

FY 2020 Annual Report of Accomplishments and Results

Indiana
Purdue University

I. Report Overview

The NIFA reviewer will refer to the executive summary submitted in your FY 2020 Plan of Work located in the Institutional Profile. Use this space to provide updates if needed.

1. Executive Summary (Optional)
<p><u>First, just a brief highlight of Purdue Research and Extension 2020 pandemic-specific activities.</u></p> <p>In Research efforts, Purdue Veterinary Medicine researchers identified an FDA emergency-authorized molecular test using Animal Disease Diagnostic Lab (ADDL) equipment for coronavirus testing of Purdue students, faculty, and staff. They created seven Standard Operating Procedures and trained molecular technicians. With the Indiana State Department of Health, they validated Clinical Laboratory Improvement Amendments for human testing. ADDL tested 140,000 samples and recently began surveillance for COVID-19 variant detection. Purdue Biological Engineering researchers used loop-mediated isothermal methods for nucleic acid amplification to detect SARS-CoV-2 in saliva, producing a color change visible in under 60 minutes. Incorporating reagents on a paper-based microfluidic device simplified the assay operation. This COVID-19 test has been transferred to an industry partner for potential commercialization. Purdue Food Science researchers evaluated a plant-based, highly potent nanoparticle called OHPP to enable niclosamide, an FDA-approved drug for tapeworm infestations, for antiviral efficacy against SARS-CoV-2. Results showed OHPP substantially increased bioavailability of niclosamide. Testing with transgenic mice showed encouraging results of OHPP-solubilized niclosamide for treating SARS-CoV-2 infection.</p> <p>For Extension activities, to help communities, families and businesses cope during the pandemic, Purdue Extension used technology to expand program delivery. Purdue Extension increased its reach to contacts by 83% via technology, but with 77% fewer in-person engagements. Indiana 4-H youth and volunteers navigated virtual and in-person events at county fairs with no known COVID-19 outbreaks. Master Gardener programs offered online tools as people looked to hobbies like gardening to enjoy the outdoors. “Tips for First Time Gardeners” video series was launched on social media receiving 30,000 views.</p> <p>In meeting community needs, Purdue Extension partnered with Prairie Farms to redistribute 9,000 gallons of milk to food pantries and communities with food deserts. 4-H youth and adult volunteers donated food assistance and volunteer time to food pantries and school backpack programs; created sharing gardens</p>

or provided seedlings and gardening information; distributed care packages for health care workers, first responders and teachers; and created activity packets for isolated nursing home residents.

Purdue Extension helped farms and family businesses. As farming and food processing were deemed essential, many farmers, ranchers, agribusinesses and financial entities, relied on Purdue's Center for Commercial Agriculture for vital economic information and market outlook reports via the website, recorded webinars, and podcasts. When stay-at-home orders were issued just before Indiana's farmers market season, Purdue Extension provided guidelines and best practices to help market masters and vendors stay abreast of products that could be sold, and how to cap capacity, at farmers markets. For growers having trouble selling produce at markets and restaurants, Purdue Extension collaborated with Microsoft to develop a platform so growers could sell their products online.

Second, an overview of the Purdue Research and Extension 2020 Annual Report.

COVID-related actions **helped communities**. "On Local Government" held virtual roundtables to discuss needs and next steps for communities across Indiana, sharing skills and knowledge in crisis communication, new technologies for online platforms, economic outlooks, grant opportunities and building meaningful economies of scale. In "Growing Together" nearly 3,000 volunteer hours of planting, maintaining, and harvesting, supported 21 community gardens and shared 7,200 pounds of produce with 33 distribution organizations for limited-resource Indiana residents to have access to fresh fruit and produce.

Adjusting to pandemic restrictions, Purdue Extension activities **supported youth**. "Soccer & 4-H @ Home", a bilingual program, helped youth explore soccer fundamentals, food and nutrition, service learning, and career options related to sports. "4-H World Changers Online Hackathon" helped middle and high school youth learn computer science skills when pandemic restrictions closed schools. "Food Safety Training for High School" provided youth with knowledge and skill-development for safely handling and preparing food. Programs **helped Indiana residents be active**. Get WalkIN', a three-month, email-based program proved especially valuable as walkers sought structure and inspiration when gyms and parks closed.

Purdue Extension is focusing on **mental health** with "Weathering the Storm in Agriculture" for farmers and families, and "Communicating with Farmers Under Stress" for agriculture organization representations and others, to build support for farmers, and for youth by training parents, teachers, and other adults in "Youth Mental Health First Aid".

Keeping producers in business, Purdue Extension assisted produce growers with "On-Farm Readiness Reviews and Mock Audits" to help with regulation compliance for safe food production.

Research and Extension efforts addressed **climate and extreme weather** events with "Critical Forage Testing for Healthy Cattle and Cost-Effective Operations" when excessive rain and delayed harvests impacted nutrition quality of forages. "Cropping Systems" research is identifying agronomic efficiency, climate-change resiliency and environmental sustainability of corn production.

Extension is facilitating **equity and inclusion** in Indiana communities with North Central Region guidelines to "Building an Equitable and Just Green Infrastructure" strategy and workforce; and "Navigating Difference" training to build cultural competence.

Research discoveries are helping identify best practices for **management and protection of resources for sustainability**, including “Mapping and Spatial Tools for Water Management Decisions” in crop production, “Minimizing Impact on the Environment” when controlling for invasive Emerald Ash Borer, establishing new herbicide and non-chemical alternatives for “Controlling Weeds for Natural Resources and Agricultural Systems”, building knowledge and skill for “Family Forest Owner” management of invasive plants, and “Effectively and Economically Producing Crops in Controlled-Environments” for year-round production.

II. Merit and Scientific Peer Review Processes

The NIFA reviewer will refer to your 2020 Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA's attention.

Process	Updates ONLY
1. The <u>Merit Review Process</u>	No updates
2. The <u>Scientific Peer Review Process</u>	No updates

III. Stakeholder Input

The NIFA reviewer will refer to your 2020 Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA's attention.

Stakeholder Input Aspects	Updates ONLY
1. Actions taken to seek stakeholder input that encouraged their participation with a brief explanation	No updates
2. Methods to identify individuals and groups and brief explanation.	No updates
3. Methods for collecting stakeholder input and brief explanation.	No updates
4. A Statement of how the input will be considered and brief explanation of what you learned from your stakeholders.	No updates

IV. Critical Issues Table of Contents

No.	Critical Issues in order of appearance in Table V. Activities and Accomplishments
1.	Global food security and hunger
2.	Food safety
3.	Childhood obesity
4.	Climate change
5.	Natural resources and the environment
6.	Sustainable energy
7.	Human, family, community health and well-being

V. Activities and Accomplishments

Please provide information for activities that represent the best work of your institution(s). In your outcome or impact statement, please include the following elements (in any order): 1) the issue and its significance (e.g. who cares and why); 2) a brief description of key activities undertaken to achieve the goals and objectives; 3) changes in knowledge, behavior, or condition resulting from the project or program’s activities; 4) who benefited and how. Please weave supporting data into the narrative.

No.	Project or Program Title	Outcome/Impact Statement	Critical Issue Name or No.
1.	“Effectively and Economically Producing Crops in Controlled-Environments” project: Toward more productive, profitable, sustainable controlled-	<p>Issue: The global grassroots movement for local production of fresh, healthy produce becomes difficult to accomplish year-round in seasonal climates where there is a definite off-season for crop production. Without inputs of energy for heating, cooling, and lighting in protected horticulture, local off-season production of quality produce is not possible for year-round production in seasonal climates.</p> <p>What has been done: For a funded NASA project to optimize light, CO₂, and fertility of leafy vegetables and dwarf tomatoes to be grown on the International Space Station (ISS) and consumed by astronauts, three different growth phases of leafy crops (lag, log, plateau) were identified and energy inputs and red:blue ratios were optimized for lighting.</p> <p>Energy reduction for controlled-environment agriculture (CEA) activities addressed minimum close-canopy lighting distance for target light intensity and maximum energy savings. Video imaging and selective switching were used to energize LED clusters located directly above plants. For high-wire greenhouse tomato production, the intracanopy supplemental lighting spectrum was optimized for spectrum, intensity, leaf position in the canopy, and time of year</p>	1.1 Global food security and hunger

