrient management plan and conduct replicated strip trials with the On-Farm Network, he has since become involved with all of the teams. Ausberger has worked with the EPS team completing tile water monitoring and nutrient benchmarking on his farm and has worked with the Analytics team to use data aggregated from other farmers to improve his management practices.

Among other things, Ausberger is currently involved in trials comparing nitrogen rates, investigating alternate fertilizers and monitoring tile water. One of the more unique projects he is working on explores the nitrogen-holding benefits of cover crops through water monitoring feedback.

While his father may have introduced him to the world of conservation, Ausberger considers his relationship with ISA Research incredibly beneficial. He has even joined the ISA Research Advisory council to help guide the future of research at ISA. "It's something I can hang my hat on," Ausberger said. "It's a third party without a dog in the fight. If they say something works, I can feel confident that it'll work on my operation."

CONSERVATION CONSCIOUS

Professionals invest countless time and energy perfecting their craft — farmers are no different.

Bothered by the soil erosion on his farm, La Porte City farmer Nick Meier transitioned all of his acres to no-till and strip-till more than 25 years ago. Since then, he has continued to expand his conservation efforts.

Focused on daily farming activities, Meier relies on his crop consultant, the local Natural Resources Conservation Service and Soil and Water Conservation District as well the ISA for additional conservation opportunities.

More than 15 years ago, Meier participated in nitrogen rate trials with the ISA On-Farm Network to determine the optimal rate for his crop. He continued rate trials for several years and added guided stalk sampling to further understand his crop's nutrient needs.

At the same time, he was involved in an ISA EPS project to help farmers establish an environmental management framework that addresses resource concerns on his operation.

"We need to keep up-to-date on the new practices available to continue to keep our farm operations profitable," the third generation farmer said.

Through these projects, Meier improved his nutrient management, and in some cases reduced his nitrogen rates.

More recently, Meier — an active participant in the Miller Creek Water Quality Initiative project — added cover crops and edge-of-field practices to his conservation program.

He installed a saturated buffer and bioreactor to further reduce nutrient loss from his farm. ISA collects water monitoring data to evaluate the performance of each practice. On average, Meier's bioreactor has reduced nitrate levels by 55 percent in the water moving through the woodchip trench. From January through July 2016, his saturated buffer — which treats approximately 120 acres — has removed 34 percent of the tile water nitrate. This fall, Meier will begin the first year of a multi-year ISA cover crop trial to evaluate benefits beyond water quality.

"By incorporating new conservation methods we're not only benefiting ourselves, but also future generations," Meier said. "In addition, the bioreactor and saturated buffer are having a positive effect on water quality. I hope to see the same favorable soil health benefits with the 5-year cover crop trial."

Meier encourages other farmers to use available resources to learn more about their operations and get involved in conservation.

"We have to get more farmers involved," Meier's said. "It's beneficial for farmers to be proactive with future soil and water conservation practices. The ISA research teams are a valuable resource to improve our soil and water quality. It's been a good experience for me."

Iowa Soybean Association
On-Farm Network®

THE ON-FARM NETWORK collaborates with the other ISA research teams, university researchers, companies and government organizations on a wide variety of topics aligned with issues farmers care about, including pest and nutrient management, planting populations, cover crops, soil health and improved agronomics and cropping systems through the independent and unbiased evaluation of products and practices. These relationships allow the On-Farm Network to provide data for soybeans, corn and the corn/soybean rotation system, as a trusted third-party source to enhance farmers' management decisions in efforts to improve profitability and environmental stewardship.

NUTRIENTS: EVALUATION OF NITROGEN MODELING/PRESCRIPTION TOOLS

While crop modeling is not a new idea, the latest industry innovations are focused on utilizing crop modeling for site-specific nitrogen prescriptions. In 2016, the ISA On-Farm Network conducted on-farm replicated strip trials evaluating the Climate FieldView Nitrogen Advisor (FieldView).

The FieldView tool generates a modeled range of how much nitrogen should remain at the corn black layer growth stage for each field by utilizing management, field information and weather data. Observed weather is used for model simulations until the application dates. Weather predictions for the following two weeks are used to simulate plant growth and soil nitrogen dynamics. After this period, remaining crop and soil simulations through the end of the season are based on historical weather from the same field location.

To evaluate the tool, sidedress application rates were estimated by running different nitrogen rates through the model until the estimated end-of-season soil nitrogen content or balance was close to zero. These estimated rates, intended to represent the maximum crop nitrogen use efficiency, were then compared to the participant's normal nitrogen practices. Some farmers accepted the estimated rates easily while others were skeptical, especially when the estimated rates were lower than their original sidedress application plans.

The prescribed nitrogen rates by FieldView ranged from 30 to 80 lbs/acre lower than farmers' normal rates. This reduction was partially due to lower than average nitrogen losses in May and June. In fact, many trial locations in 2016 had below normal rainfall before the sidedress applications. Following these applications in July and August, many of the trial locations received excessive rainfalls, creating favorable conditions for higher yield potentials with larger corn nitrogen demands.

Yields for the farmers' normal sidedress rates were slightly higher (except one) than those for the rates predicted by the tool. However in many of the trials, due to cost savings from the reduced nitrogen rates, the economic return from the prescribed rates by the tool were almost the same as from farmers' normal rates.

While weather conditions in 2016 may not have been ideal for this tool to perform, the described studies provided good examples of the complexities of using commercial crop modeling tools for nitrogen management in Iowa. Working with groups of farmers to evaluate similar commercial and public modeling tools should help farmers make better decisions by using site-specific weather, soil and management information.

