Nominating Region: North Central (NC)
Nominator: Martin Draper (AA, maddr@ksu.edu)
Project or Committee Number and Title: NCERA137 *Soybean Diseases*
Technical Committee Chair: Alyssa Koehler (akoehler@udel.edu)
Administrative Advisor: Martin Draper (maddr@ksu.edu)

Issue, Problem, or Situation Addressed: Soybeans are prized for their human nutritional traits and ability to naturally fix atmospheric nitrogen. Planted on up to 1/3 of the US cropland, it is among the biggest cash crops and principle exports of the US. NCERA137 focuses on protecting the crop from diseases that have been shown to claim up to $45/A in losses (2021).

Objectives: For at least 30 years, NCERA137 and its earlier iterations have responded to the biggest threats to soybean production. Today, objectives are to: **1)** *Foster collaborative research* and information exchange on new and emerging soybean diseases among soybean pathology scientists, soybean breeders and entomologists; **2)** *Coordinate soybean yield loss estimates* caused by diseases across the soybean producing region; **3)** *Compare ecology, epidemiology and management* data on soybean diseases; **4)** *Improve knowledge transfer* regarding soybean diseases and their management to researchers, extension personnel, farmers and agribusinesses; and, **5)** *Monitor and share information* on new or reemerging pathogens of soybeans in the North Central Region and develop appropriate responses to their emergence.

Accomplishments: Truly an integrated committee, NCERA137 conducts collaborative research with effective tech transfer. They gather data and create and promote technologies to facilitate better decision making and reduce disease losses from known diseases, anomalies, and new threats, while prioritizing coordinated research with stakeholder engagement, documented in the Multistate Research Fund Impacts report. The committee develops data-driven solutions for the soybean industry, producers and government agencies. Their rapid information exchange facilitates responsiveness, mitigating losses and improving profitability and compatibility with the environment. NCERA137 became more integrated when they incorporated NCERA200 and 208, two topic specific soybean disease committees. Through the integrated and collaborative work of NCERA137, the following selected *outputs* were realized:

- *An ongoing committee,* NCERA137 documents 384 peer reviewed publications, 20 books or book chapters, 219 proceedings and abstracts, 515 extension and 123 technical/AES reports (2015-2023). Research publications involve representation from up to 13 collaborative states.
- The committee has regularly coordinated with the Southern Soybean Disease workers on annual symposia that develop graduate student research and communicate current discoveries.
- The committee collaborates with the Sustainable Corn CAP project, a multimillion dollar AFRI project providing production data with corn rotations.
- In 2022, NCERA137 met in conjunction with NC1197 *Practical Management of Nematodes on Corn, Soybeans and Other Crops of Regional Importance* to leverage their activities with soybean cyst nematode and joined together for a nematode identification workshop, increasing soybean pathologist's competence beyond the omipressent *Heterodera* glycines.
- NCERA137 created a number of valuable tools to reduce soybean disease. One tool tracks predominant pathogen populations that have developed resistance to fungicides used to control foliar diseases, addressing Frogeye leaf spot resistance through sampling from 300 counties across 19 states and Septoria brown spot resistance across four states, and Target spot resistance from two states. These data contribute to improved IPM practices and ultimately millions of dollars of cost savings for producers and industry. Another tool is the **White Mold Sporecaster**

which is a weather-guided decision-support tool that assesses the risk of *Sclerotinia sclerotiorum* spore production in soybean fields. NCERA137 multistate trials screened and validated the tool and it is now available to the public for free on IOS or Android since May 2018. The newer companion app, **Sporebuster**, calculates the economic return on investment of deploying a white mold fungicide. The American Society of Agronomy (ASA) recognized these tools with the Extension Education Community Educational Award for digital decision aids in 2018 and 2019. NCERA137 surveys disease nationally and publishes annual soybean yield loss estimates. Since the committee assumed this reporting, the survey results are published twice as frequently than they were under the previous coordination. These data direct research investment by state Check-off boards (QSSBs) NCSRP and USB, that fund local and collaborative research. The committee seeks short-term and long-term management for this disease.

Selected Short-term outcomes demonatrate NCERA137's multi-state coordination and project breadth to address stakeholder needs:

• NCERA137 members play a critical role with an interactive data-driven decision support tool hosted on the Crop Protection Network. Data from tool users indicated that the average loss from Frogeye leaf spot in Midwestern states increased 3,400 percent from 460,000 bushels a year at $.04 an acre between 1996-2000 to 15.7 million bushels a year at $2.06 an acre between 2014-2018. These data better allow economics-based priorities for disease management, research, policy and educational efforts. These changes in disease severity and wider distribution are likely due to genetic changes in the pathogen and a warming world.