<p>environment agriculture</p>	<p>of production. Spectra also was optimized for effects on fruit yield, energy consumption, and fruit quality throughout the year.</p> <p>Hydroponics, lighting, and crop-culture expertise and support were provided for aquaponics funding and collaborative projects. Industrial support will be pursued to establish a sustainable CEA research facility driven by renewable energy.</p> <p>Results: One controlled-environment crop-production project evaluated capability of slow-release fertilizer formulations in a growth medium to provide plant nutrition for red-romaine lettuce cultivar 'Outredgeous' and Mizuna mustard for use on the ISS. Leaves were harvested at 28, 48, and 56 days after planting in six Biomass-Production Systems for Education (BPSe) plant-growth units with light-emitting diodes (LEDs) located in a temperature-and-humidity-controlled walk-in growth room. For lettuce, edible yield increased at each subsequent harvest for faster-releasing fertilizer formulation but at the expense of leaf nitrogen content. Yields were lowest when using slowest-release fertilizer, but leachates from rhizospheres at the end of the experiment indicated nutrient-solution electro-conductivity (EC) was not limiting for any fertilizer treatment. Mizuna mustard responded differently from lettuce to controlled-release fertilizer proportions, decreasing in yield at each subsequent harvest, for both fertilizer formulations, but decreasing most with slowest-releasing formulation.</p> <p>Another project involved growing a hydroponic crop stand (up to 48 plants) within a height-and-volume-adjustable cuvette space allowing CO₂ gas exchange to be monitored continuously throughout production cycles of leafy-green crops (e.g., 28-30 days). During that period, day/night temperature, CO₂ concentration, and several LED lighting parameters (adjustable intensity, spectrum, photoperiod) were controlled, and rootzone pH and EC monitored and adjusted. This "Minitron III" controlled-environment crop-growth/gas-exchange system was used to co-optimize different CO₂ and lighting conditions for stages of the cropping cycle to promote rapid, efficient growth while minimizing energy inputs and resource utilization. Crop photosynthetic rate was being used as real-time response to current environmental conditions. The dimmable, selectively switchable lighting system self-monitors electrical-energy utilization, and after a crop-production cycle, crop yield and productivity parameters are measured and expressed as a function of energy cost for lighting.</p> <p>Another controlled-environment growth system had four metallic structural frameworks to support three stationary standard plant-growth trays and height-adjustable LED fixtures mounted above. Lighting fixtures were equipped to self-monitor electrical-energy consumption during periods when LEDs were energized. Baby greens were grown in soilless medium with bottom fertigation until canopy closure, which typically is 15-17 days from seeding. Although this "OptimIA" growth system does not include capability to continuously monitor crop gas exchange, it accommodates greater flexibility for treatment replication, simultaneous species/cultivar screening, and/or simultaneous application of experimental treatments related to lighting.</p> <p>Benefit: This project developed CEA technologies and methods to deliver adequate renewable energy for crop growth, development, and yield effectively and economically, so that crop production can be profitable for local producers throughout the year.</p>	
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<p>2.</p>	<p>Gene discovery and functional validation in sorghum</p>	<p>Issue: To feed the increasing world population, it is increasingly imperative that we understand the agricultural crops we raise, how to maximize their production sustainably, and improve their nutritional quality and stress tolerance. Understanding what genes can best be manipulated in plant breeding is an essential part of answering this challenge.</p> <p>What has been done: Research conducted provides a way for breeders to advance their understanding of sorghum genes that control growth, development and output. Overall goal was to expand a sequence-indexed collection of mutagenized sorghum to:</p> <ol style="list-style-type: none"> 1) Identify and validate roles of specific target genes from sorghum, maize, and other species traits of biological, agronomic and economic interest, using "forward" and "reverse" genetic approaches. 2) Research was conducted to identify and characterize sorghum genes and genotypes having unique food and forage quality characteristics. 3) Developing acyanogenic sorghum parent lines and hybrids. <p>Results:</p> <ol style="list-style-type: none"> 1) Identification of genes controlling starch quality in sorghum. The genes and phenotypes contributing to functional food properties of sorghum are not well understood. We are backcrossing the most promising mutant alleles of genes SSIIa and SBEIIb into elite food-grade sorghum varieties and hybrids. SbEMS4308 and SbEMS4106 are being used as donor lines for alleles of SSIIa. SbEMS2703 (42%) and SbEMS3194 (44%) exhibit higher amylose values than any previously reported in sorghum as donors of SBEIIb. These alleles for SSIIa and SBEIIb are being backcrossed into elite sorghum genotypes Macia and (ATx631xTx436)-F1 to produce cultivars with novel starch properties. 2) Grain protein digestibility is a key quality characteristic in sorghum. We are using mutant lines SbEMS1613 and SbEMS3324 as donors of alleles for highly digestible grain protein phenotype. These alleles are introgressed into elite grain and forage sorghum varieties. A set of 282 breeding lines were screened for variation in protein digestibility and other quality characteristics. Crosses and selections were made to advance the most promising genotypes. 3) Sorghum breeders are developing high-yielding cultivars for commercial forage production systems, but tremendous opportunities remain for improving the nutritional value of sorghum forage. Purdue sorghum breeding identified and patented a genetic mutation in CYP79A1 (C493Y) that disrupts dhurrin production (Tuinstra MR, Krothapalli K, Dilkes B, Buescher E. Genetic Mutations that Disrupt Dhurrin Production in Sorghum U.S. Patent No. 9,512,437. Issue Date: December 6, 2016). Dhurrin is a cyanogenic glucoside that accumulates to high levels in sorghum leaves and stems. Dhurrin accumulation in sorghum leaves and stems harvested for forage can contribute to hydrogen cyanide poisoning of livestock. After discovering this mutation, we began crossing and backcrossing this mutation into sorghum parent lines to produce commercial hybrids. We developed two pollinator parents and an A-line and B-line pair to produce a dhurrin-free sorghum-sudan hybrid and forage sorghum hybrid. Purdue University and our commercial partners at AgAlumni Seed Company announced a partnership with S&W Seed Company to provide the first dhurrin-free sorghum forages in the commercial seed market. Production of dhurrin-free hybrids 	<p>1.2 Global food security and hunger</p>
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		<p>will simplify pasture and forage management by providing sorghum growers with an effective management system to get the most from every production acre.</p> <p>Benefit: This project has enabled discovery of genes that are coupled to sorghum lines with desired functional characteristics and the creation of a novel hybrid line for livestock feed.</p>	
<p>3.</p>	<p>“Controlling Weeds for Natural Resources and Agricultural Systems” - Advancing the sustainability of weed management across the landscape</p>	<p>Issue: Weed control is an important component of land management for natural and agricultural systems. Managers must contend with invasive plant species, herbicide-resistant weeds, and increasing societal pressure to reduce herbicide use and adopt alternative control practices. Among weed scientists, there is an increasing recognition of the need to incorporate weed ecology into management decisions and to examine alternate tools and strategies to achieve greater sustainability for weed management. At the same time, the cost and complexity of alternative practices to herbicides continues to provide a barrier for adoption by land managers, especially in agronomic crops</p> <p>What has been done: The overall goal of research was reminding the management strategies based on a more thorough understanding of weed ecology and herbicide resistance so that weed control can be improved, inputs optimized, and selection pressure for resistance reduced. Two objectives were addressed:</p> <ol style="list-style-type: none"> 1) Assess and develop weed management strategies for new weed challenges or cropping systems using conventional and organic management practices. 2) Examine herbicide resistance at genetic, population and landscape levels with a focus on the most recent problems with waterhemp, Palmer amaranth, and giant ragweed using new molecular tools. <p>Results: Results suggest industrial hemp may be quite impacted by competition with weeds. This research also indicates currently available hemp cultivars may have poor stand establishment, particularly on wet soils, and respond to delayed planting with reduced growth and early flowering. Surveys of farmers suggest there is great interest among organic farmers in adopting hemp but concerns about how readily hemp will fit into current farm operations and certification processes.</p> <p>Research addressed improvement in weed management for peppermint, watermelon, pumpkin, bell pepper, summer and winter squash, and tomato. Thirteen greenhouse and 11 field research experiments were conducted. Evolution of PPO and synthetic auxin herbicide resistance in amaranth is a huge concern. Currently, researchers use these herbicides for controlling glyphosate resistant populations but don't expect success to last long. Weed seed from plants with suspected resistance to key herbicides were collected, or the seed was submitted by industry professionals. Based on submissions from the last five years, concern continues to grow on management of tall waterhemp and resistance to herbicide glyphosate and PPO-inhibiting herbicides. Field research conducted evaluated effectiveness of Liberty Link (glufosinate-resistant) and Xtend (dicamba + glyphosate-resistant) soybeans for improving tall waterhemp management. Using glufosinate and dicamba integrated with other effective herbicide site of action groups shows promise to help growers control tall waterhemp. However, tall waterhemp potential to evolve resistance is significant if best management practices are not used incorporating diverse herbicide combinations and non-chemical weed management tactics.</p>	<p>1.3 Global food security and hunger</p>

		<p>As an alternative to chemical weed control researchers purchased a high-residue, row cultivator used in conventional and organic production systems. Researchers demonstrated this cultivator at Throckmorton-Purdue Agricultural Center (TPAC) with good results, but a grower must be accepting of some weed survival, especially within the crop row.</p> <p>Researchers initiated research to evaluate cover crops for potential to improve control of herbicide-resistant weeds in corn and soybeans. Results show good potential to integrate cover crops with herbicides for control of winter annual weeds and summer annuals that emerge early in the spring. However, very little benefit was observed with weeds that emerge later in the spring. Poor management of cover crops resulted in lower crop yields and interference with herbicide efficacy. Our research focused on the "planting green" concept allowing more cover crop biomass to accumulate in the spring to help with weed suppression for a longer period in the growing season.</p> <p>Benefit: The research established new knowledge on weed ecology and strategies (herbicides and non-chemical alternatives) to control weed growth including herbicide-resistance varieties.</p>	
<p>4.</p>	<p>Enhancing the competitiveness and value of U.S. Beef</p>	<p>Issue: Studies have reported consumer willingness to pay premiums for meat products with guaranteed eating quality, and consumers who shop in the local market generally have a high expectation of local meat products. They expect production-type related attributes (i.e., certified organic, grass-fed, and/or natural) and/or superior eating quality differences. Failure to meet this expectation (e.g., quality-related issues) erodes consumer satisfaction, and subsequently reduces profits for small/local processors. As such, a need exists to understand factors that should be prioritized to ensure consumer demands are met.</p> <p>What has been done:</p> <p>The ultimate research goal is to establish novel meat aging processes that can be applied to improve quality attributes of cull cow beef and foster the profitability and sustainability of the beef industry.</p> <ol style="list-style-type: none"> 1) Determined impact of optimized dry-aging on physicochemical, microbiological shelf-life, and sensory eating quality attributes of loins from cull cow beef. 2) Identified flavor-related chemical compounds that positively impact meat quality attributes of dry-aged loins from cull cow using a metabolomics approach coupled with other chemical assays and descriptive sensory analysis. <p>Results: Researchers determined impacts of post-harvest processing factors on meat quality attributes. Beef from cull cows has traditionally been perceived as low-quality/low-value meat due to inferior flavor and tenderness. Results indicated that conventional dry-aging would not negatively affect the shear force, cooking loss and oxidative stability of loins collected from mature beef loins. Trained panelists also indicated less sour and oxidized flavor in dry-aging compared to wet-aged counterparts, showing its potential to improve mature beef loins. These improvements, along with good color stability suggested the potential of dry-aging as a natural value-adding process for merchandizing cull cow beef. UV light application significantly reduced microbial concentration of dry-aged beef crust, but an increase in oxidized flavor was found. Dry-aging treatments were observed to have greater amino acids and sulfur containing compounds, while more lipid related compounds were observed in wet-aged counterparts.</p>	<p>1.4 Global food security and hunger</p>

