



# ***WINNING SOLUTIONS***

***TO ON-FARM CHALLENGES***

RESEARCH **2019** REPORT



# TEAMWORK COUNTS

One of the priorities of the Ohio Soybean Council (OSC) and soybean checkoff is funding plant research that will help Ohio soybean farmers succeed in the field. To achieve this goal, the organization partners with experts at The Ohio State University (OSU) to find new and innovative solutions. This report highlights many of these programs.

OSC works closely in the state with OSU's Center for Soybean Research, as well as with regional and national organizations such as the North Central Soybean Research Program (NCSRP), United Soybean Board (USB) and the Soybean Cyst Nematode (SCN) Coalition. This allows checkoff dollars to be maximized without duplicating research across state lines.

By combining basic research (asking why, what and how to expand knowledge) with applied research (using knowledge to create practical solutions), OSC is working to develop winning solutions for farmers across the state. To learn more about these projects and others funded by your checkoff dollars, visit [OhioFieldLeader.com](http://OhioFieldLeader.com).

# WINNING SOLUTIONS TO ON-FARM CHALLENGES

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# OFFENSE:

## DRIVING PRODUCTION & VALUE UP THE FIELD

When it comes to your soybean crop, there's no room for a Hail Mary. That's why experts at OSU are helping farmers to be on the offensive by developing solutions for better soil health, improved nutrient management, profitable conservation practices and high-value soybean varieties. This creates better production and profitability for Ohio soybean farmers, and helps you score big on your checkoff investment.

### REVISING TRI-STATE

# FERTILIZER RECOMMENDATIONS

#### PROBLEM:

Are 20-year-old fertilizer recommendations still valid?

#### SOLUTION:

Research and revision of Tri-State Fertilizer Recommendations.

#### RESULTS:

- With some minor changes, the Tri-State Fertilizer Recommendations are still valid.
- Research indicates no significant need for a draw-down phase, which will help simplify the guidelines.
- Soil testing and following the Tri-State guidelines will help minimize fertilizer costs and runoff risk without sacrificing yield.

With a goal of improving farmer profitability, as well as helping reduce impact on water quality, Dr. Steve Culman, assistant professor at OSU and state specialist in soil fertility, wanted to discover fertilizer application rates that optimize return-on-investment for Ohio soybean farmers.

“If farmers put an extra hundred pounds of nitrogen or an extra hundred pounds of phosphorus on their fields and only get an extra five-bushel yield response, it’s definitely not going to pay for itself,” Culman said. “And it’s not going to have good environmental outcomes.”

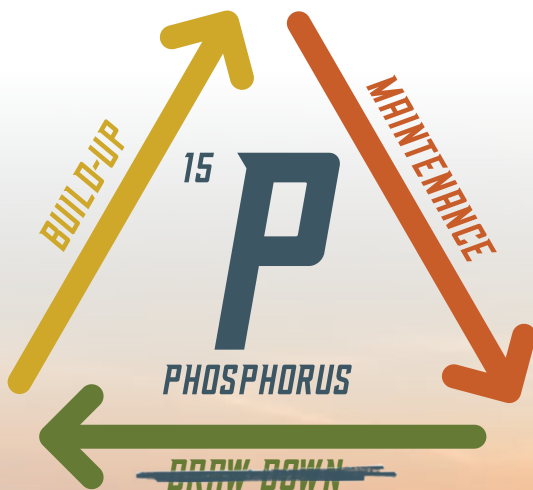
**“WE NEED TO MAKE SURE OUR RECOMMENDATIONS ARE CONSISTENT WITH THE KIND OF ECONOMIC REALITIES TODAY’S FARMERS FACE.”**

— Dr. Steve Culman, OSU

It’s been more than 20 years since the Tri-State Fertilizer Recommendations have been revised. To bring the recommendations into the 21st Century, a robust, on-farm study was conducted over the last five years including more than 300 trials on a wide variety of farm locations and soil types. Four significant nutrient rates were evaluated: nitrogen, potassium, phosphorus and sulfur. Most of the trials evaluated phosphorus rates due to growing public concerns over water quality and algal blooms.

Currently, there are three different equations for phosphorus: a build-up phase, a maintenance phase and a draw-down phase. However, the new research indicates no significant need for a draw-down phase.

