

# ANNUAL RESEARCH REPORT



Photo by Kyle Spradley - University of Missouri

## LETTER FROM THE EXECUTIVE DIRECTOR

In 1979, Missouri soybean farmers voted to create the Missouri Soybean Merchandising Council. The new organization and Missouri's state-level soybean checkoff program was the real start in soybean-related research and educational opportunities for soybean growers. Previously, limited research had been conducted in partnership between the Missouri Soybean Association and the University of Missouri. In 1991, research received another surge with the creation of the national soybean checkoff. The Soybean Promotion, Research and Consumer Information Act became effective July 9 of that year.

Over the course of more than 40 years, the soybean checkoff in Missouri, research and sharing those research results with farmers has been central to the work of our soybean organizations. From addressing soybean cyst nematode pressure to creating demand for soybean oil through biodiesel, the farmer leaders of Missouri's soybean organizations have looked toward research to improve their profitability and to protect their freedom to operate for decades.

It is an honor to work closely with the men and women who give their time to serve on the boards of directors and committees for the Missouri Soybean Association and the Missouri Soybean Merchandising Council to support soybean-focused research for the benefit of our growers. We, your Missouri soybean staff, are proud to bring you this new, annual research report showing the application of soybean checkoff dollars.



Gary Wheeler - MSA Executive Director / CEO



Gary Wheeler - MSA Executive Director / CEO



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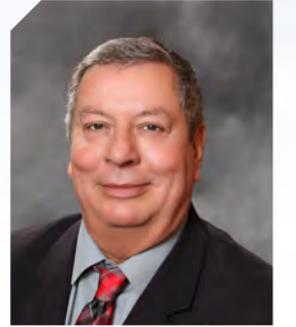
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## LETTER FROM THE MSMC BOARD CHAIR

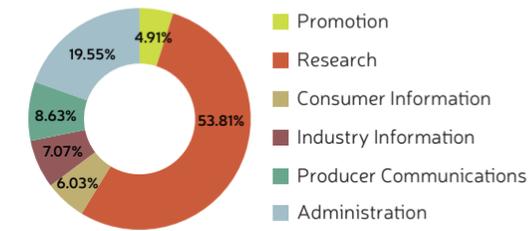
We often talk about the soybean checkoff as an investment in our future. We discuss it through the lens of long-term benefits to our bottom line and of creating opportunities for the next generation. We talk about the return on that investment - \$5.20, coming back to our bottom line through higher market demand and prices, for every dollar paid into the checkoff - but that doesn't necessarily make it any easier to see the checkoff deducted from the ticket for a load of beans, especially when prices dip.

Your Missouri Soybean Merchandising Council board of directors understands that. Each of us involved in investing the soybean checkoff is a soybean farmer in Missouri. We know the challenges and see the importance of putting those hard-earned dollars, entrusted to us by our fellow growers, to work in ways that make it as profitable as possible to raise soybeans in Missouri.



John Kelley  
MSMC Board Chair

### MSMC Program Expenses



Research is the highest priority area for checkoff funding in our state. It's tied directly to the Missouri Soybean Merchandising Council's mission of innovating to solve problems and maximize profitability, and it's what growers statewide continue to tell us they see as most valuable. In fact, we emphasize specific areas, from soybean breeding to uses, as shown in this report based on feedback from Missouri farmers.

Special thanks are in order for the members of the Missouri Soybean Merchandising Council's research committee: Cecil Demott of Rock Port, Kyle Durham of Norborne, Lewis Rone of Portageville, and Rex Wood of Meadville.

This project would also not have been possible without the hard work of the staff at the Missouri Soybean Association and Missouri Soybean Merchandising Council.

Thank you for your trust in us, and for helping us make this work possible. We take your feedback very seriously and I look forward to hearing from you on this work, and on future research direction.



John Kelley - MSMC Board Chair

### MSMC Research Committee



MSMC Research Committee Left to Right: Cecil Demott, Kyle Durham, Lewis Rone and Rex Wood

### Research Project Review Process



The Missouri Soybean Merchandising Council board of directors strategically invests Missouri farmers' checkoff dollars to develop and evaluate practical and innovative research for the benefit of Missouri soybean producers and their end users. Research investments are reviewed by professional staff as well as a team of Missouri farmers to ensure the research efforts continue to address the needs of growers. Projects currently supported by checkoff funds distributed by the Missouri Soybean Merchandising Council are listed below, divided by type of research – Agronomic, Soybean Breeding, Soybean Cyst Nematode and Crop Physiology, and Feed, Food and New Uses.



Photo courtesy the University of Missouri

## Agronomic

### INCORPORATING COVER CROPS IN SOYBEAN CROPPING SYSTEMS

Bill Wiebold, University of Missouri

The soybean rotation-cover crop systems study is designed to determine if soybean intensity in a rotation affects soil health parameters and yield. Studies have shown a significant loss in yield from soybean following soybean as compared to following another crop such as corn or grain sorghum. The yield penalty for soybean following soybean is about ten percent. This study is helping to determine if the appropriate cover crop, and appropriate management, will have a positive impact on soybean yield. Another objective of this study is to determine if soybean intensity in a rotation affects soil health parameters. This work is important to Missouri given the state's greater ratio of soybean planted after soybean than other states. Breaking the rotation by using cover crops could prove to be a very valuable benefit.