		<p>This result potentially indicates the major mechanism of flavor production would be different depending on the aging method applied.</p> <p>Benefit: Knowledge generated by this project will have immediate implications to provide solutions to small/local meat processors, offer consumers more consistent premium meat products, and increase future profitability and sustainability of the U.S. meat industry.</p>	
<p>5.</p>	<p>“Critical Forage Testing for Healthy Cattle and Cost-Effective Operations”</p>	<p>Issue: Quality of forage is important to cattle nutrition. Extreme weather and rains in 2019 created weeks of delays in harvesting. Under those conditions, shortage of hay during the following winter and earlier use of stored feed was expected, contributing to poor quality of feed for cattle. Unless supplemental feeding was combined with winter feeding, the result was going to be poor nutrition for these animals for an extended period. Testing of forages is done to determine the nutritional value. It involves using a probe to take a sample, giving it to a lab to run a chemical analysis, and then working with a nutritionist to use the results to plan feed regimens. Unfortunately, not all producers do quality tests after harvesting forages and before starting the winter-feeding regimen.</p> <p>What Has Been Done: Because of the extreme conditions and expected poor quality nutrition of forages, several Purdue Extension programs were implemented across southern Indiana to provide instruction on nutrition quality of forages and to encourage forage testing for accurate feed supplementing over the winter. In one event, the cost for forage testing was covered, encouraging participants to get it done. In the other three events, a few producers volunteered to provide forage samples which were tested and used as demonstrations during instruction. “Forage Analysis Testing Cost-Share” involved Soil and Water Conservation District (SWCD) and Natural Resources Conservation Service (NRCS) partners and free forage tests for producers. Among the 30 producers, 66 forage samples were tested. “Twilight Tour Field Day” at the Feldun-Purdue Agricultural Center (FPAC) focused on pasture renovations needed as a result of the wet weather and late harvest, importance of harvest forage samples and nutritional analysis before feeding, and supplementing the cow herd strategically with stored forages and other products. There were 52 participants of the field day. “Forage Quality and Testing Workshop” focused on how to conduct physical hay quality analysis, and demonstrated chemical analysis results of hay samples to draw attention to quality issues and address nutrition recommendations. Some 21 participants attended the training. “Grazing 102” at the Southern Indiana Purdue Agricultural Center (SIPAC) featured lectures, wagon tours, hands-on demonstrations, and pasture walks. Presentations covered plant growth under grazing, pasture fertility, forage-induced animal disorders, pasture species selection, tall fescue use, animal nutrition, and more. There were 27 participants in the grazing workshop. To expand the reach of forage information in this critical time, instructional materials and a video were created and shared across Purdue Extension. An updated video was shown at the Indiana Beef Cattle Association-Purdue University Regional meetings.</p> <p>Results: In the Cost-Share Program, survey respondents (n=12) were asked about collecting forage samples and submitting them for analysis. Most (91.7%) indicated it was easy to do and two-thirds adjusted their feeding regimen based on the results. Nine (75%) sought input from a trained nutritionist and eight implemented suggestions given. Most (91.7%) indicated that in the future, it was “likely” or “extremely likely” they would conduct</p>	<p>1.5 Global food security and hunger</p>

	<p>forage analysis, and half indicated they would adjust how they harvest or purchase forages. “Twilight Tour Field Day” survey respondents (n=44) reported, as a result of attending, they had a better understanding of using supplements to meet nutrient deficiencies in harvested forages. They felt the visual demonstration of poor vs. high quality hay was impactful, convincing them to match hay resources on the farm to the daily nutrient needs of cows. Most (88%) planned to submit a forage sample for nutritional analysis. As a result of “Forage Quality and Testing Workshop” all participants, in follow-up conversations with the educator, said their knowledge increased and indicated the most influential was attention on the impossible amount of poor-quality hay an animal would need to eat to maintain a healthy weight. One participant said, “considering the volume of hay an animal will need to eat to maintain balance, clearly, I have been giving my animals inadequate nutrients in the winter months all this time.” Another said they knew hay analysis was a good thing to do, but didn’t know it was such a big deal until this program. In a follow-up with producers who had given hay samples for chemical analysis during the event, most had used the results, or planned to use the results, to create an appropriate supplemental feeding program. After the event, participants followed up with extension for resources. The hay probe that extension loans out to producers for hay samples was requested three times more than previous years. Several producers also sought hay sample bags to ship their samples to the laboratories for analysis. “Grazing 102” survey respondents (n=14) were asked to report their level of forage knowledge before and after. Before the workshop, 18% rated their knowledge as high or very high. At the end, that had increased to 65%. They report increased knowledge of plant growth under grazing, pasture fertility, forage-induced animal disorders, extending grazing seasons, and animal nutrition. Nearly all participants (97%) reported they would, were currently, or had made changes related to plant growth management under grazing, pasture fertility, and forage-induced animal disorders. They planned to follow recommended practices including extend grazing year, use of clover, and identify/eradicate toxic plant species. A few (14%) attended in previous years and estimated financial improvements up to \$50 per acre as a result of adopting recommended practices, including increased dollar return per acre, reduced costs per acre, and drastic reduction in hay/feed costs. Six-months after the workshop, respondents (N=7) reported adopting at least one recommended practice, increased dollar returns, and reduced cost per acre due to adopting recommended practices. Two-thirds reported a financial per acre improvement of \$0-\$50 and one-third reported \$51 - \$100.</p> <p>Benefit: Cattle producers in southern Indiana learned about poor quality forages resulting from extreme weather and late harvests. They completed forage tests to check quality and worked with nutritionists for guidance on developing appropriate nutrition regimens for cattle health, which resulted in improved finances related to reduced costs and increased returns per acre, and reduction in feed costs.</p> <p>What Has Been Done: Because of the extreme conditions and expected poor quality nutrition of forages, several Purdue Extension programs were implemented across southern Indiana to provide instruction on nutrition quality of forages and to encourage forage testing for accurate feed supplementing over the winter. In one event, the cost for forage testing was covered, encouraging participants to get it done. In the other three events, a few producers volunteered to provide forage samples which were tested and used as demonstrations during instruction.</p>	
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		<p>participants (97%) reported they would, were currently, or had made changes related to plant growth management under grazing, pasture fertility, and forage-induced animal disorders. They planned to follow recommended practices including extend grazing year, use of clover, and identify/eradicate toxic plant species. A few (14%) attended in previous years and estimated financial improvements up to \$50 per acre as a result of adopting recommended practices, including increased dollar return per acre, reduced costs per acre, and drastic reduction in hay/feed costs. Six-months after the workshop, respondents (N=7) reported adopting at least one recommended practice, increased dollar returns, and reduced cost per acre due to adopting recommended practices. Two-thirds reported a financial per acre improvement of \$0-\$50 and one-third reported \$51 - \$100.</p> <p>Benefit: Cattle producers in southern Indiana learned about poor quality forages resulting from extreme weather and late harvests. They completed forage tests to check quality and worked with nutritionists for guidance on developing appropriate nutrition regimens for cattle health, which resulted in improved finances related to reduced costs and increased returns per acre, and reduction in feed costs.</p>	
<p>6.</p>	<p>Management advances and increased revenue for Midwest women in agriculture</p>	<p>Issue: In the U.S., there were more than 1.1 million farms with women listed as one of the producers. In Indiana, even with farm numbers declining and average age of farmers increasing, the number of beginning farmers and women farmers is increasing. These census data show a total of 31,225 female producers, a 30 percent increase since 2012. Indiana farm women are continuing to take a larger role in managing and owning farming operations and diversified agriculture enterprises.</p> <p>What Has Been Done: Purdue Extension leads the annual Midwest Women in Agriculture conference to address educational needs of women employed in or involved with the agriculture industry. At the 19th annual two-day conference nearly 140 attendees, speakers, and sponsors gathered to learn about succession planning, farm management, leadership, managing livestock, and health and well-being. Purdue Extension delivered, “Becoming the Employer of Choice,” developed by the University of Wisconsin Extension, as a pre-conference session, a day-long program for current and future farm manager/owners looking to improve their human resource management skills. Sessions were: 1) from managers to leaders, 2) developing a motivated workforce, 3) hiring the right people, 4) farm business culture, 5) strategic leadership and on-boarding, 6) reviews and feedback, and 7) managing conflict. During the conference, the 7th Young Ladies in Agriculture Forum was held as a networking opportunity for 78 high schoolers to learn more about careers and opportunities in agriculture.</p> <p>Results: Conference attendees (n=111) responded on the post-evaluation. Most gained resource materials they could use (77%), increased their motivation (76%) and gained names of contacts (74%). More than half (62%) shared that the conference was very important to their operation, business or future career choices. As a result of participating, most (71%) expressed plans to do things differently: getting ideas in place to make transitions easier as farms grow and expand and do a better job at succession planning, working with the farmers especially with land leasing options, doing research, speaking up more, advocating more for agriculture, putting management skills in place in hiring, and using skills learned to work with 3rd, 4th and 5th generations on the farm. Some 14 attendees reported actions they had taken since last year’s conference. One-third had updated their succession or estate plan.</p>	<p>1.6 Global food security and hunger</p>