AGRONOMICS: PEST SURVEYS

When it comes to pest management, results from field surveys provide farmers with critical decision-making data to inform seed and crop protection companies on product placement and product development decisions. For the past three years, ISA has expanded its survey work studies to include some of the key pests of corn and soybeans.

Soybean Cyst Nematode Survey

Since 2014, the ISA On-Farm Network has conducted soybean cyst nematode (SCN) surveys with the goal to inform farmers of the SCN levels present in their fields. By knowing cyst numbers and field survey profiles, farmers can make more educated input decisions. A secondary goal was to determine whether or not specific practices or geographies were more prone to higher numbers of cysts.

In the first year of the survey, soil samples were collected once in 72 fields when other data were being collected for existing trials. For the second and third years of the project, the protocol changed to improve the quality of the survey. In the latter years, four background soil samples were taken at each survey location and sent to Iowa State University (ISU) for analysis.

In the spring of each year, a composite sample (about 20 acres) as well as a point sample (25-foot radius from point) were taken, followed by another composite and point sample in the fall. More than 100 locations were sampled in the second and third years of the survey.

Results have varied by year with 90 percent of fields tested having an SCN presence of SCN in 2015, but much lower prevalence in 2016. (Figure 1) ISA and ISU researchers are seeking to understand the significance of this drop in SCN presence in 2016. Additional testing in 2017 is necessary. SCN populations stayed about the same from spring to fall in fields planted to corn, and populations increased by about 250 eggs/100cc soil when the current crop was soybeans. Locations without SCN resistance varieties had the largest increase in SCN populations during the growing season.

Corn Rootworm Survey

Continuing survey work in 2016, the On-Farm Network coordinated a statewide survey — in partnership with Monsanto, AMVAC and ISU — to determine levels of corn rootworm (CRW) beetle populations present in fields.

The team deployed sticky traps in more than 180 fields to measure CRW pressure and to determine the regions of the state facing the greatest risk. Farmer management practices also were analyzed to determine how traits and rotations affect beetle populations.

Many of the fields sampled were in first year corn allowing the detection of northern CRW soybean variants in the state.

The data from the survey showed the highest numbers of CRW beetles have consistently been in the eastern, northern and central part of the state, with several locations having more than 100 western CRW beetles per trap per week. The CRW threshold set by ISU is two beetles per day or about 14 beetles per week, meaning some of these fields had more than seven times the threshold.

East central Iowa had the highest occurrence of fields with western CRW above threshold with about 25 percent of fields having more than the 14 beetle threshold set by ISU. Northern, central and northeastern Iowa also had fields above the threshold for both northern and western CRW. If farmers have fields above threshold there should be a change in their management strategy for the next year. This could include switching to soybeans or switching the traits being used to control CRW.

The On-Farm Network will continue to identify and quantify key pests such as SCN and CRW in the future. ISA recognizes that many farmers use both soybeans and corn as part of their rotation. To provide the best and most needed data to farmers, corn research is conducted with corporate partner support and Integrated Farm and Livestock Management funds.