**“TOP-LINE, THE REVISED RATE RECOMMENDATIONS WILL BE MORE ABOUT TWEAKS THAN SIGNIFICANT CHANGES, BUT IT DOES VALIDATE THE VALUABLE RESEARCH THAT BUILT THE TRI-STATE RECOMMENDATIONS,” SAID CULMAN.**



“One of the biggest changes we’ll see is that we’re actually dropping that phase in order to simplify the recommendations. In that sense, there’s a bit of a reduction for phosphorus,” remarked Culman.

With all the risks and uncertainty in farming, the intent of this project is to help alleviate some of that uncertainty regarding profitable fertilizer rates, while helping improve water quality.



## ON-FIELD OHIO ONLINE TOOL

### PROBLEM:

Soil erosion and fertilizer runoff.

### SOLUTION:

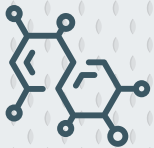
Updating and revising Ohio's Phosphorus Risk Index and developing an online tool for farmers.

### RESULTS:

- Erosion is the most important factor in phosphorus loss.
- At a high level, following the 4Rs of nutrient stewardship (right rate, right time, right source, right place) works.
- Significant reductions to phosphorus runoff can be achieved by minimizing soil disturbance and getting phosphorus in contact with the soil—banding and injecting are good options.

Dr. Elizabeth Dayton has been working to update Ohio's Phosphorus Risk Index and create an online tool that farmers can use to estimate risk of phosphorus loss on individual fields. On-Field Ohio will help support our farmers, federal and state agencies and others grappling with water quality issues.

The project collected data on more than 2,000 runoff events and more than 14,000 runoff water samples, resulting in more than 42,000 analyses. High level takeaways from the work include 1) erosion matters and is a major factor in phosphorus loss; 2) following the 4Rs of nutrient stewardship works; and 3) runoff can be reduced by getting nutrients in contact with the soil in ways that minimize soil disturbance.



**EROSION =  
PHOSPHORUS LOSS**



**FOLLOW THE 4RS  
OF STEWARDSHIP**



**REDUCE RUNOFF WITH  
MINIMAL SOIL DISTURBANCE**

**THE ON-FIELD OHIO TOOL IS NOT YET AVAILABLE TO FARMERS, BUT RESEARCHERS ARE WORKING DILIGENTLY TO LAUNCH IT IN THE NEAR FUTURE.**

The power of On-Field Ohio is the ability for farmers to evaluate the potential for reductions in erosion and/or phosphorus runoff by comparing their current crop management program with alternative scenarios. It will help farmers prioritize time and resources in making their management decisions.

**“THE OHIO SOYBEAN COUNCIL IS REALLY HELPFUL IN BETA TESTING. THEY’LL BRING IN FARMER MEMBERS, LET THEM KICK THE TIRES AND GIVE US FEEDBACK THAT HELPS REFINE THE TOOL.”**

— Dr. Elizabeth Dayton, OSU

# COVER CROPS

## PROBLEM:

Conservation farming and economic returns need more correlation.

## SOLUTION:

Evaluate yield response and benefits of cover crops on continuous and double crop soybeans.

## RESULTS:

- In terms of yield, cover crops have no effect positively or negatively.
- Cover crops add biodiversity, reduce soil erosion and help improve soil moisture maintenance.
- Future work on this project will include studying barley for farmers interested in double cropping soybeans.

In recent years, continuous soybeans have become attractive in many parts of the state. But how can farmers mitigate the negative effects of monoculture farming? One solution is to add the biodiversity of a winter cover crop. Beyond looking at effects on yield, Dr. Laura Lindsey, an associate professor at OSU, has examined the relationship between cover crop termination timing and the potential impact on soybean disease, *soybean cyst nematode*, slugs and insects. Her research also evaluates seed treatments and foliar fungicides.

Lindsey pointed out, “In our study, it certainly did not hurt yield at all. Besides adding biodiversity to the soil, farmers get another big environmental benefit with a cover crop by reducing erosion and helping improve soil moisture maintenance.”

As demand grows for Ohio’s microbrew market, new shorter-season barley varieties are gaining popularity. The premiums offered for high quality malting barley grain coupled with double crop soybean production could offer a very profitable cropping system for Ohio farmers.

However, soybeans planted later in the growing season (mid-June through early July) require different management compared to soybeans planted in May. Lindsey’s research will provide recommendations for soybeans grown in a corn/barley/soybean rotation.

**“IT’S A BIG POSITIVE FOR FARMERS BECAUSE MANY HAVE THE IMPRESSION THAT COVER CROPS WILL HURT THEIR YIELDS. WE DON’T SEE ANY EVIDENCE OF THAT.”**

—Dr. Laura Lindsey, OSU

# HIGH-VALUE CULTIVARS

## PROBLEM:

Continued low commodity prices are signaling the need for higher-value cultivars.