		<p>Others started a new business to add income, increased advocacy efforts for agriculture, implemented changes in farm business to increase profitability, and volunteered for a new leadership role in their community. One attendee shared that their farm business increased revenue potential by over \$10,000 as a result of their participation in the conference.</p> <p>Pre-conference Becoming the Employer of Choice attracted 6 participants from 5 counties. Participants increased their knowledge in strategic leadership and onboarding (66% increase) and developing a motivated workforce (31% increase). Other important things learned were being more mindful of which leadership strategy to use based on situation and employee, listening to input, getting employee ideas, figuring out extrinsic motivation, working on goals, being intentional on creating an onboarding procedure, and when conflict arises, assessing attitudes and ability to think through the situation before responding. Young Ladies of Ag high school participants reported they received at least one helpful piece of advice to motivate them in working toward their goals (100%), had options available for careers in agriculture (99%), felt more informed about options available to them for college majors in agriculture (98%) and met contacts they may reach out to with future questions or for guidance (86%).</p> <p>Benefit: The annual Women in Ag Conference is extremely important to Indiana farm women and young ladies in high school for their operations, businesses or future career choices. Conference activities create a place for women to learn and make connections with others, which leads to management advances and increased revenue for their operations.</p>	
7.	<p>“Growing Together” to provide access to fresh produce for limited-resource Indiana residents</p>	<p>Issue: U.S. households (12.3%) and Indiana households (15.2%) are food insecure. An estimated 13% of Indiana residents were considered to be living in poverty in 2018. COVID-19 exacerbated economic and social situations including food access for many families. Food insecurity is highly related to a number of health issues such as iron deficiency, low bone marrow content, mental health, diabetes, obesity, and chronic disease in general.</p> <p>What Has Been Done: Growing Together, a North Central Extension Multi-State effort including Indiana, Illinois, Iowa, Michigan, Nebraska, and Wisconsin, is a food access program to increase fresh fruit and vegetable availability to food pantries and other service agencies serving SNAP-eligible clients. Purdue Extension Master Gardeners in 14 Indiana counties were engaged with community partners and 359 volunteers to create or expand 21 donation gardens to meet the needs of limited-resource individuals and families.</p> <p>Results: For Indiana, more than 3,000 volunteer hours (value of nearly \$75,000) were committed to planting, maintaining, harvesting, and supporting the 21 community gardens. Nearly 7,200 pounds of produce was grown and distributed to 33 organizations that served as distribution and education sites for over 10,000 Indiana residents. Together, the Midwest states reached nearly 250 food pantries and distribution sites with over 140,000 pounds of donated produce, serving 99,540 low-income individuals.</p> <p>Benefit: As a result of Growing Together, thousands of limited-resource Indiana residents had access to fresh fruit and produce.</p>	1.7 Global food security and hunger

<p>8.</p>	<p>Comprehensive, targeted next-generation sequencing panels for detection and characterization of pathogens for syndromic testing and surveillance</p>	<p>Issue: Rapid, accurate diagnostic tests are critical for the prompt recognition of pathogens to prevent spread of infectious diseases and to protect against detrimental impacts to the Indiana and U.S. economy. A key element to contain a highly contagious livestock disease agent is rapid identification of the causative agent to apply appropriate control strategies. Also important is the ability to rapidly identify a suspect case as a non-threatening problem, thus more quickly lifting quarantine or containment costs from livestock producers.</p> <p>What has been done: Research objectives identified to accomplish new, improved diagnostic testing strategies were:</p> <p>1a) Develop primer pools to detect and characterize pathogens associated with syndromic illness to be used in a targeted next-generation sequencing testing platform.</p> <p>1b) Validate the primers/method with characterized/reference strains of bacteria, viruses, and parasites.</p> <p>1c) Optimize the assay to enhance analytical sensitivity by testing representatives from each disease category (e.g., bacterial DNA, parasite DNA, viral RNA and DNA) and comparing with Ct (threshold cycle) values from validated real-time PCR assays on DNA samples in the diagnostic lab.</p> <p>Results:</p> <p>1a) Primer pools were developed for multiple assays including: canine/feline panel (includes vector-borne pathogens of human interest with animals serving as sentinel hosts); food-borne pathogen panel as described in the proposal; and a meat speciation panel for detection of food adulteration. A redesign of primers for an equine pathogen panel is currently underway. A proposal was submitted to the President of the Indiana State Poultry Association and the Executive Director of the Indiana Pork Board outlining plans for development of targeted next-generation sequencing panels in poultry and swine, for feedback and potential funding opportunities. An internal grant was obtained from Purdue University to redesign an equine panel that had been previously developed and found to be lacking in appropriate sensitivity for detection of some pathogens, including Potomac Horse Fever and <i>C. difficile</i> (toxins).</p> <p>1b) Research focused on a meat speciation panel for FDA-VetLIRN. This panel was intended to be part of a food-borne pathogen panel, but FDA had more interest in meat speciation than in the pathogen portion for detection of food adulteration. These species were in the meat speciation panel and primers sets in this targeted next-generation sequencing panel to detect multiple mitochondrial genes: cow, bison, pig, sheep, chicken, turkey, canine, cat, mouse, rat-brown and black, macaque, salmon, cod, tuna, carp, tilapia, quail, pigeon, duck, deer, goat, buffalo, kangaroo, horse, and rabbit. A subset was selected for validation: cat, dog, rat, mouse, horse, cow and pig. Analytical specificity was determined by spiking muscle tissue from these species in different combinations into a commercially available canned vegetarian dog food (matrix). Evaluation of targeted next-generation sequencing confirmed that primer sets were specific for intended species.</p> <p>1c) Relative limit of detection (LOD-analytical sensitivity) was determined for the subset of targets by spiking the matrix with 1%, 0.1%, and 0.01% wt/wt muscle tissue from the different animal species. All seven species were detected at each concentration. Results for all seven species were found to be repeatable at all three concentrations.</p>	<p>2.1 Food Safety</p>
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9.	Characterization of the lettuce microbial community by metagenomic sequencing and optical light scattering	<p>Issue: Although cases of foodborne illness attributed to consumption of fresh produce has increased dramatically in the past twenty years, there remains major gaps in our understanding of how well human pathogenic bacteria persist as plant-associated microbial communities and what factors influence their survival. Fungal metagenomic data for fresh produce are lacking, as are datasets that combine fungal and bacterial communities from leafy greens. Analysis of the community will allow researchers to identify changes associated with human pathogens.</p> <p>What Has Been Done: The overall goal of this research was to use next-generation sequencing coupled with a light-scattering technology called BEAM, to identify bacteria and fungi present on romaine lettuce. Changes in microbial communities were characterized following the addition of bacterial pathogens. This will help establish a library for BEAM that can be used by the leafy green industry to rapidly sample products to determine the spoilage and/or pathogenic organisms present. Research Objectives were: 1) Develop a BEAM library of bacterial and fungal genera associated with romaine lettuce and validate BEAM as a tool for making taxonomic assignments at the genus level. 2) Determine effect of lettuce bacterial community composition and spatial distribution on the ability of human pathogens to establish themselves in the community and survive treatment with chemical sanitizers. This objective will also identify organisms that are possible indicators for the presence of human pathogens.</p> <p>Results:</p> <p>1) Three scatter image libraries were built to classify the nine most abundant bacterial genera isolated from romaine lettuce, which covered around three-fourths of the total culturable bacterial population. Results show the potential of BEAM technology to characterize culturable bacterial communities from environmental samples, and to study microbial interactions. However, specific challenges were identified, such as overlapping scatter patterns from strains of different bacterial genera, and the need of continuously feeding the libraries with new scatter images of colonies isolated from new samples.</p> <p>2) Lettuce leaves were divided into geographical regions characterized to generate a description of the microbiome present and the ecological niche occupied. This included next-generation sequencing of the microbial community, confocal microscopy to describe features of the leaf surface, measurements of stomata (pores found on leaves) size and conductance, cuticular wax analysis, and leaf surface hydrophobicity (property of molecule repelled from water) measurements by contact angle analysis. Results demonstrated the heterogeneous distribution of the microbiome and correlation of the composition with features of the niche occupied.</p> <p>Benefit: The research established baseline data for bacterial and fungal communities that are present on lettuce and how this influences the entry and persistence of human pathogenic bacteria on the plant surface.</p>	2.2 Food Safety
10.	Evaluation of "Food Safety	Issue: Dr. Feng is involved with integrating food safety and career-readiness in food and agriculture science into formal K-12 education programming. Dr. Feng hosted focus group sessions with over fifty science and agriculture high school teachers to identify the academic needs for food safety education, including 1) lack of curricula aligned	2.3 Food Safety

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	<p>Training for High School”</p>	<p>with the state standards; 2) lack of student interest in such topics; 3) lack of instruction time and resources. In response to these needs, Dr. Feng created a comprehensive extension program called “Food Safety in The Classroom.”</p> <p>What Has Been Done: The curriculum was designed to provide students with fundamental food safety concepts through experiential learning and incorporation of science, technology, engineering, agriculture, and mathematics (STEAM) activities in the context of different careers related to agriculture, especially in food science. Further, this study was conducted to evaluate the effectiveness of a food safety educational intervention for changing students' food handling behaviors, and the theory of planned behavior was used to construct factors that contribute to behavior change.</p> <p>Results:</p> <p>1) Food safety curriculum. Researchers developed a food-safety-focused curriculum for high school students aligned with Indiana Academic Standards for Agriculture, Advanced Life Science: Food. A panel of experts in the field of education evaluated the curriculum through three rounds of surveys containing questions related to six curriculum assessment topics. Experts rated the degree to which they agreed with statements about the curriculum using a 5-point Likert scale and multiple-choice questions. At the conclusion of the study, the cost to purchase materials for cooking labs was the only identified barrier to curriculum incorporation (62.5%). Experts agreed that the curriculum addressed academic standards (100%), was engaging for students (100.0%), was easy for teachers to use (89.5%), and successfully incorporated STEAM (100.0%), experiential learning (89.5%), and career-education (78.9%).</p> <p>2) Observational evaluation of curricula on students’ food safety and handling skills. A combination of stationary and wearable (GoPro) cameras was used to observe the food handling practices of high school students in key areas, including food thermometer use, hand washing and hand drying, glove changing, and environmental cleaning. The percentage of correct food handling techniques was measured categorically, and the number of groups who complied with thermometer use and environmental cleaning guidelines was recorded. The percentage of students using correct hand washing, hand drying, and glove changing techniques significantly increased in the post-observation cooking session. However, the percentage of correct hand washing and glove changing events remained <50% for certain subcategories: hand washing time (38%), hand washing after handling raw produce (36%) and touching skin (20%), changing gloves after gloves became contaminated or torn (47%), and washing hands between glove changes (15%).</p> <p>Benefit: The food safety curriculum will enhance the health and wellbeing of our communities (e.g., homes, fast food, restaurants, etc.) while providing STEAM-incorporated educational content into high school classrooms.</p>	
<p>11.</p>	<p>“On-Farm Readiness Reviews and Mock Audits”</p>	<p>Issue: Passage of the Food Safety Modernization Act (FSMA) and the Produce Safety Rule by FDA represents the first time produce growers have been subject to regulation. Growers covered by the Produce Safety Rule must demonstrate compliance with the regulation to produce fruits and vegetables without undue risk of product contamination. The Indiana State Department of Health (ISDH) began inspections of produce farms in 2019.</p>	<p>2.4 Food Safety</p>