SCN EGG COUNTS IN ISA SURVEYS FROM 2014-2016

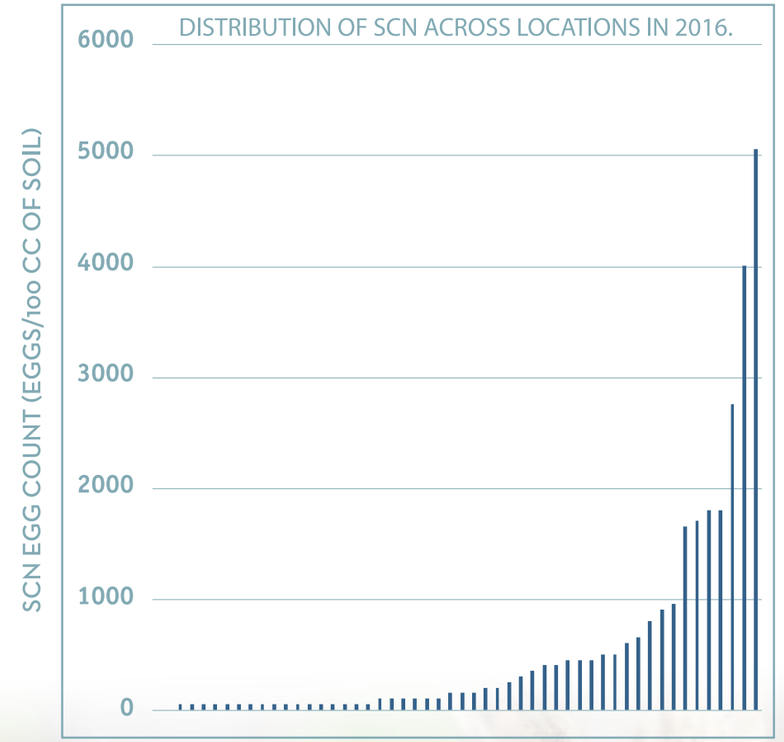
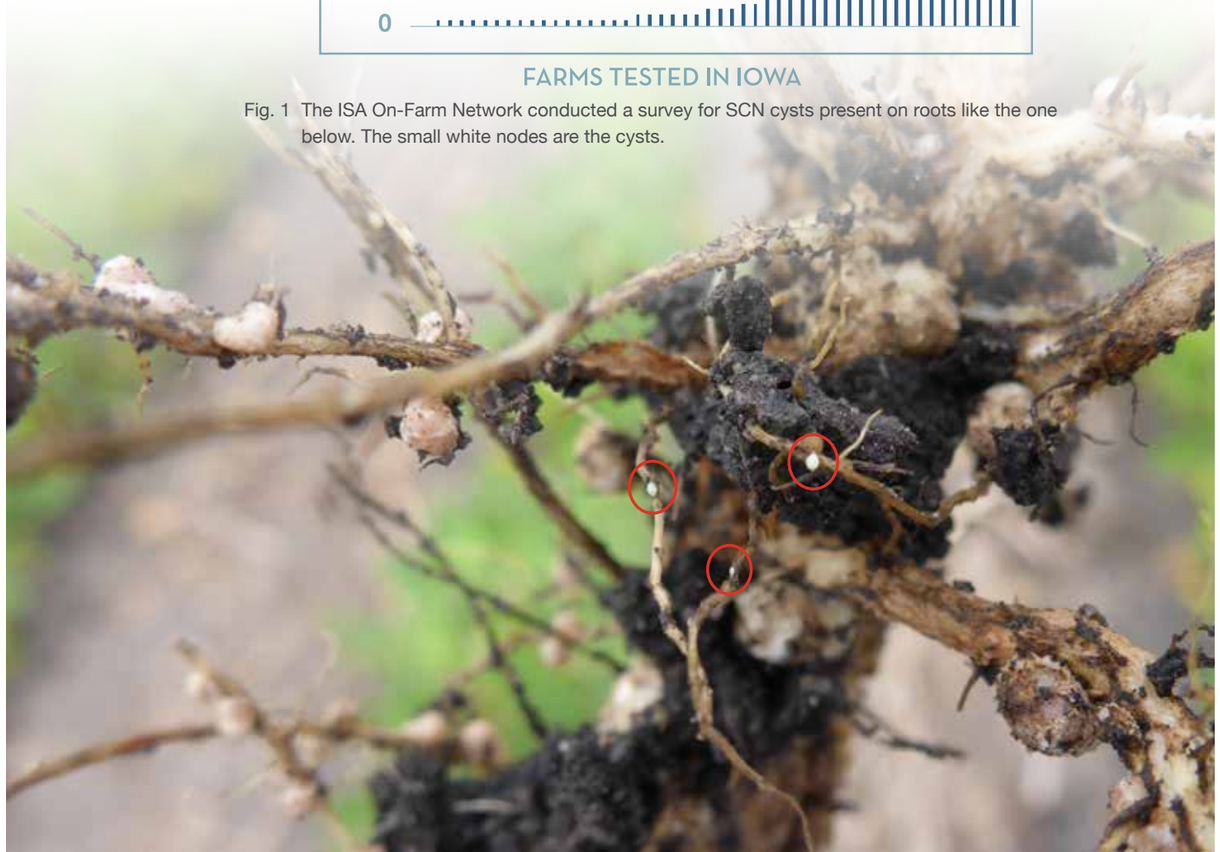


Fig. 1 The ISA On-Farm Network conducted a survey for SCN cysts present on roots like the one below. The small white nodes are the cysts.



PEST MANAGEMENT: EVALUATING SEED TREATMENTS

The number of seed treatment options for soybeans has increased dramatically over the past 10 years. These options include insecticides, fungicides, nematicides, polymers, inoculants and biologicals. To help farmers understand the value of these products, the On-Farm Network has an ongoing project to characterize the most promising seed treatment options. The following is a review of results from three new seed treatments. Results from other seed treatment testing can be found in the On-Farm Network Replicated Strip Trial Database on the website.

Clariva®

Clariva, a biological nematicidal seed treatment, was tested from 2014 to 2016. In the on-farm and small plot trials, this product showed significantly less reproduction of soybean cyst nematode (SCN) than the treatment without Clariva. When compared to a no-Clariva check, yield per responses to Clariva ranged from 0 to nearly 5 bushels per acre across 33 On-Farm Network sites.

ILeVO®

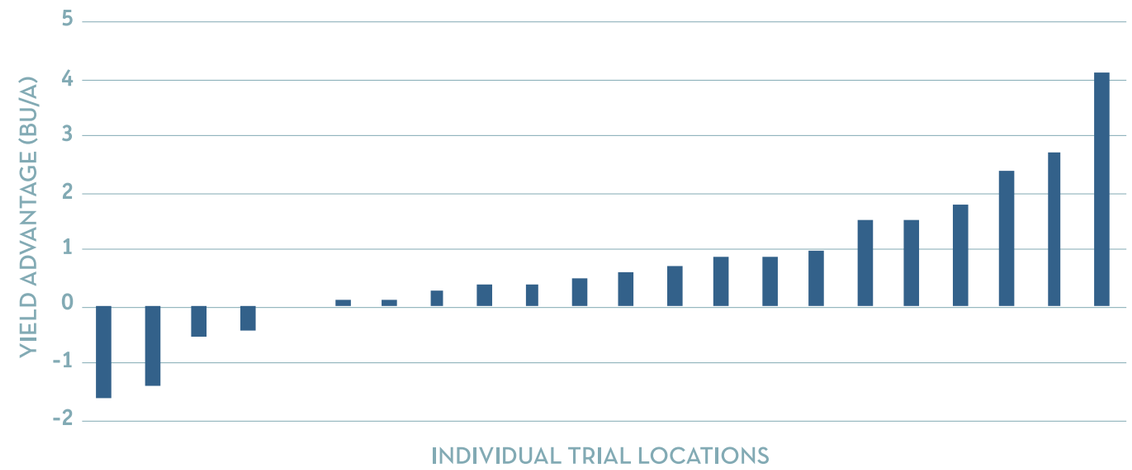
ILeVO, a fungicidal/nematicidal seed treatment, was tested in 2015 and 2016. This product has primarily been marketed for protection against sudden death syndrome (SDS). A limited number of trials had significant SDS pressure and those fields saw a significant reduction in SDS. In addition to protecting against SDS, this product resulted in a 32percent reduction in SCN egg counts. When compared to a no-ILeVO check, yield responses to ILeVO ranged from 0 to 4 bushels per acre with 73 percent of sites showing a positive response (Figure 1).

