About the ISRC

The Iowa Soybean Research Center (ISRC) works in partnership with the Iowa Soybean Association, industry, farmers and researchers at Iowa State University. The goal of this collaborative effort is to identify and fund research in the areas of soybean production and protection. The center involves and helps coordinate research, teaching and extension activities of faculty and staff who work in the areas of soybean biology, breeding, economics, precision agriculture, production and pest management at Iowa State and scientists at the Iowa Soybean Association’s Research Center for Farming Innovation.

Research Focus

ISRC-funded research includes traditional and multidisciplinary problem-solving approaches, molecular research and machine learning and artificial intelligence tools to accelerate and enhance research efforts. Specific research areas for the ISRC are identified by the center’s Industry Advisory Council.

Funding

Financial support for the ISRC comes from Iowa State University’s College of Agriculture and Life Sciences, the Iowa Soybean Association and industry partners. Our goal is to seek widespread input and support from individuals representing key segments of the soybean production and protection system.

ISRC Staff

Greg Tylka, director
Kara Berg, communications specialist
Jill Cornelis, center administrator
Steve May, industry partner recruiter
Clarke McGrath, on-farm research & extension coordinator
Industry Advisory Council

Iowa soybean farmers, industry partners and the Iowa Soybean Association have representation on the center’s Industry Advisory Council. The council provides input on research needs, which includes identifying new areas of research, gaps in research and opportunities to expand and build upon existing research.

Industry partners currently represented on the council include AGCO, Albaugh, AMVAC, BASF, Bayer, Beck’s, Cornelius Seed, Corteva Agriscience, FMC, GDM, Invictis/Simplot, Merschman Seeds, Mosaic, Peterson Genetics, Syngenta, UPL and our newest partners joining in 2023, Ag Ingenuity, Meristem, Nutrien and Sound Agriculture.

The 2022 ISRC Industry Advisory Council meeting was held at Iowa Soybean Association headquarters in Ankeny, IA.

ISRC Management Team

Funding decisions are made by the center’s management team based on guidance from the Industry Advisory Council. The management team consists of:

- Iowa State University’s College of Agriculture and Life Sciences Dean Daniel Robison and Department Chairs Steven Harris (plant pathology, entomology and microbiology), Amy Kaleita (agricultural and biosystems engineering) and Mary Wiedenhoeft (agronomy interim)
- Iowa Soybean Association Senior Director of Research Christie Wiebbecke
- ISRC Director Greg Tylka
ISRC Surpasses $2 Million in Research Funding, Adds 20th Industry Partner

In 2022, the ISRC reached a milestone in having awarded over $2 million in research funding since its inception in 2014. Financial support for research is coordinated by the center with 100% of funding provided by its partners going to research. In June 2023, the ISRC reached another milestone by adding its 20th industry partner. A list of the center’s partners are on the back of this report.