	<p>keep producers in business</p>	<p>What Has Been Done: Responding to produce grower needs for guidance to insure farm compliance with regulation, Purdue Extension set up the On-Farm Readiness Review (OFRR), developed by the National Association of State Departments of Agriculture (NASDA). Program delivery was a collaborative effort of Purdue Extension, Indiana State Department of Agriculture (ISDA), and ISDH. The service is free and grower participation voluntary and confidential. Growers request an OFRR by contacting ISDH. A team of representations from all three agencies (which includes the ISDH inspector who will be doing the farm's inspection) visits the farm for a two-hour interview and tour. The team observes growing conditions, harvesting practices, packinghouse operations, water sources, and discusses common food safety touch-points. At the end of the review, the team provides suggestions to improve food safety practices. Afterwards, educational materials and resources are provided to the grower to assist with solutions to achieve compliance.</p> <p>A total of 17 OFRR's were conducted. For all reviews, growers received recommendations aimed at strengthening their food safety programs and/or bringing them into compliance. For producers who are moving into wholesale or increasing sales, Purdue Extension conducts Mock Audits to growers to prepare for third-party audits (a buyer-driven industry requirement). Helping growers pass audits assists them in gaining access to new or additional markets. Six Mock Audits were completed in 2020.</p> <p>During the pandemic, OFRRs and Mock Audits did not resume until July. Precautions were taken with team members wearing face coverings, maintaining a distance of six feet, and meetings and discussions being held outside where adequate space for separation existed.</p> <p>Results: Since ISDH produce farm inspections began in 2019, all inspected farms that had completed the OFRR were in compliance. All producers who had Mock Audits conducted passed their official industry-required audit and moved ahead with the expansion of their operations.</p> <p>Benefit: Purdue Extension Readiness Reviews and Mock Audits help Indiana produce operations meet regulations and requirements for safe production.</p>	
<p>12.</p>	<p>Molecular mechanisms of control of adipose development and obesity by bioactive food components</p>	<p>Issue: Obesity is associated with increased adipose mass and aberrant activation of hydrolysis of fats accumulated in adipose tissue, called lipolysis. Adipose lipolysis plays a key role in cancer cachexia (extensive body fat and muscle loss) resulting in therapy failure and reduced survival of patients. Moderate inhibition of lipolysis has been proposed to be an effective approach to delay development of both obesity and its related metabolic disorders.</p> <p>What will be done: Our long-term goal is to identify and characterize novel dietary factors that modulate adipose tissue development and function, to provide dietary strategies for obesity prevention and related chronic metabolic and inflammatory diseases. We identified and characterized the function of several dietary bioactive components playing key roles in fat storage cell differentiation, lipid metabolism and aging in fat cells. Our objectives focus on explaining the molecular mechanisms underlying anti-obesity function of bioactive components and the metabolic impact linking adipose tissue and other pathogenic tissues, such as cancer cells, using both cultured cell systems and animal models of obesity and/or cancer. Achieving these objectives will extend knowledge in dietary control of</p>	<p>3.1 Childhood obesity</p>

	<p>adipose biology, and ultimately allow for designing novel dietary strategies to prevent and/or delay development of obesity and associated chronic diseases.</p> <p>Results:</p> <p>1) Determine the function of piceatannol in lipolysis, enzymatic hydrolysis of triglyceride to free fatty acids in adipocytes, and its impact on obesity and cancer.</p> <p>Piceatannol, a natural analog of resveratrol found in fruits and red wine, is suggested to promote health. Researchers identified that piceatannol inhibits lipid droplet (LD) synthesis and adipocyte differentiation by suppressing insulin-related signaling pathways. Piceatannol suppresses obesity-associated hydrolysis of LDs (i.e., lipolysis), resulting in lowering release of free fatty acids from adipose tissue in cultured fat cells and obese mice. These findings firmly place piceatannol as a novel anti-obesity compound that could regulate generation of LDs and development of obesity, and obesity-induced aberrant free fatty acid release. Overly activated adipose lipolysis is recognized to be primarily responsible for cancer cachexia. Since piceatannol is shown to inhibit adipose lipolysis effectively, in collaboration with Purdue University Center for Cancer Research, researchers demonstrated piceatannol protects animals from cancer cachexia-induced adipose lipolysis. This finding allows researchers to develop an innovative strategy to treat cachexia-associated adipose tissue loss during cancer therapy.</p> <p>2) Determine the function of advanced glycation end-products (AGEs), a group of non-enzymatic Maillard browning reaction products on lipid metabolism in adipose tissue. Maillard reaction products are important food ingredients for improving food texture, color, aroma, and taste. Chronic intake of Maillard reaction products called AGEs recently were reported to be detrimental to health (e.g., development of atherosclerosis and diabetes complications) during aging. AGEs are generated during aging through a non-enzymatic reaction with glucose, and is accelerated during disease development, such as type 2 diabetes. However, AGEs in the development of obesity and adipose aging has never been addressed. Using <i>in vitro</i> cell culture, <i>ex vivo</i> and <i>in vivo</i> animal studies, researchers found AGEs were able to restore impaired lipid accumulating ability of senescent preadipocytes through modulation of the aging marker protein p53 (tumor suppressor protein). Since aging is associated with impaired lipid accumulating ability in fat cells, this study provided new insights into modulation of adipose aging by dietary compounds in processed foods.</p> <p>3) Determine the role of cholesterol metabolism in neutral lipid metabolism in adipocytes. Increased lipid storage in adipose tissue with the aberrant secretion of adipokines (cell signaling proteins secreted by adipose tissue), such as leptin (a satiety regulatory hormone) is a hallmark of obesity and type 2 diabetes. Adipocyte LDs are primary sites for storage of energy-dense triglycerides and cholesterol ester (CE), a storage form of cholesterol. Researchers found inhibition of activity of acyl-coenzyme A (coenzymes that metabolize fatty acids). Cholesterol acyltransferase (ACAT), a rate-limiting enzyme catalyzing conversion of free cholesterol to CE for storage, not only blocked LD formation in adipocytes but also reversed pathophysiology of obesity and insulin in obese mice, possibly through suppression of food intake and obesity-induced leptin resistance.</p> <p>Benefit: These studies are significant because the results provide new insights into therapeutic approaches to uncouple obesity and its-related metabolic diseases, and cancer-induced wasting.</p>	
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<p>13.</p>	<p>“Soccer & 4-H @ Home” keeps youth active</p>	<p>Issue: CDC data on the health status of youth show 20.6% of adolescents and 18.4% of children are obese. Only 1 in 5 high school students meet the recommended physical activity guidelines. Low levels of physical activity can contribute to heart disease, type 2 diabetes, some kinds of cancer, and obesity.</p> <p>What Has Been Done: As part of Soccer for Success, a collaboration between 4-H and the U.S. Soccer Foundation, and at the invitation of Indianapolis Indians (minor league baseball team) Charities, Purdue Extension created a research-based curriculum that integrated soccer play with nutrition and youth development through mentoring. RightFit, an afterschool program funded by the Indians Foundation, provided funding and school sites, and Metropolitan Soccer supplied 44 college-aged coach mentors. These partnerships gave Purdue Extension a chance to connect with underserved youth, welcoming new audiences. Due to COVID-19, the 13-week program, with just some weeks delivered in-person, had to be adapted to a virtual experience. “Soccer & 4-H @ Home” in Spanish and English, for youth in grades 3-10, was created by Purdue Extension Specialists and Educators as a summer program for the 500 youth from Indianapolis who had started the program prior to pandemic restrictions. The online program was opened to youth in Florida and Missouri, too. The re-built “at your own-pace” 10-week summer program posted weekly activities and videos. Topics were soccer fundamentals, learn and earn, home challenges, do and serve others, and eat well. Some activities were picture your food, which highlighted where food comes from, soccer fun fact videos illustrating history and relevance worldwide, a well-being focus on actions to be physically and mentally healthy, and an exploration of sports-related careers in business, medicine, engineering, agriculture, education, communication, and many others. Youth completed ten weekly reports on their engagement, use of program resources, and knowledge gained.</p> <p>Results: Purdue, Florida and Missouri 4-H programs reported 4,117 active online users from May to July. A total of 611 youth completed at least one weekly report, with responses ranging from 77 to 115 weekly. Youth reported they had learned ten facts related to soccer sports history (99%), at least eight new opportunities available in the 4-H program (92%), at least seven techniques that promote well-being (92%), how to prepare eight new healthy recipes (91%), at least eight careers related to the sports industry (89%), and ten facts related to food production and agriculture (87%).</p> <p>Benefit: Soccer & 4-H @ Home was selected to be available on the National 4-H Council site and is the only bilingual program. Participating youth benefited from this program that kept them physically active and helped them learn healthy eating and cooking skills during pandemic social restrictions.</p>	<p>3.2 Childhood obesity</p>
<p>14.</p>	<p>“Get WalkIN” participants increase their</p>	<p>Issue: CDC data indicate most Americans are not meeting physical activity guidelines. Physical inactivity is directly related to prevalence of obesity in adults and youth. In 2017, Indiana adults (68%) were considered overweight or obese and 46% self-reported not meeting physical activity guidelines. Walking is an easy way to start and maintain a physically active lifestyle. Walking is accessible to almost anyone, does not require specific skills or abilities to</p>	<p>3.3 Childhood obesity</p>