Intego™

Intego contains a new fungicide, ethaboxam, that is being introduced to the seed industry under various trade names. It has a unique mode of action to control common pathogens like *Phytophthora* or *Pythium*. In On-Farm Network trials, Intego treated seed was compared with seed treated with a base treatment not containing ethaboxam (Innovate). Results indicated a 0 to 6.1 bushels per acre response depending upon the level of *Phytophthora* and *Pythium* pressure in the fields.

In 2017, the On-Farm Network will continue to provide accurate third-party assessments of new technologies and help farmers make informed decisions on the most economical and effective crop protection inputs.

FIGURE 1. YIELD ADVANTAGE FOR ILEVO SEED TREATMENT ACROSS LOCATIONS.



Iowa Soybean Association

Environmental Programs & Services

THE ENVIRONMENTAL PROGRAMS AND SERVICES team is action oriented and science-and data-driven to help farmers with decision-making. EPS's primary strategy is to improve natural resource management practices and environmental quality while improving the competitiveness of Iowa soybean farmers. The team features experts in watershed planning, water monitoring, conservation planning and conservation drainage. Working closely with farmers and through engagement with the government agencies, non-government organizations and companies, the EPS team provides research, information and technical assistance to help Iowa make progress in achieving the goals of the nutrient reduction strategy.

WATER MONITORING: ISA WATER LAB STAYS FLUID

In its sixth year of operation, the ISA's water laboratory continues to serve agriculture's desire for water monitoring at the field, farm and watershed scale.

The lab, which is certified by the Iowa Department of Natural Resources, analyzed a total of 3,868 samples for nutrients between January 1, 2016 and October 1, 2016. Of the samples analyzed, more than half came from drainage tiles. Another 34 percent were from streams and rivers and the remaining 10 percent measured the effectiveness of conservation practices such as bioreactors, oxbow wetlands and more.

This year, the popular tile monitoring program continued to grow. In addition to monitoring water quality, ISA staff work with farmer participants to gather field management data from the tile drainage area each fall. The management data — such as crop, tillage practices and nutrient application rate — help develop meaningful information for farmers to use when making conservation and agronomic decisions. Monthly reports are sent to participants, but it is the year-end report which provides the most content. Farmers are shown how their results compare to others statewide and how water from their cropping system compares to similar and different systems. Additionally, suggestions to modify the cropping system or water quality practices are made based on the results.

Scaling up from the field level, streams and river monitoring help ISA and partner organizations prioritize water quality improvement projects. Along with Agriculture's Clean Water Alliance (ACWA) and other partners, ISA continues to target water quality improvement practices to subwatersheds showing the greatest need for improvement.

The latest example is the Elk Run Watershed in Carroll, Sac and Calhoun counties. This watershed has continually shown higher than average nitrate levels in the Raccoon River Watershed. In 2015, ACWA began a project working with local farmers and landowners to demonstrate and implement bioreactors, saturated buffers, cover crops and other water quality practices.

At the watershed scale, ISA continues to engage with the Iowa Department of Agriculture and Land Stewardship's Water Quality Initiative (WQI) projects around the state. The ISA lab analyzed samples for the Benton/Tama, Miller Creek, Boone, Van Zante, Crooked Creek, Lower Skunk River, Walnut, Elk Run, Rock Creek and Bluegrass/Crabapple WQI projects. Additionally, ACWA, Practical Farmers of Iowa, The Nature Conservancy, Smeltzer Farm Trust and other groups had samples analyzed at the ISA lab.

Water monitoring has allowed ISA and its partners to target limited funds to areas of highest need, track water quality improvements from fields and watersheds and has placed ISA at the forefront of the water quality dialogue in Iowa.

WATERSHED PLANNING: SCALING UP THE IOWA NUTRIENT REDUCTION STRATEGY

Water quality improvement at the scale called for in the Iowa Nutrient Reduction Strategy (INRS) is a monumental task. Watershed plans provide action plans to meet nutrient reduction and other goals.

The goals of the INRS include 45 percent reductions in nitrogen and phosphorus loads in Iowa's waterbodies. Cost estimates for fully implementing the strategy for agricultural land range from $1.2 billion to $4 billion in initial investment, plus $77 million to $1.2 billion annually. These amounts can be difficult to translate to the scale of small watersheds and individual farms. Watershed planning allows local stakeholders to create a detailed vision for implementing the INRS in their watershed.

A watershed plan identifies water quality and natural resource goals and recommends the best approaches to achieve them. A detailed implementation strategy can help watershed stakeholders to efficiently allocate available funds to maximize benefits per dollar invested. As Iowa turns the corner from demonstration projects to statewide INRS implementation, watershed planning will be key to scaling up the strategy by increasing implementation efficiency.