## SOLUTION:

Food grade and specialty variety breeding program.

## RESULTS:

- Work is ongoing to develop unique cultivars and accelerate their availability to the market.
- When novel traits are categorized, the information will be released to the public domain and made available to breeders.
- Two new varieties are planned for release by the end of 2019.


Associate Professor Dr. Leah McHale cares a lot about breeding better soybean varieties. Her research at OSU focuses on the breeding and development of unique, higher-value soybean cultivars, and helping accelerate their availability to Ohio soybean farmers. Development of food-grade cultivars helps expand international niche market opportunities for Ohio farmers. Through improvement of pest and disease resistance, farmers can better reduce risk while helping increase yields. And development of high oleic cultivars will help farmers meet growing demand for lower saturated fats.

**“WE ARE DEVELOPING FERMENTED, OR NATTO SOYBEANS, BLACK-SEEDED SOYBEANS, AS WELL AS CULTIVARS FOR SOY MILK, TOFU AND SPROUTS FOR THE GROWING MARKETS HERE AND IN ASIA.”**

— Dr. Leah McHale, OSU

Additionally, the project will develop cultivars that integrate resistance to various pests and pathogens, including *pythium*, *phytophthora*, *fusarium* and *soybean cyst nematode*. McHale works in collaboration with the soybean checkoff through the United Soybean Board on a project that studies seedling





diseases. The project helps McHale identify those seedlings showing disease resistance and characterize the genes that are actually controlling resistance. When all these novel traits are genetically categorized, materials will be released with breeder-friendly molecular markers, making it easier for breeders to select traits of interest and bring new soybean cultivars to market.

**“THE SOYBEAN COMMUNITY AT OSU IS HIGHLY INTERACTIVE. ALL RESEARCHERS HAVE BI-MONTHLY MEETINGS, SO RESEARCHERS AND STUDENTS ARE VERY AWARE OF THE RESEARCH GOING ON IN EVERY ONE OF OUR DIFFERENT AVENUES,” SAID MCHALE.**

Another of McHale’s objectives is training the next generation of plant breeders.

“We’ve developed a plant breeding and genetics website for the university to make The Ohio State University known as a hub for plant breeding and genetics expertise,” said McHale.

The Ohio State Crop Variety Release and Distribution Committee determines if a proposed variety can be released and under what mechanism, either a named university release or a branded release.

Ultimately, this project can help Ohio soybean farmers access higher-value niche markets and improve their profitability while reducing risk of disease.

# SOIL HEALTH

## PROBLEM:

Soil health and quality tests need an improved low-cost rating system.

## SOLUTION:

Build a better soil health and quality index that can be easily adopted by commercial soil testing labs.

With rising emphasis on soil quality for optimal yields and sustainability, there is a need to develop soil health and soil quality indicators that are low cost and can be easily adopted by commercial soil testing labs. Previous research has identified an enzyme that detects soil change relatively rapidly, within one or two years, allowing researchers to relate the index to yield while also accounting for the effect of soil drainage.

## RESULTS:

- Several enzymes (which are used in testing) were identified that are good and consistent indicators of the long-term biology (health) of the soil.
- The differences in soil types that exist in Ohio will require additional calibration to ensure consistency in tests across the state.
- Using the basic research, the next goal is to create an index that will indicate how higher soil quality equates to higher yields.

**“BY MEASURING THE ENZYME ACTIVITIES AND DIVIDING BY THE CLAY CONTENT, A SIMPLE CALCULATION HELPS LEVEL THE PLAYING FIELD AMONG THE DIVERSE SOIL TYPES.”**

— Dr. Richard Dick, OSU

“We’ve screened a lot of different enzymes and came up with several that met these criteria: they reflect a long-term biology, do not change rapidly or fluctuate within a season but can show changes under three years,” said Dick.

The team is currently working out differences in how this enzyme works within soil types. For example, sandy soils will never have the robust biology or the structure of a loam soil. The research team will have to calibrate those differences.

Ultimately, the index may evolve to factor in up to eight different measurements that would include chemistry, biology and physics. “The holy grail will be creating a reliable index that can indicate how higher soil quality equates to higher soybean yields,” said Dick.