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	<p>physical activity for health</p>	<p>perform, can be performed alone or with others, and is adaptable (i.e., can be performed at any chosen intensity, and is inexpensive). Participation in regular physical activity decreases the risk of coronary heart disease, hypertension, type 2 diabetes, osteoporosis, depression, obesity, breast and colon cancers, and falls in older adults.</p> <p>What Has Been Done: Purdue Extension provides physical activity education for adults and ways to increase walking behaviors with Get WalkIN'. This program is a twelve-week series delivered via e-mails sent twice weekly for weeks 1-4 and once a week for the last 8 weeks. Topics are benefits of exercise, how to overcome barriers, principles of self-efficacy, social support, goal setting, walking locations, and relapse prevention. During Get WalkIN', Extension educators help motivate participants to make simple changes to their daily routine that can improve their physical activity and overall health and well-being. Get WalkIN' was delivered 26 times reaching 682 individuals. Participants were female (92%), middle age (50+ years), and white (95%).</p> <p>Results: At baseline, participants reported walking an average of 146.2 minutes per week, and this increased to 310.3 minutes at post-program. At baseline, 28% met national physical activity guidelines and this increased to 92% at post-program. Participants reported an average of 297.0 minutes of walking per week during the program and 73% reported meeting physical activity guidelines. At baseline, participants reported a 5-point self-efficacy score of 2.96 which increased to 3.44 post-program. Social support from friends and family on a 5-point scale was 2.48 at baseline and increased to 3.05 post-program. Participant feedback indicated intervention emails were easy to read and understand (4.5 out of 5). Participants reported email frequency was acceptable and receipt of emails encouraged an increase in walking. Half of participants reported always reading the emails. Participants reported being highly likely to continue to use the information they learned from the program.</p> <p>Benefit: Results show that as a result of Get WalkIN', participating adults increased their walking and overall physical activity behavior, which are positive factors for their health and weight.</p>	
<p>15.</p>	<p>Corn, soybean and environmental responses to integrated "Cropping Systems" that are potentially more stress-resilient</p>	<p>Issue: Lack of diversity in crop rotations and intensive tillage practices (primarily before corn in rotation) impair both field crop productivity and soil quality. Overall sustainability of corn production in the Midwest can be enhanced via continuing refinements of management systems and by achieving better scientific understanding of underlying reasons for genotype by environment by management (G x E x M) interactions as climate and crop inputs or equipment change.</p> <p>What has been done: This cropping systems research was to enhance agronomic efficiency, climate-change resiliency and environmental sustainability of corn production. Specific objectives were:</p> <ol style="list-style-type: none"> 1) Assessment of modifications to no-till practices, such as fall strip tillage, vertical tillage, and rotational tillage for their effectiveness in enhancing corn growth while conserving soil quality in corn following either corn or soybean. 2) Evaluation of technological advances in N management programs (e.g., high clearance N applicators, N stabilizers, and split-timing alternatives) on corn yields and N use efficiency of modern corn hybrids that accumulate more N during the post-flowering period. 	<p>4.1 Climate Change</p>

	<p>3) Assessment of greenhouse gas emissions, and especially nitrous oxides (per unit yield and per unit plant N uptake) associated with integrated conservation tillage and N fertilizer management systems in high yield corn production systems.</p> <p>4) Improving scientific understanding of corn genetic and physiological factors involved in achieving greater yield resiliency to drought stress at higher plant populations, higher N use efficiency, and positive responses to macro- and micro-nutrient balance in plant component tissue.</p> <p>Results:</p> <p>1) and 3) The long-term tillage and rotation experiment, in place since 1975, was one of 124 long-term experiments across North American chosen for the Soil Health Assessment under a Noble Foundation and FFAR grant. Detailed soil measurements were taken on soil samples collected in April of 2019. Tillage treatments (mostly in place since 1975) consisted of no-till (NT), strip-till (ST), chisel plow (CP), and moldboard plow (MP). All yield data are accessible via a Dashboard and confirmed: continued good performance of strip-till regardless of rotation system, equal yields of no-till to conventional tillage in corn-soybean rotation, and continued substantial yield gains of corn when grown in rotation with soybean instead of in continuous corn. Greenhouse gas emissions were measured from 2015 to 2017 from tillage and nutrient management experiments and revealed consequences of tillage and nutrient management for nitrous oxide losses per unit area, per unit yield.</p> <p>Plots were measured for Nitrous oxide emissions and whole-plant N recovery in corn to express greenhouse gas losses relative to recovery efficiency of N fertilizers for that environment, soil, hybrid and management combination</p> <p>2) Experiments at the research station and on-farm. High clearance applicators were used, and comparisons were made of those delivering N in bands alongside corn rows on the soil surface versus those that injected N bands into the soil. Investigations were completed on impacts of N rates and supplemental, late-season N applications on N fertilizer recovery efficiency (NRE), and on N accumulation and partitioning in corn at silking (R1) and at physiological maturity (R6) via biomass and on nutrient concentration sampling of thousands of plant tissue samples from hundreds of plots over the last 5 years. Findings addressed: multiple timing and placements of sidedress N fertilizers to corn, and timing of late-split N applications to tall and short corn hybrids.</p> <p>4) Researchers continued experiments on different nutrient rates and timings with the addition of extensive plant sampling in five corn hybrids grown within the same study (3 tall hybrids versus 2 short hybrids of similar maturity). The focus was on learning when nutrient uptake occurred, relationship of leaf factors to nutrient remobilization and grain yield, and potential interactions among hybrid, plant density and management impacts on nitrogen use efficiency. Researchers continued detailed endosperm cell number determination from corn kernels plucked from ears at the end of the lag period (about 16 days after silks first emerged) and correlated those to whole-plant and ear N uptake in the critical period. Results confirmed grain yield improvement was more about kernel weight gains than about higher kernel numbers per unit area, and that higher endosperm cell numbers could predict higher final kernel weights.</p> <p>Benefit: This project provides new knowledge on the use of cropping systems for environmental sustainability, climate resilience, and agronomic efficiency.</p>	
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16.	North Central Climate Collaborative (NC3): Intention to Act to Address Climate Change for Farm, Operation, Family, or Community	<p>Issue: Climate dictates what crops grow where, how water resources are distributed, and how storm water infrastructure is built. Climate change threatens communities and farms accustomed to a certain amount of annual precipitation, sunny days, or winter snowpack. Extension is uniquely positioned to educate our clientele on potential adjustments needed for climate changes, but many colleagues lack the education needed to teach about climate change. As a result, Extension has very little climate change training available.</p> <p>What Has Been Done: North Central Climate Collaborative (NC3), included Extension professionals from the 12-state region to increase the flow and usability of climate information for Extension, farmers, natural resource managers, communities, families, and youth. A white paper was produced on the status of climate programs. Nine training webinars were presented in the first years, then bi-monthly webinars were started to build available climate change training. In addition, NC3 members presented climate topics to legislators, consumers, and clientele in their states. Two professional development trainings were provided for Extension professionals and partners. A website, https://northcentralclimate.org/, was created to house educational content for anyone wanting to learn more about climate issues. The NC3 website averages 220 views per month. NC3 webinars have had over 1,000 participants with 680 additional views on the website or YouTube. In Indiana, a needs assessment by Purdue Extension, Purdue Climate Change Research Center, and Indiana State Climate Office determined interest in understanding science behind climate change, tips for finding and interpreting trusted climate data, understanding Indiana-specific climate change trends and impacts, and best practices for effective climate change communication/dealing with science skeptics. Of the 62 educators, 37 were interested in providing training and 25 were not comfortable presenting climate-related material. As a result, a six-session webinar series was implemented virtually. Educators, Indiana agency representatives, and the general public were invited to attend. Sessions were: 1) What does climate change mean for Indiana? 2) Back to Basics – The Science Behind Climate Change, 3) What Do Historical Observations Tell Us About Indiana’s Climate? 4) Climate Change Myth-Busters, 5) Tips for Tough Conversations, and 6) The Climate is Changing – Now What? This Indiana series was attended by 967 participants and recorded videos were accessed by 420.</p> <p>Results: NC3 webinar participants (99%) reported learning something new and two-thirds reported an interest in sharing the information. The gain in confidence in speaking about climate change result showed as the lowest measure across all sessions. Some 380 participants increased knowledge, skills or attitudes about sustainable agriculture topics, practices, and strategies, and 356 agriculture professionals intend to use the knowledge they learned. Nearly all Indiana professional development participants (86%) reported that as a result of their training, they were more comfortable providing programs on climate and climate change issues. A majority (60%) reported intention to offer more climate education programs and 40% will recommend changes to agricultural operations. For individual session post-surveys (ranging from 35-96 respondents), results showed three-fourths or more had gained climate change information, felt more confident implementing or sharing, or planned to use it. In the end-of-</p>	4.2 Climate Change

		<p>series survey (n=30), participants (87%) would recommend to others “Talking Confidently About Climate Change in Indiana and Beyond”, and two-thirds felt the series increased their confidence discussing climate change. A participant wrote, “Framing discussion is so important in talking confidently, and making the discussion relate to the audience seems effect[ive]”. Another respondent felt all topics and speakers were extremely valuable, but “Tips for Tough Conversations” was the most valuable, “I find it hard to know how to correctly approach someone who may have a different opinion, especially on a topic that is so polarizing. I appreciated the techniques and advice on how to talk to others about tough topics.”</p> <p>Benefit: Collaboratively building climate change resources and making them available to Extension professionals, partnering agencies, and the public has been a successful approach to ramping up what people know about climate change. Via professional development, Extension professionals and partners gained knowledge and confidence to share information and instructional programs with the public. And, public participants gained knowledge, confidence to discuss, and intended to act regarding climate change for their farm, operation, family, or community.</p>	
<p>17.</p>	<p>“Family Forest Owner” - Reducing invasive plant spread into forest ecosystems: Opportunities and barriers in the horticultural sector</p>	<p>Issue: Previous studies have shown the majority of U.S. woody invasive plants were introduced by the horticultural sector for landscaping or conservation purposes. So far, limited research has been done to document how family forest owners (FFOs) perceive invasive plants and associated impacts on forest ecosystems, and what opportunities may exist to reduce spread of invasive plants.</p> <p>What has been done: The overall goal of this research was to improve understanding of “Family Forest Owner” (FFO) perspectives on invasive plants that affect U.S. forest ecosystems and to identify and assess potential strategies for reducing invasive plant spread in forest ecosystems. Activities completed were to assess knowledge, attitudes, beliefs and behaviors of FFOs in the North Central Region regarding management of invasive plants; and to identify and evaluate opportunities for and barriers to reduce invasive plants and promoting native plants.</p> <p>Results: FFOs had moderate familiarity with, concern about, and interest in invasive plant control on and around their forest properties. 1) Despite lack of confidence in ability to manage invasive plants, FFOs had taken actions on the ground, including inspecting their woodlands, talking to their families and other landowners, and removing invasive plants, all without much input from natural resource professionals. 2) Most FFOs relied on self-directed learning and social networks for invasive plant-related information and advice. They had little or no experience, or interest in, interacting with natural resource professionals. 3) FFOs had greater intentions to manage invasive plants when they perceived the problem to be more severe and when they felt more vulnerable to invasive plant impacts, but also when they felt a stronger sense of self-efficacy to address the problem. 4) FFOs who had previous invasive plant management experience, had a Bachelor's degree or higher level of education, owned woodlands for recreational purposes, and were more subject to normative social influence and tended to have greater intentions to manage invasive plants. 5) Talking to others or working with neighbors to remove invasive plants were important predictors of landowner intentions to work collectively. 6) Perceived self-efficacy, perceived need for collective management, social norms, and concerns about invasive plants on neighboring or nearby properties were important predictors of landowner intentions to work collectively. Results suggest that there is a need for natural resource</p>	<p>5.1 Natural resources and the environment</p>