### SOYBEAN GENE ZOO – A COMMUNITY OUTREACH

Bill Wiebold, University of Missouri

The goal of the gene zoo is to conduct an educational demonstration project, at the University of Missouri's Bradford Research Center, that targets a diverse audience from elementary school students to adult consumers to ag-knowledgeable Certified Crop Advisers, regardless of beginning knowledge of agriculture.

This project helps to teach those both familiar and unfamiliar with agriculture more about the crops we grow in Missouri. The current soybean gene zoo is laid out to showcase the following:

- Soybean history from domestication to modern varieties
- Use of biotech and non-biotech traits
- Maturity group adaptation
- Special use soybean types
- Effects of single genes on soybean growth, development, and morphology

A web site has been developed to highlight the excellent demonstrations that can be seen at the MU Gene Zoo and Crop Gardens: <http://genezoo.missouri.edu/soybean.cfm>. Each year about 10,000 visit the gene zoo, from elementary school students to certified crop advisers.

### INTERACTION OF COVER CROPS AND NEMATICIDES IN RELATION TO SCN POPULATION MANAGEMENT AND SOYBEAN YIELD

Bruce Burdick, Melissa Mitchum, Tim Reinbott & Andrew Scaboo; University of Missouri

Cover crops are generally planted for long term soil health benefits and/or to provide erosion control for our precious soil resource. A side benefit that is frequently claimed is that some cover crops can also dramatically drop soybean cyst nematode populations. However, this has not been fully documented and it deserves further controlled evaluation.



nematode populations. However, this has not been fully documented and it deserves further controlled evaluation.

There are also newer seed treatments that claim to reduce SCN populations.

The research goal of this project is to evaluate the contribution and magnitude of cover crops and nematicides on soybean cyst nematode populations. It will also compare the yield of several resistant and non-resistant soybean varieties within the study. As new management tools such as iLeVo seed treatment, and more widespread cover crop use is adopted by soybean producers, there is a need to determine best management practices and measure their impact. This study specifically measures the ability of the tested practices in the management of SCN in soybean fields.

### MISSOURI AGRICULTURAL WATERSHED MONITORING PROJECT

Darrick Steen MSMC; Kurt Boeckman & Colleen Meredith, DNR

The goal of the watershed monitoring project is to measure the effectiveness of farmer practices and document and demonstrate the grower's continuous improvements. Edge of field monitoring provides a way for farmers to measure the runoff leaving their fields. Establishing reliable monitoring stations in producer owned crop fields allows farmers, collaborating partners and agencies the ability to collect and monitor water samples and hydrologic data. The impact of the farmer's management practices can be measured to determine their effectiveness. Edge-of-field monitoring will provide information about the amount of runoff, soil, nutrients and if desired, crop chemicals moving off a given field into an adjacent waterway. Assessing the water quality impacts from farmland as well as assessing the performance and effectiveness of best management practices (BMPs) in reducing nutrients and sediment are important to document and demonstrate the progress that is being made in state, national and industry stewardship goals. Monitoring will allow producers to measure the value and benefit of their past, current and future conservation efforts.

### ENHANCING SOYBEAN PRODUCTION EFFICIENCY IN NORTHWEST MISSOURI

James Crawford & Wayne Flanary, University of Missouri

The research goal is to look at various production methods and practices to help producers increase yield and reduce input costs while working to protect the environment. The practices evaluated at the University of Missouri's Graves-Chapple Research Center include:

- Plant population: Six different populations are evaluated in a replicated trial to determine the most profitable planting rate.
- Row spacing: Yield, weed pressure and input costs for soybeans are compared on the two most common row widths, 15 and 30 inches. Planting time and variety impact is also evaluated.
- Herbicide Systems: Roundup Ready and Liberty Link herbicide systems are compared for herbicide costs, weed pressure and yield. Multiple varieties within each system are compared.
- Foliar Fertilizer: The use of foliar fertilizer is compared for cost and soybean yield benefit.
- Foliar Fungicides: This trial will examine multiple fungicides for benefit to plant health and ultimately yield and cost effectiveness.



Photo by Kyle Spradley - University of Missouri

The goal is help determine the most cost effective practices for a grower's operation.

### MU CERTIFIED STRIP TRIAL INITIATIVE

John Lory, Peter Scharf, Bill Wiebold, Wayne Flanary, Kent Shannon; University of Missouri

This program is an integrated research, education and demonstration project helping Missouri producers validate management decisions on their own farm and document their efficiency and environmental stewardship. Strip trials are focused and easily implemented experimental tests that farmers can perform on their fields using their own equipment or that of a commercial applicator. The adoption of yield monitors and precision agricultural tools and strategies provides tremendous opportunity for wide-spread adoption of strip trials throughout Missouri. Comparisons are made across soil types to determine the impact of management practices and the variability throughout the field. The Missouri Strip Trial Program is an unbiased

source of data for nutrient management, agronomic, and conservation practices. The program is proactive and documents the most effective management practices. The information provided through this program will improve the efficiency and profitability



of Missouri farmers. Practices that are compared include nitrogen timing, phosphorus application comparisons, and cover crop impacts on corn and soybean yield. Other agronomic comparisons are planned for future evaluation.