Additionally, watershed planning can increase the cost efficiency of water quality investments by establishing detailed guidelines for implementing conservation practices in a watershed. Watershed plans with specific recommendations focus funds, outreach and technical assistance to key sites in a watershed to maximize water quality improvement. Watershed plans also can open the door to conservation funding from multiple and diverse sources.

The Rock Creek Watershed in Mitchell County has demonstrated this "plan the work, work the plan" approach. In 2013, the ISA led the watershed planning process for the Rock Creek Watershed with input from local farmers and conservation experts. The resulting plan was one of the first in Iowa with watershed goals to meet the INRS nonpoint source goals of 41 percent nitrogen reduction and 29 percent phosphorus reduction.

The Rock Creek Watershed plan recommends practices for both specific locations and for all cropland within the watershed at the levels needed to achieve water quality goals. Grants in 2014 and 2015 provided funding for in-field and edge-of-field practices identified in the plan. Through 2016, farmers have planted cover crops on 3,600 acres in the watershed and have installed or completed designs for nine bioreactors.

ISA and partners have expanded this approach of watershed planning to advance implementation to more watersheds. In 2015, ISA led plan development for the Miller Creek and the Benton/Tama watersheds. This was the first step of the Middle Cedar Partnership Project led by the city of Cedar Rapids. In 2016, ISA worked with farmers and conservation leaders to develop plans for the Lime Creek Watershed in Buchanan County and the Headwaters Cedar Creek Watershed in Pocahontas County. In each of these watersheds, stakeholders adopted both INRS and local goals.

Agricultural Conservation Planning Framework

ISA uses the Agricultural Conservation Planning Framework (ACPF) watershed planning tool to identify potential locations for practices that will contribute to watershed goals.
The ACPF mapping tools use terrain, soils and land use data to locate suitable sites for conservation practices that treat drainage water, control runoff and improve stream corridors.

The INRS provides an overall framework for water quality improvement, but every watershed is unique. Watershed planning links state goals to local goals by customizing a strategy to meet both. This connection is critical. Experience has demonstrated the watershed planning process increases stakeholder recognition of the level of local effort needed to meet INRS goals. Such realization can serve as a call to action.

To develop useful and valuable watershed plans, ISA applies the best science and uses cutting edge technologies and methods. One such tool is the Agricultural Conservation Planning Framework (ACPF). The ACPF is a mapping tool recently developed by the National Laboratory for Agriculture and the Environment in Ames. ISA used the ACPF tool in 2016 watershed planning for the Lime Creek Watershed and the Headwaters Cedar Creek Watershed.

ISA integrates ACPF results, local goals and practice preferences, data from the INRS science assessment and economic information to prioritize practices, identify their ideal locations and determine necessary implementation levels for each watershed plan. This approach ensures data driven watershed planning while maintaining local values.

ISA will continue to use the best available watershed planning tools and technologies along with the most recent data on the cost efficiencies of nutrient reduction practices. This will help public and private funders ensure water quality funds are efficiently allocated. ISA continues to advance the INRS through watershed planning to streamline the scaling up of water quality practice implementation.

CONSERVATION DRAINAGE

Subsurface (tile) drainage is an important contributor to crop production in Iowa, but it also provides a pathway for loss of nitrogen from cropland. Conservation drainage is an emerging set of practices designed to maintain the benefits of agricultural drainage while addressing water quality and flow impacts.

Conservation drainage is a critical part of the Iowa Nutrient Reduction Strategy (INRS) for reducing nitrogen losses into Iowa waterbodies. Practices promoted as part of conservation drainage include in-field nitrogen management, cover crops, edge-of-field and drainage system practices as well as land use changes. Practices vary in their nitrogen-reduction effectiveness, site suitability and cost. No single practice can meet the goals of the INRS on its own, so it will take a combination of practices across multiple scales to reach target nutrient reductions.

Edge-of-field and drainage systems will play particularly important roles for cropland with subsurface drainage. Edge-of-field options include bioreactors, saturated buffers, wetlands, shallow drainage and controlled drainage (or drainage water management).