		<p>professionals to refocus efforts on developing communication strategies to target specific segments of FFOs, stronger online presence to facilitate self-directed learning, and partnerships with non-profit organizations trusted by FFOs to encourage self-organization and sharing of information and resources; perceived vulnerability, severity, and self-efficacy may be used to inform potential strategies, programs, and outreach for engaging family forest owners in invasive plant management; and building individual competence and shared concern may facilitate community-led collective action to manage invasive plants.</p> <p>Benefit: The project produced new insight on FFO knowledge, attitudes, beliefs, and behaviors with respect to the management of invasive plants and shed light on future opportunities to reduce the spread of invasive plants into forest ecosystems.</p>	
<p>18.</p>	<p>“Mapping and Spatial Tools for Water Management Decisions” - Improving the sustainability of soil and water resources through modeling and visualization</p>	<p>Issue: Advances in inexpensive sensors and computer resources means data management and analysis techniques are rapidly available and have potential to improve ability of farmers to put into practice more holistic farm management practices, even at scales required to maintain a profitable commercial farming operation. Soil science is intrinsically spatial, yet spatial aspects of soil science are often not addressed. By integrating spatial soils and remote sensing information into hydrology models, we can provide more relevant local information on how climate and land-use changes affect water availability.</p> <p>What has been done: The goal was to produce better soil spatial information and share that information with end users to facilitate sustainable management of agricultural systems. This involved integration of spatial soil databases and remote sensing products into hydrological and other modeling tools. Model output can be used to provide agricultural system management recommendations for sustainable use of soil and water resources. Finally, state-of-the-art visualization tools bring these recommendations to end users. Project goals were to:</p> <ol style="list-style-type: none"> 1) improve hydrologic modeling of agricultural systems through analysis of spatial soil and remote sensing data; 2) use digital information to improve tools and recommendations for management of sustainable agricultural systems; and 3) integrate findings into interactive visualization tools for research, extension and teaching. <p>Results:</p> <ol style="list-style-type: none"> 1) Researchers improved representation of poorly drained agricultural landscapes in hydrologic simulation models, including impacts of surface ponding and artificial subsurface drainage on hydrologic response, irrigation needs and crop yield. Researchers investigated frequency and extent of occurrence of surface ponding and runoff to understand generation processes in seasonally frozen, subsurface drained agricultural field in eastern Indiana, based on time-lapse photography, and DRAINMOD (computer simulation model that predicts the effects of drainage and water management practices on water table, soil water and crop yields). In-field flooding on crop yield was investigated in west central Indiana using data collected from unmanned aerial systems (UAVs) and the RapidEye satellite. Researchers developed an algorithm to quantify soybean yield loss from excess water stress from early season spectral data, then used these data to improve ability of the VIC-CropSyst model (a regional-scale modeling platform to simulate climate, hydrology, cropping systems and human decisions) to predict impact of excess water 	<p>5.2 Natural resources and the environment</p>

	<p>stress on crop yield. Researchers continue to collect monitoring data from a small, augmented wetland that receives drainage water from Purdue’s Agronomy Center for Research and Education (ACRE), to prepare for a demonstration site in spring 2021 with funding from the USDA-funded Transforming Drainage project and the Indiana Soybean Association. Researchers continued testing and evaluating potential for Drainage Water Recycling (DWR) across the Corn Belt using the VIC model with data from this site.</p> <p>2) Researchers developed and implemented a modeling framework for DWR to estimate irrigation and water quality benefits. Global sensitivity analysis was used to identify high- and low-influential input parameters affecting model outputs, showing parameters controlling total available water had the most influence on applied irrigation and captured tile drain flow. Researchers, using freely available databases of U.S. weather, annual streamflow and water withdrawals analyzed the correlation between the dominant groundwater doctrine in each state and water withdrawals. This analysis showed states following traditional "Eastern" water use doctrines (such as reasonable use and correlative rights doctrines) have increasing trends in groundwater use for irrigation, and, increase in water use during times of low surface water availability demonstrates these doctrines are not designed to protect water resources during times of stress. Researchers developed a Subirrigation Suitability Tool (SST) to identify potential suitability for subirrigation of land in the Midwest. Subirrigation is a practice of using subsurface tile drains to deliver irrigation water to a field by raising the water table. In locations that are suitable, it can provide an efficient and low-cost means of irrigation providing the drains are close enough to achieve uniform distribution. Suitable areas are agricultural land likely to be drained and with a restricting layer that causes the water table to rise, permeable soil above the restricting layer that allows water to move horizontally between tile drains, and flat topography that allows economical systems. The SST is an online map of the Midwest, displaying layers that can be turned on or off, and downloaded https://transformingdrainage.org/tools/subirrigation-suitability/.</p> <p>3) Researchers created four tools. The “Evaluating Drainage Water Recycling Decisions” (EDWRD) tool estimates potential irrigation and water quality benefits from DWR across multiple reservoir sizes. EDWRD integrates water balances for a tile-drained field and reservoir to estimate how much water can be captured, stored, and reused for irrigation. Benefits are quantified in relation to irrigation demand, while water quality benefits are quantified by amount and percentage of tile drain flow captured by the reservoir https://transformingdrainage.org/tools/edwrld/. The “Likely Extent of Agricultural Drainage” tool identifies agricultural areas likely to have been drained for crop production through subsurface tile drainage in the Midwest. The tool is an online map and data can be downloaded for GIS analysis https://transformingdrainage.org/tools/drained-area/. The “State of Indiana Waters” website provides quantity and distribution of Indiana ground and surface waters, including real-time data, flood and drought monitoring systems, and condition summaries from the most recent water year https://www.agry.purdue.edu/indiana-water/. “Soil Explorer” is a free app and website to visualize soil properties in highly detailed maps that can be zoomed, panned, and queried. “Soil Explore.net (https://soilexplorer.net/) is used by USDA Natural Resources Conservation Service, Soil and Plant Sciences Division to update boundaries of Major Land Resource Area (MLFA) maps, and Indiana Department of Natural Resources wildlife biologists are using the site to search for habitat of the eastern spadefoot frog.</p>	
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<p>19.</p>	<p>“Minimizing Impact on the Environment” - Managing emerald ash borer in urban and natural forests</p>	<p>Issue: Emerald ash borer (EAB) is an invasive woodborer insect that threatens to destroy ash trees from North America following its accidental introduction from Asia in the 1990s. Since that time, efforts have been underway to identify the most effective means of protecting ash trees from attack. The most efficacious and cost-effective approach for protecting individual ash trees is with a trunk-injected treatment of the insecticide emamectin benzoate with a single injection providing protection for multiple years. Recent research suggested ash tree mortality can be slowed by treating just 40% of trees in a community with insecticides and targeting the period before first eggs of EAB females. Called Slowed Ash Mortality (SLAM), this program is based on applying insecticides early in the invasion to kill most beetles before eggs are laid. Most municipalities, however, are hesitant to employ this approach without validation of varying stages of EAB invasion.</p> <p>What has been done: The research goal was to assess an evidence-based strategy for protecting ash trees from EAB by judiciously using insecticides to prevent growth in beetle populations and slow ash tree mortality.</p> <p>1) Researchers tested capacity of the SLAM program to protect ash trees at three urban forest sites at the cusp of EAB invasion. Comparisons were made in insecticide-treated ash tree decline with nearby untreated control trees.</p> <p>2) Researchers compared distribution, persistence and efficacy of three insecticide injection systems for the insecticide, emamectin benzoate, in leaf tissue during the year following treatment.</p> <p>Results:</p> <p>1) While the SLAM program reduced overall mortality of untreated ash trees, survivorship varied considerably between sites. In the first site, SLAM was most successful (54% survival) where initially < 10% of ash trees were moribund (canopy thinning \geq 30%) and 40% of all trees were treated with emamectin benzoate every two years. SLAM was less successful (38% survival) in a second site where 15% of trees treated with emamectin benzoate and 25% with annual applications of another insecticide, imidacloprid. In the third site, where 51% of an ash forest were initially moribund and 40% were treated, only 23% survived. Overall survival of treated ash trees declined by 18-22% and trees that were not moribund were most likely to survive. Although many treated trees, initially moribund, regained their health, this was not the case for untreated ash trees. SLAM was most successful for untreated and treated white ash which were more likely to survive than green ash trees. Untreated ash trees at all three sites were more likely to survive when closer to trees treated with emamectin benzoate, but not to those treated with imidacloprid. Findings suggest SLAM can protect urban ash trees, but success is strongly influenced by initial tree condition, species composition and proximity to treated ash trees.</p> <p>2) Comparisons of all three insecticide injection systems provided two years of protection from EAB, although amount of emamectin benzoate recovered from leaves one year after injection was greatly reduced. Additionally, trees injected using Tree I.V. and Q-Connect systems showed no decline in canopy cover three years after injection.</p>	<p>5.3 Natural resources and the environment</p>