# DEFENSE:

## HELPING GUARD, BLOCK & TACKLE AGAINST DISEASES, INSECTS & WEEDS

A good offensive strategy needs a good defense. Weeds, insects, disease and other yield robbers must be managed to get the most from your soybean crop. While fighting resistance is a constant challenge, thanks to experts at OSU, we are not only helping soybean farmers develop better soybeans—we're finding new and innovative ways to defend return on investment.

### BIOLOGICAL CONTROL

#### PROBLEM:

Current nematode controls are losing their effectiveness.

#### SOLUTION:

Employ a biological plant growth stimulant to protect soybean roots.

In the last two years, OSU researchers have identified bacteria that show consistent ability to reduce *soybean cyst nematode* populations. They are currently working with a company called 3Bar Biologics to commercialize a biological product that can help protect soybean roots against nematode attack.

At OSU, Dr. Chris Taylor, associate professor of molecular genetics and nematology, studies plant-growth-promoting rhizobacteria (PGPR) that have been shown to exhibit activity against root-knot and *soybean cyst nematodes*.

“We’ve screened over 12,000 bacterial isolates and have identified a few of those in a particular group called pseudomonas. These are bacteria commonly found in all types of agricultural soils,” Taylor said. “We looked closely at about 50 of them and narrowed it down to six or seven that showed interesting activity in the greenhouse.”

#### RESULTS:

- Over 12,000 bacterial isolates were screened, which researchers then narrowed down to six or seven that showed promise.
- Work to narrow the options down further is ongoing.
- OSU has partnered with 3Bar Biologics on commercialization of the product when it's ready.

# DISEASE RESISTANCE

## PROBLEM:

Excessive wet weather raises pressure along with resistance.

## SOLUTION:

Identify new genes and combinations of genes that can transfer resistance to Ohio soybeans.

## RESULTS:

- Several pathogens have re-emerged stronger than ever as yield-robbing threats.
- Severe Frogeye Leaf Spot outbreaks have been reported, and it has become resistant to several strobilurin fungicides. *Phytophthora* is appearing this year in regions where it hasn't previously been a problem.
- New resistant genes are being identified and will eventually be incorporated into Ohio soybean varieties, offering farmers additional cutting-edge management tools.

Following years of wet springs and growing fungicide resistance, Dr. Anne Dorrance, professor of soybean pathology at OSU, is working to bring farmers new solutions to soybean pathogens that have re-emerged as threats. Her goal is to identify the best disease management practices for Ohio's challenging environments and changing pathogen populations.

The study involves monitoring soybean pathogens throughout the year to determine what pathogens represent the biggest threats to Ohio soybean farmers.

"I've gotten first reports of severe Frogeye Leaf Spot outbreaks. Previously, this pathogen wasn't threatening enough to require a fungicide application," Dorrance explained. "Now we know it's resistant to a lot of our strobilurin fungicides, and it's already at high levels, which means it definitely warrants use of a fungicide. We've also heard reports of *phytophthora* outbreaks in regions of Ohio where we've never seen it before."

There are two basic types of resistance, classical single-gene resistance and quantitative resistance. The problem is that many Ohio *phytophthora* populations have adapted to overcome single-gene resistance.

Dr. Feng Qu, an associate professor of molecular plant virology and plant resistance at OSU, works closely with Dorrance to approach these same problems from a different angle, utilizing a cutting-edge research technique called Virus-Induced Gene Silencing (VIGS). VIGS helps identify elusive locations where resistant and partially-resistant genes can be found within the soybean genome. This allows for a deeper dive into some of the cultivars from around the world to expand the gene pool.



**“WE’RE EXCITED ABOUT A NUMBER OF NEW GENETIC SOURCES CHARACTERIZED FOR TRANSFERRING *PHYTOPHTHORA* RESISTANCE. IT’S A WHOLE NEW AREA OF SCIENCE.”**

— Dr. Anne Dorrance, OSU

“The scale of what we’re looking for is quite small. It’s very difficult to segregate those into individual genes. My group comes in and tries to knock-down those genes one by one to see if we can identify the one or two individual genes responsible for resistance,” explained Qu.

With multiple genes, each of the genes have a relatively small effect. As many as 15 genes may account for only 20 percent of the expressed resistance. Multiple genes must work together. Multiple genes also make it harder for the pathogen to develop resistance to them.