<table>
<thead>
<tr>
<th>Award Period</th>
<th>Project Title</th>
<th>PI</th>
<th>Award Amt</th>
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<tbody>
<tr>
<td>2015 - 2016</td>
<td>Iowa Pesticide Resistance Management Plan</td>
<td>Steve Bradbury</td>
<td>$60,000</td>
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<tr>
<td>2015 - 2016</td>
<td>RNA-based Approaches for Resistance to Soybean Cyst Nematode</td>
<td>Thomas Baum</td>
<td>$63,922</td>
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<td>2015 - 2016</td>
<td>Integrated Research and Education Program for Use of Remote Sensing and UAVs for Enhanced Soybean Production</td>
<td>Matt Darr</td>
<td>$36,893</td>
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<td>2015 - 2016</td>
<td>Cropping Systems Modeling Tools to Improve Soybean Management and Yield in Iowa</td>
<td>Sotirios Archontoulis</td>
<td>$79,914</td>
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<td>2015 - 2016</td>
<td>Soybean Planter</td>
<td>Mark Licht</td>
<td>$95,000</td>
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<td>2016 - 2019</td>
<td>Root and Microbiome Traits to Tailor the Next-Gen Soybean Cultivars</td>
<td>Gwyn Beattie Danny Singh</td>
<td>$400,000</td>
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<td>2018 - 2020</td>
<td>Machine Learning Framework to Identify and Quantify Multiple Biotic and Abiotic Stresses in Soybean</td>
<td>Arti Singh</td>
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<td>2019 - 2021</td>
<td>Hyperspectral Imaging for Early Detection of Herbicide-Resistant Weeds in Soybean</td>
<td>Prashant Jha</td>
<td>$120,000</td>
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<td>2019 - 2021</td>
<td>Virus-mediated Gene Editing in Soybean</td>
<td>Steve Whitham</td>
<td>$100,000</td>
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<td>2020 - 2022</td>
<td>In-field Soybean Seed Pod Analysis on Harvest Stocks Using 3D Imaging and Machine Learning</td>
<td>Lie Tang</td>
<td>$100,000</td>
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<tr>
<td>2020 - 2022</td>
<td>Mechanisms of Defense Suppression by Cyst Nematode Effectors</td>
<td>Thomas Baum</td>
<td>$116,000</td>
</tr>
<tr>
<td>2020 - 2022</td>
<td>Time of Disease Onset as an Early Indicator of Soybean Resistance to SDS</td>
<td>Leonor Leandro</td>
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<td>2021 - 2023</td>
<td>Low-cost Multimodal Sensor Arrays for Early-detection of Soybean Diseases</td>
<td>Liang Dong</td>
<td>$60,000</td>
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<tr>
<td>2021 - 2023</td>
<td>Enhancing Implementation and Adoption of Non-chemical Tactics for IWM in Soybean</td>
<td>Prashant Jha</td>
<td>$100,000</td>
</tr>
<tr>
<td>2021 - 2023</td>
<td>Time of Disease Onset as an Early Indicator of Soybean Resistance to SDS (expanded)</td>
<td>Leonor Leandro</td>
<td>$60,000</td>
</tr>
<tr>
<td>2021 - 2023</td>
<td>Effects of Increased Atmospheric CO2 and Abiotic Stress on Soybean Performance in the Enviratron</td>
<td>Steve Whitham Danny Singh Lie Tang</td>
<td>$200,000</td>
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<td>2022-2024</td>
<td>Optimizing Continuous Soybean Production</td>
<td>Sotirios Archontoulis</td>
<td>$156,500</td>
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<tr>
<td>2022-2025</td>
<td>Seed Treatment Effects on the Seed and Soil Microbiome</td>
<td>Gary Munkvold</td>
<td>$156,500</td>
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**TOTAL ALL PROJECTS** $2,070,860
New Research Projects for 2022

Optimizing Continuous Soybean Production
Sotirios Archontoulis, associate professor of agronomy, Iowa State University

Funded in 2022, this study initiates research on the continuous soybean cropping system in Iowa. While soybean after soybean cropping in Iowa has been discouraged in the past, this may change in coming years. In Argentina, growing soybean after soybean is very common because of increased profitability (no nitrogen fertilizer input, less field operations).

Archontoulis’s team has established long-term plot experiments at two locations in central and northwest Iowa with seven cropping systems per experiment: 1) soy-soy (30” rows), 2) soy-soy (15” rows), 3) soy-corn, 4) corn-soy, 5) corn-corn, 6) soy-rye-soy, 7) soy-rye-soy with manure. Each system is replicated four times in large plots which allows multiple teams to work on different research questions on the same plots connecting agronomy, plant pathology and soil science while also having enough area to measure crop yields. Experiments are designed by a multi-disciplinary team, and plots are equipped with sensors to support system level assessments.

Seed Treatment Effects on the Seed and Soil Microbiome
Gary Munkvold, plant pathology, entomology and microbiology, Iowa State University

Another project receiving funding in 2022 studies the effects of seed treatments on nontarget organisms on roots and in soil. The spermosphere (the soil environment around the soybean seed) is chemically and biologically altered by the presence of the seed and anything applied to the seed, but there is little information about specific changes that take place as a result of using seed treatments. To better understand seed treatment effects, experiments are being conducted in a growth chamber and in the field with different soybean cultivars treated with various chemical and biological seed treatments. Soil was sampled just before planting. After planting, seeds and soil from the spermosphere are carefully excavated at intervals and the microbiome is characterized using amplicon sequencing to profile bacterial and fungal microbial communities. Changes in the entire microbial community are measured, providing insight into the mechanisms by which seed treatments affect crop performance.
Ongoing Research Projects

Time of Disease Onset as an Early Indicator of Soybean Resistance to Soybean Sudden Death Syndrome (SDS)

Leonor Leandro, plant pathology, entomology and microbiology, Iowa State University

Initially funded in fall of 2020, this project received additional funding in 2021 to extend and expand ongoing work. Unfortunately, dry weather conditions in 2021 and 2022 were not very conducive to SDS development, although some useful results were collected.