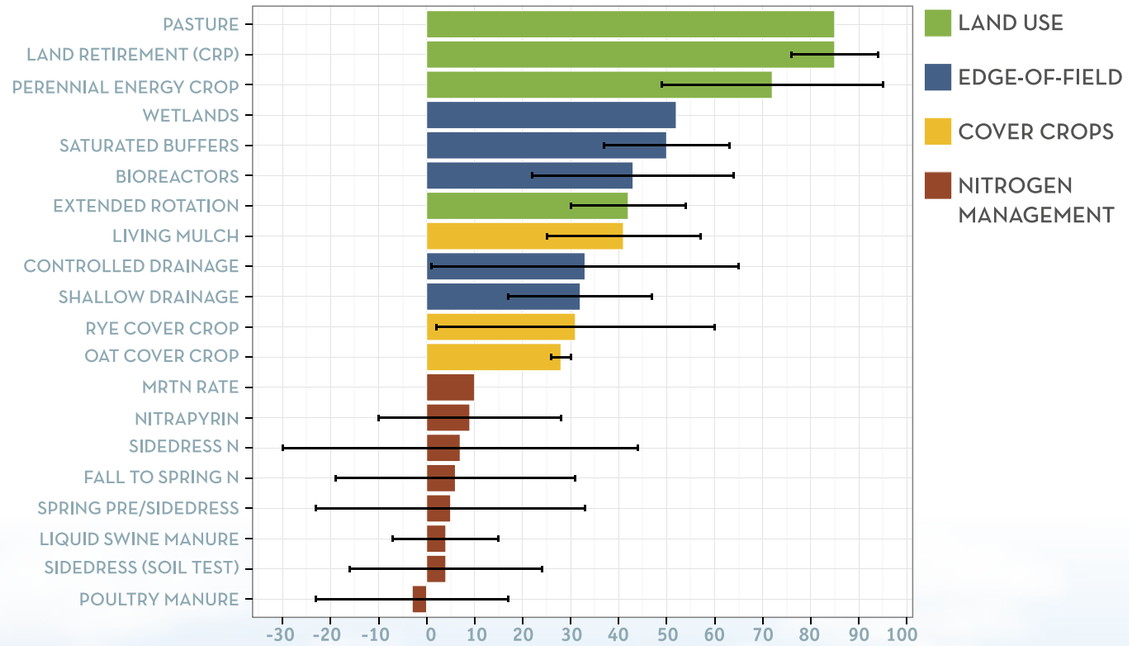
As the accompanying figure illustrates, edge-of-field and conservation drainage system practices (blue bands) have some of the best performance for nitrogen reduction short of land use conversion. With the exception of drainage water management, which is highly dependent on weather, edge-of-field practices generally have less variability (uncertainty) associated with their performance than other INRS options such as nitrogen management and cover crops. Finally, edge-of-field practices are some of the most cost effective strategies for nitrogen reduction with equalized annual costs of just over $1 per pound of nitrogen removed.

In 2016, the pace of new edge-of-field installations picked up in Iowa. ISA focused efforts in the Elk Run and Rock Creek watersheds, as well as contracting with the Iowa Department of Agriculture and Land Stewardship (IDALS) to facilitate site determination and design. Three bioreactors and two saturated buffers were installed in ISA's watersheds of focus with an additional 13 practices planned.

ISA has already been contracted for 12 research sites as part of the IDALS edge-of-field project which began in June. An innovative saturated buffer system connecting seven outlets into three separate distribution lines was installed at the farm of ISA District Advisory Council member Tom Vincent as part of the IDALS project.

ISA remains in the forefront on edge-of-field practices in Iowa, and it is encouraging to see the pace of installations increase. In order to meet the ambitious goals of the INRS, the pace and scale of conservation drainage adoption and innovations to the practices themselves will need to continue to increase and intensify.