## UTILITY OF SUBSURFACE DRIP IRRIGATION FOR SOYBEAN PRODUCTION

Kelly Nelson; University of Missouri

There were two main goals of the drip irrigation study:

**Objective 1:** To evaluate the effect of subsurface drip irrigation on soybean response in rotation with corn. Soybean plots were maintained weed-free following various application timings, sources, and rates of nitrogen for corn.

**Objective 2:** To evaluate the effect of subsurface drip irrigation spacing on soils with slopes greater than 3% on soybean response in a claypan soil. All treatments were harvested above and between the drip irrigation lines late last week. Soybean yields were over 80 bu/acre.

A field day with over 300 in attendance at the site featured the soybean plots and an explanation of the design of objective 2, goals of objective 1, and current results. Kelly presented current research along with his graduate student, who presented on the Irromesh sensors that were installed to evaluate the water status of the soil for the different irrigation systems.

## MANAGEMENT OF INSECTICIDE RESISTANCE IN SOYBEAN PODWORM POPULATIONS

Moneen Jones; University of Missouri

The soybean podworm, cotton bollworm or corn earworm,

*Helicoverpa zea* (Boddie), is the most common and difficult to control pest for soybean in Southeast Missouri. Beans planted late in the season are most vulnerable to flower and leaf damage. Infestations during peak flowering to early pod fill stages can delay seed production and lower yields. Therefore, the continued efficacy of available insecticides is of paramount importance, and reliable strategies for resistance management are urgently needed. Although sometimes viewed as a pesticide resistance strategy, tank mixes and premixes simultaneously expose the pest population to more than one mode, reducing the potential products available for rotation. The mixture versus rotation debate has a long history in the literature but these alternatives have not been tested for CEW. Data obtained includes results from field experiments on success of present programs necessary to manage resistance.



Photo by Wayne Bailey - University of Missouri

Soybean podworms chew holes in bean pods, impacting the crop's yield

## BIOCHEMICAL MECHANISMS RESPONSIBLE FOR RESISTANCE OF BOLLWORM TO SELECT INSECTICIDES AND MIXTURES

Moneen Jones; University of Missouri

The cotton bollworm and the soybean podworm are the same insect. Bollworm adults are considered highly mobile, which suggests that pyrethroid resistance would quickly spread from one region to another. Pyrethroid resistance persisted in pockets for several years, but now appears to have become widespread. Field control of bollworm larvae has been inconsistent throughout many parts of the cotton belt for a number of years, and now it appears that resistance is widespread enough to be readily detected in moth bioassays.

Since there are many applications made in the agricultural landscape to continually decrease pyrethroid susceptibility, making the selection of this class of chemistry for targeting bollworms a risky decision. The goals of this research are to determine baseline susceptibility of bollworm to select commercial and reduced-risk insecticides; and to develop diagnostic doses to monitor susceptibility of soybean podworm to key modes of action in field populations of these pests exposed to intensive versus modest insecticide use.



## GROWING FOR THE BOTTOM LINE – MISSOURI'S BAY FARM RESEARCH FACILITY

The Bay Farm Research Facility is a cornerstone in the Missouri Soybean Association's work to improve the bottom line for Missouri soybean farmers. The nearly 300 acre farm supports and facilitates research, business and market development and educational programs and is home to partnerships between soybean farmers, the University of Missouri, USDA and many others. The farm is also home to a large portion of Missouri's soybean checkoff funded research, similarly focused on growing opportunities and demand for the soybean crop and soy-based products.

The Bay Farm Research Facility began to take shape in 2004 with the purchase of the first parcel of land just off Rangeline Road outside Columbia. Eight years later, in 2012, the facility opened with a top-notch facility for soybean-related research. Named after the family who farmed the land for many years prior, the Bay Farm Research Facility and its staff strive to be responsive to the needs of Missouri soybean producers, showcase the importance of biosciences in agriculture, and support Missouri's soybean industry in bringing reliable, safe, sustainable and profitable products to the marketplace.

Missouri is the only state to have a state soybean association that owns and operates a research farm for the benefit of soybean farmers.

The Bay Farm Research Facility is home to the Northern Missouri soybean breeding program led by University of Missouri soybean breeder, Dr. Andrew Scaboo. His soybean breeding research is focused on development of conventional varieties that meet the agronomic needs of Missouri growers. Those varieties are developed on, and for, Missouri soils and growing conditions. Important traits, like soybean cyst nematode resistance and sudden death syndrome tolerance, are evaluated as well. Through the breeding program, those and other key traits are packaged and varieties developed that express those traits and maintain superior yield. A major emphasis of the North Missouri Soybean program is developing high yielding lines.

Missouri's checkoff research investments, through the Missouri Soybean Merchandising Council, also have an emphasis on soybean varieties with high oleic acid content. The Bay Farm Research Facility is home to field trials for those soybean varieties with

the high oleic acid content, as well as a superb laboratory for the evaluation of soybean compositional traits. Ongoing projects include efforts to further develop soybean varieties with value-added traits that will improve the profitability and competitiveness of soybeans grown in Missouri while also optimizing yields.

In addition to soybean breeding work, the Bay Farm Research Facility is home to many cooperative research efforts on cover crops, soil fertility, and weed resistance issues. The Bay Farm Research Facility also provides on-farm research and demonstration opportunities for soil, water and wildlife conservation projects, including those with the USDA Natural Resource Conservation Service and Missouri Department of Conservation. The facility is also used for events, meetings and training sessions focused on growth in Missouri's soybean industry.