**“WE’RE CURRENTLY WORKING TO IDENTIFY A GROUP OF GENES THAT COMBAT AND RESIST THE INFECTION OF A PATHOGEN THAT INFECTS WATERLOGGED SOYBEANS, WHICH HAS BEEN A COMMON SITUATION IN OHIO,” SAID QU.**

By continuing these investigations, new resistant genes can be mobilized and incorporated into Ohio soybean varieties, offering farmers cutting-edge disease management tools that can reduce pesticide use and help assure the long-term viability of Ohio soybean farmers.

# WEED RESISTANCE

## PROBLEM:

Weed pressure and resistance is a major challenge for Ohio farmers.

## SOLUTION:

Raise awareness, monitor fields and educate farmers on what works and what doesn't in weed management.

## RESULTS:

- Prevention and control of every single weed before they seed is vital, as billions of seeds can be released in a field.
- Resistance continues to develop even in three-way herbicide programs. Researchers continue to look for better ways to stay ahead of this problem.
- It is recommended that farmers use a diverse weed management program that includes multiple types of herbicides and other actions that kill the weed prior to seeding.

Dr. Mark Loux, professor and Ohio State University Extension weed control specialist, wants to make sure farmers appreciate the impact and damage weeds can cause, the sources of infestations and the importance of prevention and controlling every single weed—before they go to seed.

Waterhemp seems to have entered Ohio from the west and is now found across the state. “The bottom line is, if we don't get these weeds before they seed, they will have an almost permanent negative input on Ohio farmer profitability,” said Loux.

In the western part of the state, three-way herbicide resistance to glyphosate, dicamba and 2,4-D has already been documented. While there's not much in the eastern part of the state yet, the three-way resistance is already starting to morph into more types of resistance.

**“THERE CAN LITERALLY BE BILLIONS OF SEEDS RELEASED IN A FIELD, MEANING MORE OPPORTUNITIES FOR MINOR MUTATIONS TO EXHIBIT RESISTANCE AND TAKE ROOT IN YOUR FIELDS.”**

— Dr. Mark Loux, OSU

This USB-created campaign includes magnets, bumper stickers and t-shirts to raise awareness about waterhemp and Palmer Amaranth prevention. To learn more, please visit [IWillTakeAction.com/Weeds](http://IWillTakeAction.com/Weeds).

No pigweed left behind  
Go Rogue! Stop the seed



THE OHIO STATE UNIVERSITY

USB

OHIO STATE UNIVERSITY

# REMOTE SCOUTING

## PROBLEM:

Accurate crop scouting is limited and time-consuming on large fields.

## SOLUTION:

Employ new technologies like artificial intelligence (AI), unmanned aerial systems, remote sensing and more.

## RESULTS:

- An unmanned aerial system using remote sensing technology has been developed that can identify 90-95 percent of common Ohio soybean stresses with impressive accuracy.
- This technology could potentially double daily coverage for crop scouts.
- The project leaders are currently accumulating hundreds of thousands of high-resolution images to improve and validate the technology.

OSU Professor Scott Shearer is developing small Unmanned Aerial Systems (sUAS) that use remote sensing technologies to rapidly diagnose soybean crop health issues. By using machine-learning, AI and cutting-edge image-acquisition techniques, crop scouts will be able to cover acres more quickly and with more accuracy when diagnosing crop stress.

In one set-up described by Shearer, sensors and cameras are placed on the end of a rod suspended below the drone. The rod drops down into the plant canopy where early signs of soybean disease or insect pressure can be spotted.

An AI neural network classifier is trained to identify those images so stresses can be diagnosed almost instantly. While some stresses have been easier to identify, nutrient deficiencies are still a work in progress, according to Shearer.

**“WE’RE HOPING TO PUT A CROP CONSULTANT OR SCOUT IN 15 TO 20 LOCATIONS IN A LARGE SOYBEAN FIELD, WITHIN A MATTER OF MINUTES INSTEAD OF HOURS.”**

— Dr. Scott Shearer, OSU

TO LEARN MORE ABOUT THIS RESEARCH AND OTHER  
PROJECTS FUNDED BY YOUR SOYBEAN CHECKOFF  
DOLLARS, VISIT [OHIOFIELDLEADER.COM](https://ohiofieldleader.com)



[SOYOHIO.ORG](https://soyohio.org)



[OHIOFIELDLEADER.COM](https://ohiofieldleader.com)

The Ohio Soybean Council (OSC) was founded in 1991 to manage the Soybean Promotion and Research Program, commonly known as the soybean checkoff. OSC is governed by a volunteer farmer board, which directs the investments of the checkoff. The program's primary goal is to improve soybean profitability by targeting research and development, education and marketing projects.