PRACTICE PERFORMANCE FOR N REDUCTION

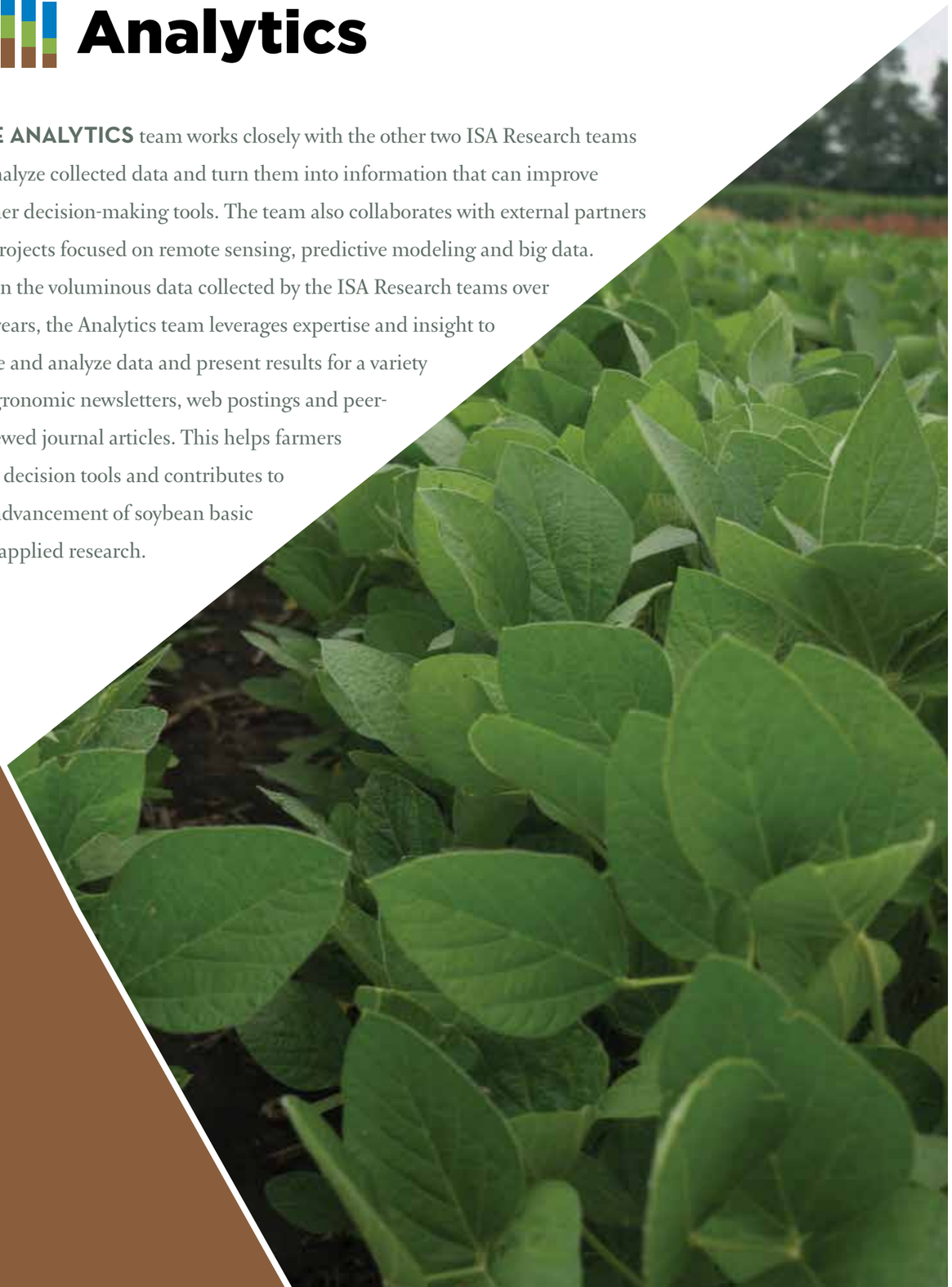


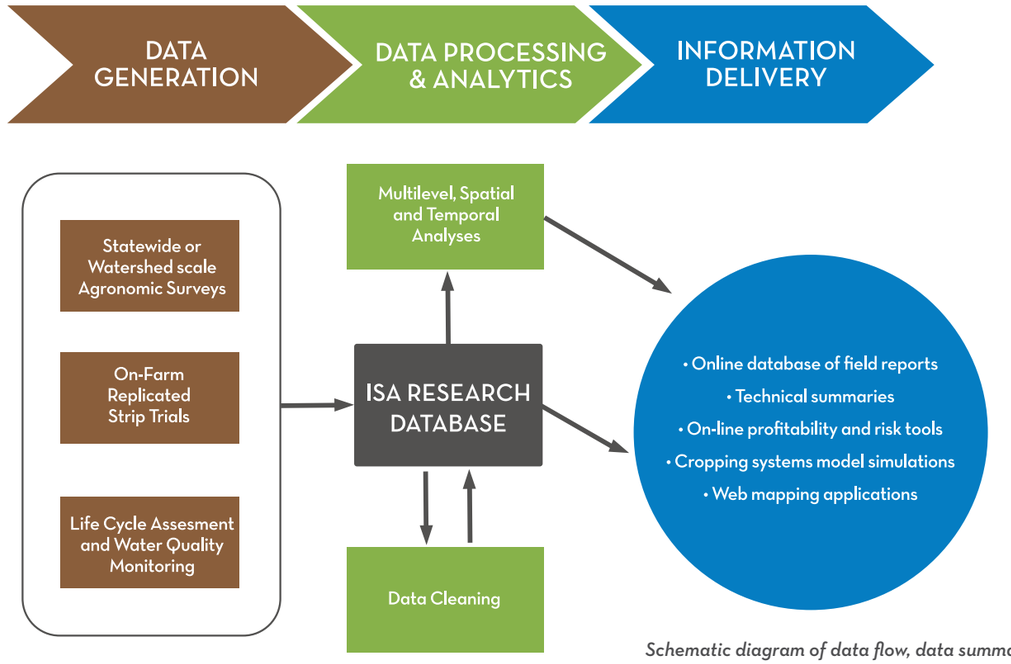
Average nitrate-nitrogen concentration or load reduction as a percentage. Error bars represent one standard deviation above and below the mean. Data from the Iowa Nutrient Reduction Strategy: A science and technology-based framework to assess and reduce nutrients to Iowa waters and the Gulf of Mexico (IDALS, IDNR, and ISU CALS, 2014).

Iowa Soybean Association

Analytics

THE ANALYTICS team works closely with the other two ISA Research teams to analyze collected data and turn them into information that can improve farmer decision-making tools. The team also collaborates with external partners on projects focused on remote sensing, predictive modeling and big data. Given the voluminous data collected by the ISA Research teams over the years, the Analytics team leverages expertise and insight to mine and analyze data and present results for a variety of agronomic newsletters, web postings and peer-reviewed journal articles. This helps farmers with decision tools and contributes to the advancement of soybean basic and applied research.





Schematic diagram of data flow, data summaries, data analyses, and delivery of information to farmers and agronomists.

AN INTRODUCTION TO ISA ANALYTICS

Many important decisions in crop production should be based on site-specific data. Recognizing this need, the ISA Analytics team was established three years ago to advance data analyses and show farmers how collected data and information from their fields can be used to make better agronomic decisions.

The Analytics team works with the On-Farm Network and EPS teams to collect, process and analyze data from on-farm agronomic and environmental studies. Additionally, the Analytics team collaborates with university and industry partners.

Applying modern methods of statistical analysis and predictive analytics, observations are continually compiled and developed into aggregate summaries and online management decision and risk assessment tools for farmers.

Analytics strives to provide timely, comprehensive summaries and information to farmers. Emphasis is placed on providing more robust analyses focused on addressing local soil, weather and management variability. To achieve this, area specific observations from individual fields — such as soil and tissue testing — are combined with entire field-level observations such as previous crop, planting date and in-season rainfall.

Through the development of online applications, these data are made available to help farmers and agronomists better understand variability within individual on-farm trials. This is done by employing a variety of graphic techniques to visually display the effects of treatments and technologies on yield response under site-specific weather and management conditions across differing landscapes. In addition, methods are being tested that will help estimate the number of locations and treatment replications needed in future on-farm trials to detect statistically significant or economically practical yield responses of interest for broader application to commercial production.