Visitors are welcome at the Bay Farm Research Facility. Contact Greg Luce, Missouri Soybean director of research and superintendent of the Bay Farm Research Facility at (573) 635-3819 to set up your tour of the farm and laboratory space.

# Soybean Breeding

## GENETIC MAPPING OF A UNIQUE MORPHOLOGICAL TRAIT IN SOYBEAN AND EVALUATION OF THE CORRELATIONS WITH YIELD POTENTIAL AND SEED COMPOSITION

Andrew Scaboo, University of Missouri; Jason Gillman, USDA, ARS

The goal of this project is to identify genomic regions controlling a unique branching pattern discovered in wild soybean and to evaluate the yield potential and seed composition in experimental lines exhibiting this trait. The specific trait of this project is directed toward the improvement of genetic seed yield potential.

Although this project is in the early stages, identification of genomic regions have been located on three different chromosomes that explain a significant portion of the branching results. Also found are the locations which explain a significant portion of the variance for protein and oil. This promising work is a collaboration between MU and USDA at the Missouri Soybean Association's Bay Farm Research Facility.

## IDENTIFICATION AND EVALUATION OF DOMESTICATED SOYBEAN LINES FROM WILD SOYBEAN CROSSES WITH INCREASED LEVELS OF PROTEIN AND VALUE-ADDED AMINO ACIDS

Andrew Scaboo, Grover Shannon & Edward Large; University of Missouri



Photo by Kyle Spradley - University of Missouri

Soybeans at Fisher Delta Research Center

This project is designed for the development of high yielding domesticated soybean lines of recent wild ancestry that have increased protein and high-value amino acid seed content using

conventional breeding. Identification of the specific wild soybean genes responsible for improved seed composition of domesticated lines is also a major goal of the project.

Wild soybean lines have been grown at the Bay Farm Research Facility and evaluated for protein, mineral and amino acid content. Identification has been made of lines that are higher in protein and have more desirable amino acid profiles than domesticated soybean check comparisons. These lines have been crossed with domesticated parent varieties in order to further develop improved seed protein and amino acid composition using modern soybean breeding techniques. This important research can aid in the diversity of the soybean industry and specifically improve measurable quality traits. The unique combination of wild seed composition data, wild type genetic blueprints, and soybean breeding expertise will provide Missouri and U.S. soybean farmers improved soybean selections.

## NORTH MISSOURI SOYBEAN BREEDING PROGRAM

Andrew Scaboo, Pengyin Chen and Grover Shannon, University of Missouri

This project involves developing new soybean varieties to be used in north Missouri maturity zones with the focus on yield and agronomic traits important for soybean farmers in north Missouri. Variety development is focused on maturity group III and early group IV varieties.



Andrew Scaboo at the Bay Farm Research Facility

The North Missouri Soybean Breeding Program is located at the Missouri Soybean Association Bay Farm Research facility. The Bay Farm Research Facility is the only soybean research facility owned and operated by a state soybean association. An important aspect of the soybean breeding research is the continued development of high oleic soybean varieties. The high oleic trait was discovered and developed by USDA and MU researchers and is a focal point of variety development. The research location houses a state of the art composition marker and analytical lab to aid in the

development of high oleic varieties. This program works closely with the Fisher Delta Research Center soybean breeding program and shares resources and germplasm for testing throughout Missouri.

## WINTER PRODUCTION PROJECT

Pengyin Chen, Andrew Scaboo, and Grover Shannon, University of Missouri

The use of the winter nurseries is an essential component of a successful soybean breeding and genetic program. Costa Rica and Puerto Rico are used so that crossing can be made in off-season for Missouri and year-round. This greatly enhances the efficiency and timeliness of the Missouri soybean breeding program. These winter nurseries greatly support our breeding programs and are crucial in order to compete in variety performance and provide productive genetics for Missouri farmers. The process of utilizing winter nurseries starts as soon as seed is harvested. Once the seed is harvested in September or October it is sent to winter nursery. The first cycle is October through January and a second from February through May. The seed is then sent back to Missouri for planting in May or June. In the past two years more than ten soybean varieties were released from our two soybean breeding programs and this would not have been possible without the support provided by our winter nurseries.

## DEVELOPING HIGH-YIELDING, HIGH OLEIC ACID, LOW LINOLENIC ACID SOYBEAN VARIETIES WITH ADDITIONAL VALUE-ADDED COMPOSITION TRAITS (HOLL PLUS)

Kristin Bilyeu, USDA, ARS; and Andrew Scaboo, University of Missouri



Photo by Kyle Spradley - University of Missouri

High Oleic Soybeans/Oil

The goal is to create competitive soybean lines with the high oleic and low linolenic traits plus additional seed composition traits that will enhance the value of the soybean to the producer, processor and the end user.

This research project will focus on multiple aspects of improved oil and meal. There is current

characterization of soybean lines with high oleic plus high vitamin E trait. If high oleic/low linolenic (HO/LL) soybeans are a viable value added oil trait, it makes sense to combine that trait with a value added meal trait as well. Combining with high protein or an altered carbohydrate trait are factors under current testing. The work within this project is specifically dedicated to high yielding maturity group III and IV soybean varieties for Missouri farmers.