In 2022, 11 field experiments were planted across Iowa. Five were established at ISU research farms; two of which were artificially inoculated with the SDS pathogen, *Fusarium virguliforme*, one was irrigated and the other was not. Six studies were established at commercial farms by collaborator Nathan Schmitz from GDM who coordinated the planting, maintenance and harvesting of the experiments.

Many of the same field experiments are being repeated again in 2023, with 4-5 planted at ISU research farms using artificial inoculation and irrigation. GDM’s Nathan Schmitz again kindly agreed to plant studies at multiple locations for this project. An ISU colleague is obtaining drone images from the Ames locations to determine if digital imaging can detect SDS onset more reliably than visual ratings. Greenhouse experiments were conducted to compare SDS resistance levels in the varieties used in the field studies. A statistician may be consulted for more in-depth analysis of the data collected from 2021-2023.

Low-cost Multimodal Sensor Arrays for Early Detection of Soybean Diseases

Liang Dong, electrical and computer engineering and Steve Whitham, plant pathology, entomology and microbiology, Iowa State University

This project received two-year funding in fall 2021 to develop a diagnostic device for economical, rapid detection of soybean pathogens to better recognize diseases at an early stage to reduce their spread and minimize damage. In a March 2023 update, Dong explained that the research team developed two low-cost sensors, one capable of detecting bean pod mottle virus (BPMV) in soybean plants and the other capable of detecting salicylic acid of soybean plants under various stresses.
In-field Soybean Seed Pod Analysis on Harvest Stocks Using 3D Imaging and Machine Learning

Lie Tang, agricultural and biosystems engineering, Iowa State University

Completion of this project was delayed due to a hardware problem and supply chain issues. A final report will be available at the end of 2023.

This study first received funding in fall of 2020 to characterize the phenotypical traits of soybean seed pods using a stereoscopic sensing technology to collect three-dimensional data of soybean plants before harvest. Because soybean seed pods grow in clusters oriented in different directions, it is difficult to analyze them from the images of only one side of crop rows. The Tang group designed a gate-shaped camera rig to mount their PhenoStereo 3D cameras to capture images of soybean plants from two sides. Using the collected images, a deep learning detection method called Mask R-CNN detected individual soybean pods in the images from two sides of soybean plants.

The Tang group also has worked on the algorithms to detect pods from the two sides and from the cameras on the same side to generate a correct count of the total number of pods. The researchers conducted 3D calibration of the cameras stitching together data from different cameras. With the availability of the 3D data, researchers continue to work on algorithms to quantify the phenotypic traits of pods such as the size and distribution of pods and the number of pods in each internode. Another important task was to detect the number of seeds in each pod. The laboratory plans to use a deep-learning-based key point detection algorithm to detect soybean seeds in images and then group the seeds into each pod. Based on these calculated phenotypic traits of soybean pods, the genetic characteristics of different soybean lines can be further analyzed by plant scientists.
Ongoing Research Projects (cont.)

Effects of Increased Atmospheric CO\textsubscript{2} and Abiotic Stress on Soybean Performance in the Enviratron

*Steve Whitham, plant pathology, entomology and microbiology, Lie Tang, agricultural and biosystems engineering and Danny Singh, agronomy, Iowa State University*

This team initially was funded in 2021 to investigate soybean performance with respect to disease development and abiotic stress tolerance under future climate scenarios. Researchers are studying the effects of CO\textsubscript{2} concentrations on soybean responses to pathogens and the effects of elevated ambient temperatures on soybean phenotypes and gene expression. A greater understanding of how increased atmospheric CO\textsubscript{2} affects development of diseases caused by viruses, bacteria and fungi in soybean will provide insight into disease management. A greater understanding of the genetics for heat stress tolerance in soybeans will allow breeders to develop soybean varieties that can withstand these temperatures.

Experiments are conducted in the Enviratron, a controlled-environment plant growth facility at ISU that enables multiple environmental variables to be controlled and manipulated to study effects on plant performance. The Enviratron’s data collection is automated by the use of a robotic rover that autonomously visits the plants in growth chambers and collects data using an array of cameras and sensors.

Initial data have been collected and analyses are in progress. Some early findings can be found under the “Research” section of the ISRC website.

A view of the controlled chambers of the Enviratron Lab at Iowa State.