• Ongoing screening of Frogeye leafspot pathogen isolates has disclosed an increasing distribution of QoI fungicide resistance, which assists in providing relevant managemtne information to producers. Further, genomic analysis has also detected greater frequency of fungicide resistance to the Septoria leafspot and target spot pathogens.

• The team detects emerging diseases which drives research among the group. Among these concerns are taproot decline, red crown rot, and bacterial blight. They have also confirmed that GPS guided planting of continuous soybeans has contributed to the emergence of taproot decline which was identified through survey and has been proven to cause losses of up to 30% in trials.

Selected Mid-term outcomes demonstrate NCERA137's research and extension integration across the region to drive new research, grower education, and effective decision making:

• Widely used by extension specialists and crop consultants, **Sporecaster** had been downloaded over 3,000 times with peak use of 600-800 users a day in 2020. Such decision support tools support fact-based decisions and downloads indicate adoption and user behavioral change.

Selected Long-term outcomes of NCERA 137 include –

• ***Continued regular communication and effective coordination*** across NCERA 137 members. NCERA137 vets data from ecology, epidemiology and management of soybean disease studies to improve knowledge transfer about soybean disease biology and management for maximum impact across Land-grant functions, while specifically improving collaborative research.

• ***Responsiveness to disease and fungicide resistance***: New knowledge and tools helped *detect and monitor diseases* and prevented serious losses. For example, Frogeye leafspot appeared to be expanding its range and with diminished fungicides control resulting in a nationwide responsive study. IPM (disease reduction) include reduction in crop losses for improved profitability, reduced adverse impact on both the environment and human health. The National IPM Roadmap was revised in 2018 to: 1) Prevent unacceptable levels of pest damage; 2) Minimize the risk to people, property, infrastructure, natural resources and the environment, and;

3) Reduce the evolution of pest resistance to pesticides and other pest management practices NCERA137 has addressed and accomplished each of those goals.

- **_Increased profitability,_** driven through technology and forecasting models for decision support to optimize inputs and reduce disease losses. In alignment with the industry-sponsored Soybean cyst nematode coalition activities, "Take the Test. Beat the Pest" (ver. II), raised grower awareness and improved practices since the baseline research in 2015.
- **_Improved environmental health_** through recommendations on new research and alternative products for the wise and judicious use of chemical inputs and minimizing unnecessary applications guided by technology-driven decision support disease forecasting models, a foundation of integrated pest management.
- **_Other Accomplishments_** include: 1) Increased yields and more sustainable soybean production; 2) _Unbiased, science-based_ information and tools, raising awareness of issues and increasing the use of effective solutions. For example, the fungicide efficacy table reached over 98,000 clients in 18 states; 23) _Cost-effective_ control options reduced grower losses and kept consumer costs low. The fungicide efficacy table reached more than 98,000 clients in 18 states.

Added Value & Synergistic Activities: *Multi-disciplinary activities* – Pathotype screening assists soybean breeders by identifying which disease-resistance genes will be effective against the current pathogen population. The regularly updated study map provides locally relevant data on the distribution of *Phytophthora sojae* pathotypes, which is crucial for genetic deployment of varieties, a classic example of ever-evolving recommendations for an ever-evolving pathogen. *Multi-functional integrated activities* – Many members have split research and Extension appointments securing Research:Extension feedback loops and connections to stakeholder groups for improved relevance. Projects report to stakeholders in the USB's (United Soybean Board) National Database of Soybean Research. *Additional partnerships, associations or collaborations* – Industry, USB, and the North Central Soybean Research Program (NCSRP) regularly participate with the committee. *NCERA137 accomplished together that which would not have been possible without collaboration*.