## MISSOURI SOYBEAN DISEASE FIELD GUIDES NOW AVAILABLE



Missouri soybean farmers have another option for soybean disease information for 2017 – the Missouri Soybean Disease Field Guide.

Made possible with support from the soybean checkoff, the guide features full-color photos of viral, stem, seed and foliar diseases affecting soybean throughout the growth cycle, as well as written descriptions of each.

Printed guides are available by contacting Missouri Soybean Merchandising Council staff.

## GWAS TO GENES: A SYSTEM TO UTILIZE ASSOCIATION ANALYSES TO CLONE GENES AND DEVELOP MARKERS TO IMPROVE SOYBEAN BREEDING FOR GERmplasm AND VARIETY DEVELOPMENT

Kristin Bilyeu, USDA, ARS; and Dong Xu & Trupti Joshi, University of Missouri

This research is designed to enhance bioinformatics tools and systems to enable broad and efficient identification of soybean genes that control important phenotypes. The strategy is a proof of concept approach using a validated data set of cloned genes to test different methods for providing gene information that can immediately be used to develop soybean varieties. The computer science team is working closely with the molecular biology team to determine the desired outcomes for modifying an existing decision tool or building a new tool.

This project is focusing on mining data to characterize genes that control plant traits and use that information to develop molecular markers to make efficient selections.

## CHARACTERIZATION OF GENETIC LESIONS AND YIELD POTENTIAL OF TWO FAST NEUTRON MUTANTS WITH HIGH SEED-PER-POD VALUE TRAITS

Minviluz Stacey & Andrew Scaboo, University of Missouri

The goal of this project is to characterize the growth, developmental attributes, and seed yield potential of experimental lines. Researchers will genotype the mutant plants to identify genetic lesions and design corresponding genetic markers.

Soybean lines exposed to fast neutron irradiation have been evaluated and selected for the multiple seed per pod trait. These lines are showing very high expression of pods with four seeds. Other yield impacting characteristics such as branching, seed size and number of pods are also compared to ensure those traits are not limited or reduced. Promising preliminary yield data has been evaluated with further testing to determine if the high seed-per-pod trait could be used to develop varieties for the Missouri soybean farmers.

## BREEDING PRODUCTIVE, PEST RESISTANT, CONVENTIONAL AND HERBICIDE TOLERANT GROUP IV AND V SOYBEANS

Pengyin Chen, Grover Shannon & Andrew Scaboo; University of Missouri

The objective of this research is to develop new soybean varieties for the Missouri Delta region and other Mid-South environments. The specific objectives are breeding for higher yields, disease and nematode resistance and quality traits.



Photo by Kyle Spradley - University of Missouri

Soybean harvest at the Fisher Delta Research Center

This soybean breeding program is housed at the University of Missouri's Fisher Delta Research Center in Portageville. Grover

Shannon led the program for many years and he retired from the program in fall of 2015, handing over the reins in 2016 to Pengyin Chen. Chen is an accomplished soybean breeder with experience managing the University of Arkansas soybean breeding program for many years. Key focus areas are the development of varieties with SCN and Root Knot nematode resistance, frogeye leaf spot resistance and of course yield. Multiple varieties have been released the last two years from the Fisher Delta Research Center soybean breeding program. High oleic varieties are also an important aspect of the research program.



Photo courtesy of the University of Missouri

Pengyin Chen, soybean breeding program leader

## BREEDING AND GENETIC MAPPING FOR FLOODING TOLERANCE IN SOYBEAN

Pengyin Chen, Grover Shannon & Andrew Scaboo; University of Missouri

The objective of this research is to develop new flood tolerant soybean varieties for the Missouri Delta region and Mid-South environments. Breeding varieties with flood tolerance for higher yields, disease and nematode resistance and quality traits. The project objectives are as follows:

1. Screen a set of soybean varieties and new plant introductions in group III, IV, and V to identify new sources of flooding tolerance.
2. Identify new flood tolerance germplasm and identify and map genes for tolerance.
3. Evaluate the lines aimed at developing new adapted varieties for flood tolerance as well as current cultivars for tolerance.

Modern soybean breeding techniques and mapping of new genes of flood tolerance are employed to accomplish the



Photo by Kyle Spradley - University of Missouri

Soybeans are grown as part of variety trials at Fisher Delta Research Center

goals. Further work will be conducted to yield test lines under flooding and under optimum conditions.

## EVALUATION OF OLEIC ACID GERmplasm FOR DEVELOPMENT OF SOYBEANS WITH HIGH OLEIC ACID

Pengyin Chen, Grover Shannon & Andrew Scaboo; University of Missouri

The primary goal of this project is to develop productive group III, IV and V soybean varieties for Missouri with the high oleic and low linolenic traits. The outcome is to deliver soybean oil with a healthier profile and provide a more functional oil for food, feed and industrial applications. This is being accomplished using the patented, non-GMO, high oleic genes and methods discovered in Missouri by USDA and University of Missouri researchers. High oleic, low linolenic acid soybean oil is similar to olive oil but, it can be produced in huge quantities and sold more economically than olive oil. This trait has tremendous potential benefit to Missouri Soybean Farmers.

This work is conducted at both the Fisher Delta Research Center and Bay Farm Research Facility and is a collaborative effort between Pengyin Chen, Andrew Scaboo and Grover Shannon.