All ISRC-funded research project progress and final reports can be found on the ISRC’s website under “Research” at iowasoybeancenter.org or on the National Soybean Checkoff Research Database at soybeanresearchdata.com
Concluding Research Projects

Mechanisms of Defense Suppression by Cyst Nematode Effectors

*Thomas Baum, plant pathology, entomology and microbiology, Iowa State University*

Funded in 2020, The Baum Laboratory explored the mechanisms of a phenomenon previously discovered in cyst nematodes that suppresses or inactivates plant immunity through a small group of molecules called “effectors.” Cyst nematodes are sedentary parasites that feed at single feeding sites inside the root throughout their life. It is critical for cyst nematodes to avoid or inactivate strong plant defense responses. Understanding how cyst nematodes interfere with plant defense mechanisms can pinpoint strategies to strengthen natural plant defense mechanisms. Among nine previously identified effectors able to suppress plant immunity, Baum’s team focused on the two effectors showing the strongest Effector Triggered Immunity suppression abilities: GLAND1 and GLAND9, which show promise in being strong immune suppressors.

Enhancing Implementation and Adoption of Non-Chemical Tactics for Integrated Weed Management in Soybean

*Prashant Jha, agronomy, Iowa State University*

Originally funded by USDA-NIFA in 2021, this project received additional two-year funding from the ISRC later in 2021 to help expand the project’s scope. This project then received additional USDA-NIFA funding in 2022 that included researchers from Iowa, Arkansas, Illinois and Kansas.

Jha studied two new harvest weed seed control technologies to manage herbicide-resistant weeds on farm fields: chaff lining and the weed seed destructor. Preliminary results showed 75-80% of waterhemp seeds are retained by plants at the typical harvest dates of soybean in Iowa. More than 90% of waterhemp seeds that entered the combine and passed through the seed destructor had damage making them non-viable. Biological data on waterhemp emergence, percent control and end-of-season seed bank decline as influenced by cereal rye cover crop by herbicide by harvest weed seed control interactions will be collected in soybean in 2023. Results will be included in a final report later this year.
**ISRC Education and Outreach Activities**

August is a busy month for the ISRC as it hosts several events in conjunction with Soybean Month in Iowa, including the following.

**ISA Experience**

The ISRC/ISU hosted the ISA Experience Class on August 2, 2023, at ISU’s Field Extension Education Laboratory near Boone, Iowa, with a tour of the teaching farm, demonstration plots and an opportunity to learn from ISU graduate students and staff how to identify soybean diseases. The group also stopped at the nearby Agricultural Engineering and Agronomy Research Farm to learn more about a new research project funded by the ISRC to study continuous soybean production to help Iowa farmers meet an anticipated increase in demand for soy oil in coming years.

**Meals from the Heartland**

The ISRC hosted its third annual Meals from the Heartland event on August 2, 2023. Fifty ISU students, faculty and staff packaged 38,000 meals in two hours. Cargill has sponsored the event each year through a generous monetary donation to cover the cost of the ingredients, which include soy protein. Meals from the Heartland works with teams of volunteers from local organizations to package meals for delivery to food insecure people in Iowa, across the U.S. and around the world. Some of the meals packaged at the ISRC-hosted event were delivered to food pantries at ISU and in downtown Ames.

**Annual Farm and Industry Tour**

On August 7, 2023, the ISRC coordinated a group of 30 graduate students, faculty and staff to visit Bruce and Jenny Wessling’s farm near Grand Junction, Iowa, to learn about their low-till farming operation. They grow 4,600 acres of corn and soybean and finish nearly 19,000 hogs each year. Another stop on the tour was to Clayton Farms, an indoor vertical farm that produces healthy local produce hydroponically. The farm is located at the ISU Research Park in Ames, Iowa.
The ISRC hosted its second biennial SoyFest celebration on August 23, 2023, on Iowa State’s central campus. This free, outdoor celebration of all things soy featured Iowa vendors, ISU research labs and student clubs to highlight the importance of soy and its many uses in everyday life from food to new and innovative products. SoyFest offered grilled pork and soy-veggie burgers, soy-based ice cream, soy-related snacks, technological demonstrations, soy-themed prize giveaways, carnival games and a special drawing for students.

The event was a fun, educational opportunity for ISU students during the first week of classes. Two new games were added this year: a putting green hosted by SYNLawn made with artificial soy-backed synthetic grass and a wooden “Soyhole” beanbag toss game donated by Columbia Forest Products made with their PureBond® soy-based adhesive plywood.

Businesses and groups that contributed to SoyFest 2023 included the Iowa Soybean Association, Iowa Food & Family Project, ISU Creamery, Hy-Vee, Corteva Agriscience, Chevron-REG, Iowa Turkey Federation, Iowa Smokehouse, Old Capitol Food Co., Okabashi Shoes, USDA, numerous ISU student clubs and several ISU researchers.
Thank you to our industry partners!