The Analytics staff works with ISA teams and research partners developing farmer friendly and peer-reviewed scientific articles. Key results are shared through the ISA Research Advance e-newsletter, which focuses on providing farmers with up-to-date information relevant to farming decisions. The peer-reviewed science articles continue to build and expand ISA's credibility within the agricultural industry, the scientific community and both government and non-government agencies and organizations.

The collaboration among the Analytics, EPS and On-Farm Network teams provides farmers with applicable, scientific-based information to guide key agronomic decisions.

RESEARCH WITH AERIAL IMAGERY

Today, farmers can purchase different sources of aerial imagery or collect their own. Aerial imagery can help farmers and agronomists assess management problems, and detect nutrient, pest, disease or water stresses within their fields.

In the majority of situations, farmers use aerial images of their fields only as pictures for visual assessments. The quantitative use of aerial imagery is often limited due to its lack of calibration (Fig. 1). While useful for scouting and visual assessments, the uncalibrated imagery is not always suitable for time sequence analyses to detect different stresses or overall crop health over time, or to make decisions to apply, spray or change management practices within fields.

The Analytics team has been working with university and aerial imagery providers to develop methods of calibrating aerial imagery collected by airplanes and unmanned aerial systems. Imagery calibration tarps with known reflectance values are used to provide reference data for calibration. The calibrated imagery can then be used to analyze imagery collected over time to better quantify different plant stresses or prescribe targeted actions throughout the growing season.

This year, the imagery project is focused on identifying other methods besides reference tarps to calibrate imagery at many locations simultaneously. The goal is to better utilize digital information from the crop canopy in agronomic and environmental studies.

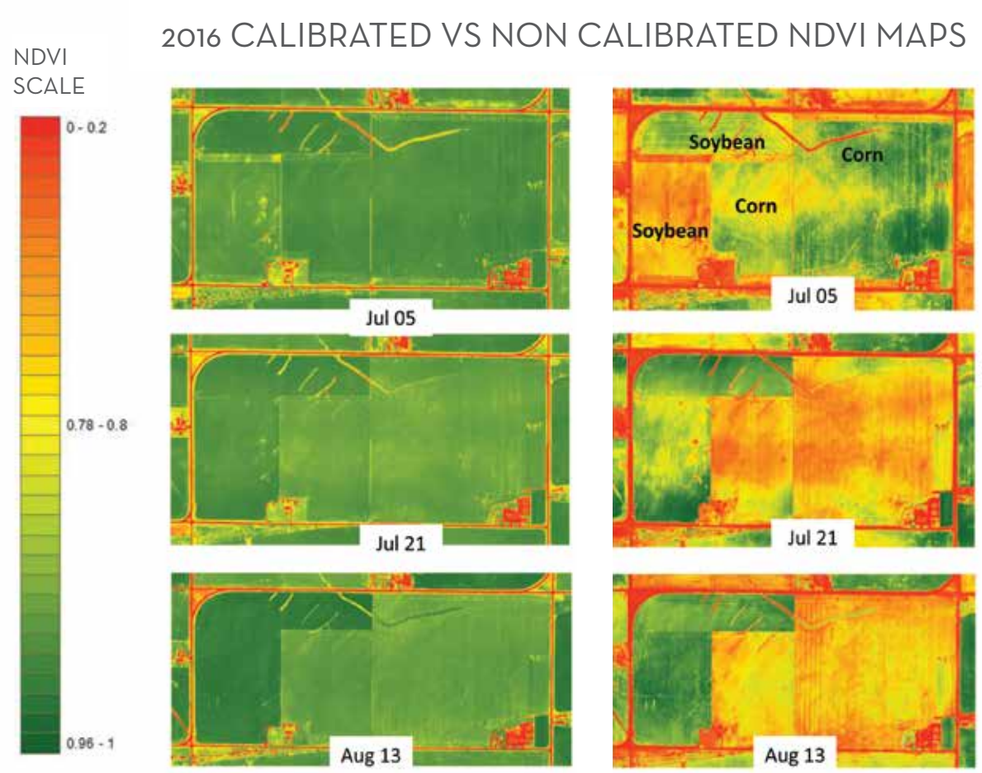


Fig. 1. Example of calibrated vs non-calibrated normalized difference vegetative index (NDVI) maps from a 200-acre field with corn and soybean planted in different row spacing. The calibrated imagery enables researchers to conduct spatial-temporal analyses to detect different plant stresses and management issues over time.

ISA Analytics and On-Farm Network staff members are setting reference calibration tarps for the 2016 imagery calibration project. The tarps are used to test and improve the quality and utility of different sources of aerial imagery.

Make 2017 the year you put ISA Research to work on your farm!

One of the most unique aspects of belonging to the Iowa Soybean Association as a farmer member is the opportunity to participate in research projects on your farm. Working with the experts with the ISA Research team can help you find ways to be more profitable and enhance sustainability efforts. Becoming a farmer member is easy. If you are investing in the soybean checkoff, your farmer membership has no additional cost. We simply need to sign you up and make sure we are connecting with you. We're only successful when our farmer members succeed and we're ready to help you make the first step. Get involved with ISA, whether it's through the On-Farm Network or Environmental Programs and Services.

Email research@iasoybeans.com to sign up for research program opportunities. Our team would be thrilled to work with you!

ISA RESEARCH

IOWA SOYBEAN Association

Expanding Opportunities, Delivering Results

Iowa Soybean Association On-Farm Network®

Iowa Soybean Association Environmental Programs & Services

Iowa Soybean Association Analytics