## FAST NEUTRON MUTAGENESIS IN SOYBEAN: A RESOURCE TO AID IN THE TRANSLATION OF GENOMIC INFORMATION INTO APPLIED TECHNOLOGIES

Gary Stacey, University of Missouri

A driving force in changing the soybean crop through fast neutron mutagenesis is the relatively low genetic diversity in soybean compared to other major crops such as corn. The low diversity limits the available naturally occurring plant variations that can be exploited for crop improvement. Inducing mutagenesis is a method that create a large number of genetically diverse parental cultivars. Fast neutron is used because of its known ability to induce genetic deletions, which can be rapidly identified by using a Comparative Genome Hybridization technique.

This research is designed for the improvement in the quality of U.S. soybean by improving meal and oil through mutational breeding, while also seeking to increase the combined soybean seed content of protein and oil.

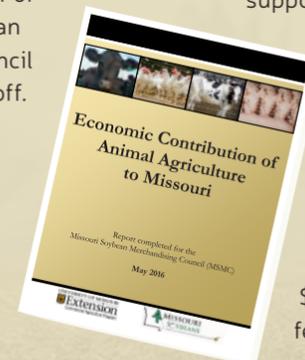
## 2016 REPORT REVIEWS ECONOMIC CONTRIBUTIONS OF ANIMAL AGRICULTURE IN MISSOURI

The University of Missouri Extension Commercial Agriculture Program prepared

this report on behalf of the Missouri Soybean Merchandising Council and soybean checkoff. This report covers the contribution of both Missouri's animal production and processing industries. The economic impact from Missouri's

animal agriculture industries extends beyond production of raw agricultural commodities. Missouri has significant animal product processing industries, and livestock are the top consumer of Missouri-grown soybeans. Details from the report's executive summary follow, with the full report available at mosoy.org.

For Missouri, the aggregated animal production and processing industries supported 154,268 jobs and paid \$6.212 billion in labor income. Additionally, the effect to value-added (also referred to as gross regional product) provided \$11.682 billion to the state's economy. State/local entities were supported with \$698.7 million in taxes and \$1.435 billion was provided in federal tax dollars.



For individual Missouri counties, top counties in jobs supported from animal production and processing industries were St. Louis (8,665), Greene (7,012) and Buchanan (5,977), which all include large animal processing industries. Similar as jobs supported, the top counties in total value-added were St. Louis (\$1.694 billion), Buchanan (\$590.7 million), and Greene (\$556.8 million). Some counties are more reliant on animal agriculture than others. Sullivan County represents the most dependent county on animal agriculture, with 72 percent of its regional economy supported by these industries. Other counties that have a high proportion of animal agriculture in its total economy include McDonald (51 percent), Vernon (36 percent), Saline (32 percent) and Barry (30 percent).

# SCN and Crop Physiology

## USING MICROGENOMICS TO IDENTIFY NEW SOURCES OF SOYBEAN CYST NEMATODE RESISTANCE IN SOYBEAN

Melissa Mitchum; University of Missouri

This project will study a new biotech approach to soybean nematode resistance. SCN have been adapting to the current source of resistance. Looking at new approaches to resistance as well as resistant sources is of utmost importance for fighting this serious pest of soybean. SCN continues to be a top priority for soybean producers which has been addressed by widespread planting of resistant soybeans. However, the source of resistance found in nearly all commercially available soybean varieties can be traced to one plant introduction (PI) 88788.

The key to developing broader, more durable resistance in soybean cultivars hinges on understanding how resistance genes work on a molecular level. Research is being done to understand how plant defense mechanisms work against SCN and exploiting the information through novel

or conventional plant breeding approaches. Molecular markers have been developed that can differentiate between resistance alleles and inform soybean breeders how to combine SCN resistance genes to generate new resistance options.



Photo courtesy of the University of Missouri

Melissa Mitchum and colleagues study soybean plants in a greenhouse on the University of Missouri Campus

## MISSOURI SOYBEAN VALUE CHAIN STUDY

The Missouri Soybean Merchandising Council (MSMC) recently received a valuable report that will help it prioritize checkoff investments for the future. The report, Missouri's Soybean Value Chain, provides a comprehensive overview of the varying factors that influence the state's soybean supply chain, including an analysis of producing, transporting, processing and marketing Missouri soybeans.

In addition to providing a snapshot of the soybean industry from farmers to end-users, the report provides an outline of opportunities to enhance

the profitability of Missouri soybean growers. Other sections of the report break down and analyze each sector of the value chain such as supply, distribution, demand and financial flows.

Ray Massey, an agricultural economist with University of Missouri Extension's Commercial Agriculture Program, is one of four authors who contributed to the writing of the report. He notes that while soybeans are already Missouri's top commodity in terms of cash receipts, there's room for soybean farmers to generate even bigger returns.

"Overall, I'd say our findings should be seen as encouraging for Missouri soybean farmers," Massey says. "They are in good position to capture

additional value from their soybeans due to the many opportunities that exist to make improvements throughout the value chain."

The report starts with the basics, tracking acreage, yield and production trends, before moving into an assessment of the state's grain storage and transportation resources. Additional sections explore the processing industry and the financial considerations associated with the Missouri soybean industry.