Multi-institutional & Leveraged Funding: The work of this committee has led to nearly $400,000 in USDA-CPPM-ARDP competitive funding on Sclerotinia stem rot and Sudden Death Syndrome in the last thee years, while soybean QSSBs, the Mid-south Soybean Board, NCRP and USB faithfully fund this group's research. Currently, about half of the NCSRP projects link to NCERA137 initiatives and function in the NC, S, and NE regions. USB has refocused its funding to more production research, including plant diseases. NCSRP and USB promote NCERA137 collaboration by funding disease studies to discover mechanisms/genes that confer resistance to pathogens, particularly soil-borne root infecting organisms. QSSBs also regularly contribute to activities directly related to collaborative projects with NCERA 137. QSSB's regularly support preliminary data collection, enabling broader study across soybean country. NCERA137's relationship with QSSBs, USB and NCSRP led to the trust to run "Beat the Pest. Take the Test, Version II," for SCN, building on monitoring for new and re-emerging diseases. The SCN project generated over $2.2M in research and Extension funding to committee members from the three sources. These entities have also collaborated on seedling disease, sudden death syndrome (SDS), Phytophthora root and stem rot, charcoal rot and white mold projects, which represent the vast majority of the disease losses in the crop.

Summary of Participating Institutions and Units:
State (Region) FTE x Function - *Institution/Institutional Unit*

Alabama (S) – 1 R/E - *Auburn University*
Arkansas (S) – 1 R/E - *Arkansas Cooperative Extension*
Delaware (NE) – 1 R/E - *University of Delaware*
Florida (S) – 1 – R/E - *University of Florida*
eorgia (GA) – 1 R/E - *University of Georgia*
Illinois (NC) – 2 R - *University of Illinois / 1 E - Illinois Cooperative Extension*
Indiana (NC) – 1 R/E - *Purdue University*
Iowa (NC) – 1 R/E - *Iowa Cooperative Extension*
Kansas (NC) – 1 R, 1 R/E - *Kansas State University*
Kentucky (S) – 1 R, 1 R/E - *University of Kentucky*
Louisiana (S) – 1 R/E - *Louisiana State University*
Michigan (NC) – 1 R/E - *Michigan State University*
Minnesota (NC) – 1 R/E, 1 R - *University of Minnesota*
Mississippi (S) – 1 R/E - *Mississippi State University*
Missouri (NC) – 1 E - *University of Missouri (currently vacant – previous faculty member was a member)*
New York (NE) – 1 R/E – *Cornell University*
North Dakota (NC) – 1 R/E - *North Dakota State University*
Ohio (NC) – 1 R, 1 R/E - *The Ohio State University*
Oklahoma (S) – 1 R/E - *Oklahoma State University (currently vacant – previous faculty member was a member)*
Pennsylvania (NE) – 1 R/E - *Pennsylvania State University*
South Dakota (NC) – 1 R - *South Dakota State University*
Tennessee (S) – 1 R/E - *University of Tennessee*
Virginia (S) – 1 R/E - *VPI & SU (Virginia Tech)*
Wisconsin (NC) – 1 R/E - *University of Wisconsin-Madison*
Industry – 1 - *Cibus, Inc. (trait development/gene editing)*
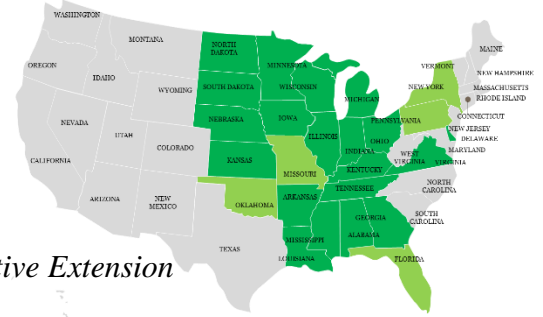
NCERA137 has participants from 20 states in the NC, S and NE region, which accounts for 94% of planted soybean acres in the U.S. Industry and commodity representatives regularly participate as well as unofficial participants from other soybean producing states.
NOTE: Five states have been indicated in light green represent states that have been members over term of this project, there is now a vacancy (MO, OK, FL) or the new hire have indicated they will file Appendix E's but had not done so at the time of this filing. Others have been regular participants but were not enrolled (NY, PA).

Industry and Stakeholder collaborators (2014-2023)
United Soybean Board (USB); Richard Joost, Kelly Whiting, Jennifer Jones, Jacque Weiss
North Central Soybean Research Program (NCSRP); Ed Anderson
Industry sponsors: BASF, Bayer, Corteva, FMC, Syngenta, UPL, Valent, Stratton Seed Company, and Progeny Ag Products. These partners have covered meeting costs for NCERA137 and the SSDW or have contributed to offset costs of collaborative projects.

Grand Challenges Addressed:
Sustainability, Competitiveness & Profitability of Food & Agriculture
Environmental Stewardship & Sustainable Practices

Impact Assessment Report:
https://www.mrfimpacts.org/single-post/managing-soybean-diseases-ncera-137-2014-2019