Learn more about the report online at [mosoy.org](http://mosoy.org).

## ENHANCING WATER USE EFFICIENCY OF ADVANCED SOYBEAN GERmplasm TO IMPROVE DROUGHT TOLERANCE

Felix Fritschi & Andrew Scaboo; University of Missouri

This project will study the response of genotypes with contrasting stable isotope signatures under distinct growing conditions. Objectives are to determine genotype by environment interactions and suitability in distinct environments, enhance our understanding of physiological mechanisms that underpin the stable isotope traits, and use soybean germplasm previously identified to have increased water use efficiency based on stable isotope analyses to incorporate this trait into breeding lines.

Development of soybean varieties with greater drought tolerance is very challenging, but also has very promising potential to stabilize soybean yields. The stable isotope technique has been tested in various crops, and University of Missouri research has successfully identified soybean genotypes with distinct indications of water use efficiency. The program is uniquely positioned to pursue breeding with these promising novel traits, and better understand and explore mechanisms that could lead to improved drought tolerance in soybean varieties for Missouri farmers.

## HIGH-THROUGHPUT PHENOTYPING TO ACCELERATE SOYBEAN IMPROVEMENT THROUGH AGRONOMY, BREEDING AND GENETICS

Felix Fritschi, Gary Stacey, Andrew Scaboo, Bill Wiebold, Guilherme DeSouza, & Minviluz Stacey; University of Missouri

Research focus is to implement and deploy a phenotyping platform that will accelerate soybean improvement by facilitating repeated, rapid, accurate, non-destructive plant measurements. The optimized platform will be available to Missouri soybean researchers conducting experiments ranging from crop management to fundamental genetics for many years to come.

Yield measurements are the ultimate measure of crop performance. However, while yield improvement is the desired outcome, final yield does not provide sufficient information of crop growth and development differences that led to the improved yield. In-season crop measurements are critical to understand why yield may differ, and what we might want to change within the growing season to improve profitability. Phenotyping platforms combine multiple types

of sensors that complement or expand measurements commonly made in agronomic, physiological, and genetic studies. This platform can and will be used by many different researchers at the University of Missouri.

## IMPROVING HEAT TOLERANCE: IDENTIFICATION AND CHARACTERIZATION OF SOYBEAN GERmplasm

Felix Fritschi, Jason Gillman & Arun Prabhu Dhanapal; University of Missouri

Soybean yield is strongly influenced by the weather conditions prevalent during key parts of the growing season. Among the weather factors, temperature plays a major role in the success or failure of flower and pod development and therefore, yield! Soybean yield is known to be very



Photo by Kyle Spradley - University of Missouri

Soybean variety testing fields at University of Missouri South Farm

sensitive to high temperature. The knowledge gained about the genetics and physiology involving heat tolerance can be employed to guide breeding of more heat tolerant soybean varieties.

The goals of this project are to:

- 1) Identify germplasm with increased heat tolerance by exploiting genetic variability of MG III and IV genotypes
- 2) Develop a better understanding of the mechanisms that protect soybean yield from losses during episodes of high temperature stress.
- 3) Initiate incorporation of heat tolerance traits into advanced soybean germplasm and development of mapping populations.

# Feed, Food and New Uses

## NUTRITIONAL EVALUATION OF SOYBEAN MEAL GENERATED FROM HIGH OLEIC ACID SOYBEANS

Monty Kerley, University of Missouri

This project is to provide nutritional information (amino acid profile, amino acid digestibility, energy digestibility) of HO soybean meal for use by animal production facilities (purchasers of soybean meal) in valuing HO meal. The goal of this research is to determine if high oleic acid soybean produced meal is comparable in nutritional quality to soybean meal generated from seeds without this characteristic. A growth and digestibility study with broiler chicks is being conducted to determine nutritional



Photo courtesy of the University of Missouri

Improved soybeans may benefit the nutrition of livestock feed

consequences of soybean meal with enhanced properties. Protein chemistry techniques are being added to the research to determine if a particular change in protein structure was responsible for differences measured in feed to gain.

## INTRAGASTRIC GELATION OF MIXED SOY PROTEIN AND FIBERS AND ITS EFFECT ON POSTPRANDIAL SUGAR RELEASE

Bongkosh Vardhanabhuti & Heather Leidy; University of Missouri

This project will investigate the digestion properties of mixed soy protein and fibers and how their in-vitro intragastric gelation affects postprandial sugar release in human subjects. Knowledge gained could be used to develop

food products for diabetic and pre-diabetic aging population around the globe. The preliminary study showed that beverages containing soy protein isolate and anionic fibers could form intragastric gel resulting in slower release of sugar. This potential product can lead to the development of high protein beverages or semi-solid foods with slow release sugar property that could lead to lowered blood glucose for diabetic or pre-diabetic population. This could lead to a significant increase in utilization and sale of soy protein ingredients.

## OIL-DERIVED EPOXY MONOMER FOR STRUCTURAL COMPOSITE APPLICATIONS

Thomas Schuman; Missouri University of Science and Technology

The project goal is to develop monomer into a marketed product and further develop applications toward broader market access. This project is working to further develop application and begin commercialization of a unique soybean oil-derived monomer as a resin system that shows promise for structural composite applications. The resin material is considered to be 100 percent bio-based. The use of oil monomer material by itself or with commercial epoxies in structural and structural composite applications has demonstrated unique properties including high strength, higher temperature application window, and improved computability and reactivity. This additional application data will demonstrate higher market value with the potential for Missouri farmers to move new industrial materials into the marketplace via performance and cost.

## NEW MID-SOUTH SOYBEAN BOARD CHAIR



Pat Hobbs, Dudley, MO

Missouri's own Pat Hobbs chairs the Mid-South Soybean Board, created by the soybean promotion boards in Arkansas, Louisiana, Mississippi and Texas to coordinate research in the four-state area.

Pat also volunteers as the District 7 Director on the Missouri Soybean Merchandising Council.

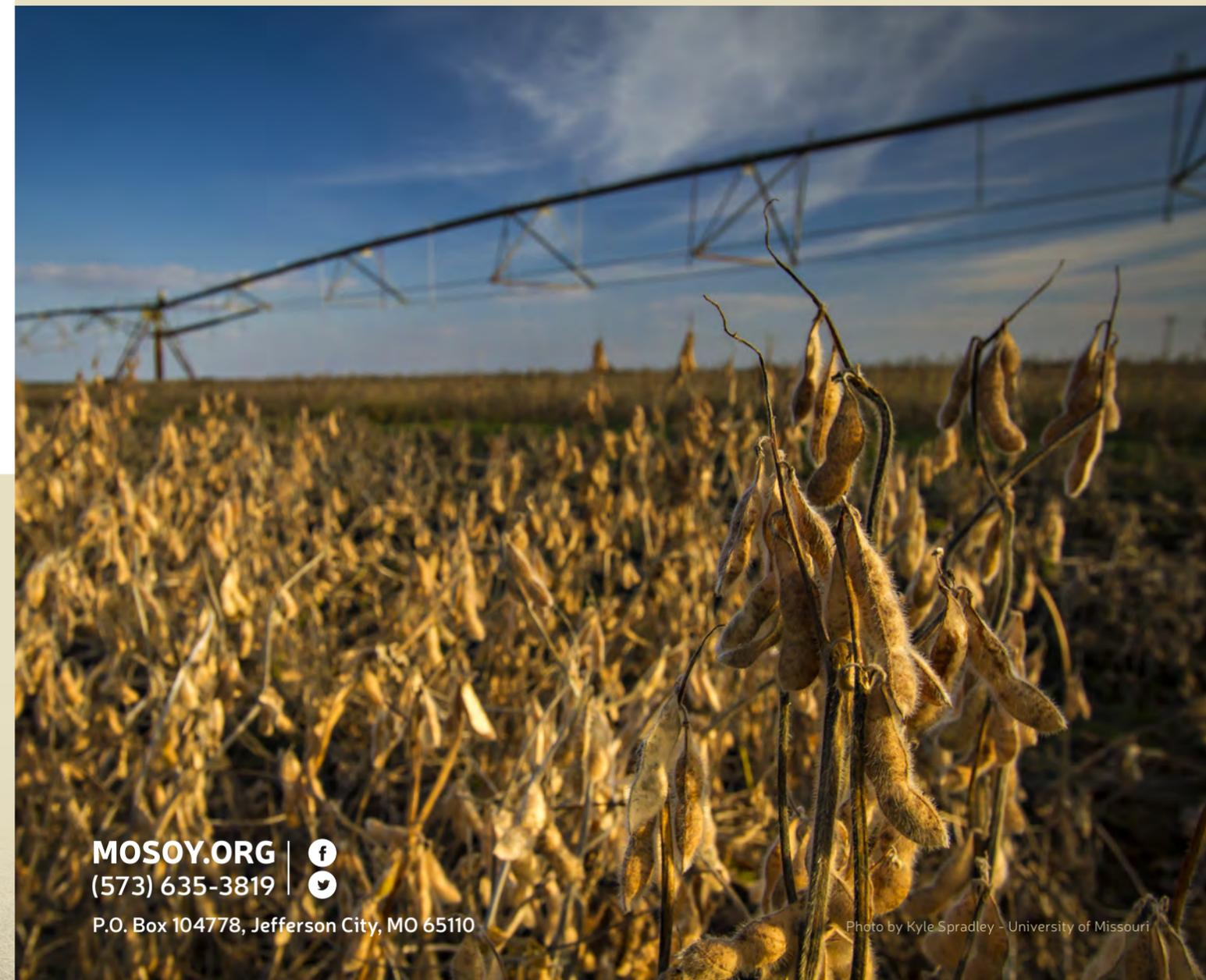
## THE SOYBEAN RESEARCH & INFORMATION INITIATIVE



A project funded by the North Central Soybean Research Program (NCSRP), the Soybean Research and Information Initiative helps make soybean research more accessible. The initiative launched in the spring of 2014 as an effort to build upon the functionality and success of the Plant Health Initiative (PHI) in developing an easy access one-stop shop for soybean research. The site can be found at [www.soybeanresearchinfo.com](http://www.soybeanresearchinfo.com). The Missouri Soybean Merchandising Council is a member of the NCSRP and supporter of this project.



Missouri soybean farmer Cecil Demott of Rock Port serves as the NCSRP vice-chairman.



MOSOY.ORG  
(573) 635-3819



P.O. Box 104778, Jefferson City, MO 65110

Photo by Kyle Spradley - University of Missouri



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