		<p>Benefit: This project provides evidence for an area-wide strategy to suppress EAB that could substantially reduce the costs of managing ash trees in cities, and retain the benefits provided by mature urban trees, with minimal impacts on non-target organisms or the environment.</p>	
<p>20.</p>	<p>“Building an Equitable and Just Green Infrastructure” Strategy and Workforce in the North Central Extension Region</p>	<p>Issue: Midwest communities are adopting green infrastructure (GI) practices as low-cost ways to update aging stormwater infrastructure and generate social and environmental co-benefits. While community challenges are similar, practices vary considerably. This is particularly true for co-benefits, such as recreation and beautification, where best practices are not well defined. GI distribution throughout communities have major impacts on who benefits. When sited in disadvantaged communities, impacts on local property values lead to displacement of longtime residents. While experts project jobs within GI will grow, communities struggle to provide sustainable careers and build workforces matching population demographics.</p> <p>What Has Been Done: GI practices restore or mimic natural hydrological processes. GI captures stormwater at or near where it naturally flows and pools and allows it to be absorbed by soil, plants, or other media. GI allows pollutants from roadways and rooftops to be absorbed in place, improving downstream water quality, and helping control flooding by reducing water volume and speed reaching rivers and streams. To residents, GI looks like parks, gardens, parking lots, and green roofs, and provides important community amenities like recreational spaces and pollinator habitats. Extension, Sea Grant, and other partners, with funding from the North Central Regional Water Network (NCRWN), identified the intersection of social justice, workforce development, and GI programs as a growth opportunity for the twelve-state region. The team completed a needs assessment gathering background data, conducting listening sessions in selected communities, and convening a summit to identify and prioritize successes, gaps, and opportunities. Eighteen listening sessions, with representatives from over 30 communities across nine states, were led by facilitators with five discussion questions to guide conversations. In Indiana, the Northwest Equitable GI focus group met virtually. To synthesize all regional listening session results and prioritize next steps, the project team coordinated an Equitable GI Summit held virtually because of COVID-19. Over 100 Summit attendees joined from Extension, Sea Grant, state and local government agencies, nonprofits, and private businesses. Presentations by Extension and Sea Grant Networks members, local government officials, and private and public sector subject matter experts provided overviews of work in the region and summarized results and themes from listening sessions. During breakout sessions, Summit participants identified and prioritized barriers and opportunities for communities to add socially just benefits to their GI practices.</p> <p>Results: Needs assessment findings provided five recommendations for communities seeking to implement GI programs: 1) Keep it simple to lower installation costs and reduce burden of care over a project’s lifetime. 2) Emphasize co-benefits as communities with multiple societal benefits were more successful implementing low-cost GI networks to enhance communities beyond stormwater management. 3) Design GI careers, not GI jobs, to create sustaining careers affording opportunities for advancement. 4) Provide education at every level for government staff, officials, and city planners to implement GI policies, contractors and crews for performance and maintenance, decision-makers for function and value, and K-12 students. 5) Build relationships and establish partnerships for</p>	<p>5.4 Natural resources and the environment</p>

		<p>sharing knowledge and resources and providing expanded opportunities. Following the Summit, most attendees reported they would use information received at multiple events, and had increased understanding and awareness of social justice and workforce practices and challenges related to GI. From listening sessions and the Summit, it was found that including societal aspects for planning/designing GI resulted in greater community and internal support, greater ability to secure additional funding through grant programs, and greater integration of GI and other community-benefit programs. Making co-benefits and the economic costs and benefits explicitly part of decision-making helped communities address multiple needs deriving more value from money already going to stormwater capital improvements.</p> <p>Benefit: As a result, communities now have a guide for building an equitable and just green infrastructure strategy and workforce.</p>	
<p>21.</p>	<p>Analysis of energy efficient solutions for modern agricultural machines</p>	<p>Issue: Current state-of-the-art technology of tractor-implement hydraulic systems have overall energy efficiencies of ~25%. This is in line with findings from a U.S. Dept. of Energy study which found average efficiency of hydraulic drives in off-road vehicles to be about 21%. However, there is a tremendous opportunity to significantly increase this low energy efficiency through a re-design of hydraulic control systems.</p> <p>What has been done: This research involved formulating, designing and demonstrating a novel energy efficient architecture for the actuation system of future generations of electrified agricultural tractors using hydraulic functions. Focus was on the actuation system for tractor suspensions, steering, hitches and remotes, which is commonly based on energy-inefficient high-pressure hydraulic technology, particularly when implements are powered through hydraulic remotes. The five-year research plan included numerical modeling of the electric hybridization (EH) system, numerical optimization and experimental activities on a prototype machine.</p> <p>Results:</p> <p>1) Architecture formulation accomplishments related to duty cycle definition; modeling of state-of-the-art load-sensing (LS) system; and EH hybrid architecture. A reference tractor of 380 hp was analyzed. A tractor provided to Purdue by Case New Holland (CNH) made it possible to formulate a numerical model reflecting the nature of the high-pressure system of a typical state-of-the-art tractor. The model was formulated with significant data provided by CNH and Bosch Rexroth, to achieve a good level of accuracy. A 16-row planter (Case Earlyriser) was selected as a reference case for the hydraulic implement. This choice was made considering the power level (a planter is one of the most energy-demanding implements) and the wide use of large planters among U.S. farmers.</p> <p>2) System design accomplishments related to alternative architectures for the tractor and planter hydraulic control systems to minimize energy consumption and consider proper control strategies. Some architectures formulated were based on minor modifications, and the most significant was the advanced electro-hydraulic load sensing system. It uses an electro-controlled supply pump with advanced control of the whole system similar to load-sensing systems. Preliminary study of multi-pressure rail system was performed. Both systems increased energy efficiency during a simplified drive cycle for planter use.</p>	<p>6.1 Sustainable energy</p>

		<p>3) For the experimental tests, the reference New Holland Tractor 380 hp was instrumented to perform baseline measurements on consumption of main hydraulic functions in the high-pressure hydraulic system. A literature search found insufficient standards for testing hydraulic systems for energy losses. The research team, based on feedback from CNH, formulated a specific test plan. Measurements of system efficiency of the fluid power transmission system showed efficiency on the hydraulic remotes as low as 25%, depending on operating conditions.</p> <p>Benefits: This project formulated and provided design criteria for a novel energy-efficient architecture for the next generation of agricultural machines using electrification.</p>	
<p>22.</p>	<p>The influence of cereal bran and bran arabinoxylan chemical and physical structure on the human gut microbiome</p>	<p>Issue: Low gut microbiota diversity is associated with multiple diseases, including chronic metabolic diseases such as metabolic syndrome and type II diabetes, irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), and increased risk for colorectal cancer. Westernization of diet is strongly correlated with lower gut microbiome diversities compared with more indigenous diets. Recently, many research groups determined this loss of species from the gut microbiome is linked to consumption of the high-fat, low-fiber Western diet, which starves colonic microbiota of the dietary fibers they ferment as their primary energy source. Therefore, dietary interventions are urgently needed to repopulate very low-abundance (nearly extinct) gut microbiota that are safe and tolerable enough for routine use.</p> <p>What has been done: The research goal was to identify how structural characteristics of fiber carbohydrates or the physical context of these carbohydrates, influence ecological responses of gut microbiota, the metabolic fate of the carbohydrate, and its influence on host physiology. The overarching hypothesis is that structural properties of carbohydrates govern gut microbial ecology, and generalizable relationships between fiber structural variables and microbiome structure and function exist. This research combines <i>in vitro</i> and <i>in vivo</i> experimentation, cultivation, and cultivation-independent molecular microbial ecology techniques to address relationships between structural properties of soluble fibers, gut microbial ecology, fiber metabolic fate, and host physiology; and the degree to which physical properties of insoluble fiber carbohydrates impact structure and function of gut microbial communities</p> <p>Results: We determined that bran particle size influences are not limited to wheat, but more broadly influence interactions of cereals with the gut microbiome. We determined fine structures in bran arabinoxylan (found in cell walls) select for different microbial communities. These advances set the stage for use of bran fiber structures (including variables of cereal type, particle size, and fine chemical structure) for dietary manipulation of gut microbiomes of both humans and production animals. Understanding desirable microbiome structures and functions will promote population-scale dietary approaches to tune the gut microbiome for improved health. For whole bran particles, we found that maize bran particles exhibited a similar size-dependent fermentation as for wheat brans, with similar shifts in short-chain fatty acid production. Furthermore, we found specific microbial taxonomy units were associated with maize bran particles differing in size; although this effect was not as strong as observed in wheat, owing to their slower overall fermentability. These experiments demonstrated that particle size effects are likely common across cereal bran fibers. For soluble bran fibers, we determined that small variations in fiber</p>	<p>7.1 Human, family, community health and well-being</p>

		<p>structure make significant impacts on which microbiota are most successful in fermenting them and the metabolic outcomes of fermentation. Solubilized arabinoxylans extracted from hard vs. soft red wheat brans promoted different microbes (hard varieties were dominated by bacteria (<i>Prevotella</i> spp.) whereas <i>Bacteroides</i> was more efficient on soft varieties).</p> <p>Benefit: Research findings established foundational understanding of how cereal brans and their composite arabinoxylans influence gut microbiome diversity and function <i>in vitro</i>, providing a foundation for future <i>in vivo</i> studies of interfaces between cereal bran fibers and microbiota to improve gut health.</p>	
<p>23.</p>	<p>Exposure to the herbicide atrazine and influence on mental health pathways</p>	<p>Issue: Atrazine (ATZ), the second most commonly used agricultural herbicide in the U.S., has been linked to a variety of detrimental health effects including disruption of the hypothalamic–pituitary–gonadal axis in rodents; with decreased semen quality and testosterone in men; menstrual cycle irregularities and increased risk of breast cancer in women; and increased prevalence of infants born small-for-gestational-age and birth defects in Indiana. Additionally, the central nervous system has been identified as a potential target of ATZ; however, impacts of ATZ on neurological development are still largely unknown.</p> <p>What Has Been Done: Zebrafish were rinsed following ATZ exposure during embryogenesis and allowed to mature under control conditions until adults. Neurobehavior assessments were completed as well as an analysis of gene expression changes in the brain of male and female zebrafish. Further analysis completed determined specific mechanisms and adverse effects on neurotransmission, specifically nerve endings that release or are stimulated by serotonin, and nervous system tissue. In addition, assessments were completed in human cell systems to define mechanisms of atrazine neurotoxicity.</p> <p>Results: Male zebrafish exhibited decreased locomotor parameters during behavior tests at nine months post fertilization. Analysis of RNA molecules revealed a number of pathways and networks were altered including those involved in organismal development, cancer and nervous and reproductive system development. Microscopic examinations of brain tissue led to a discovery of decreased number of cells in raphe populations (serotonin-producing cells in the midline of the brainstem). In related studies, human cells exposed to ATZ exhibited numerous gene expression changes including decreased methylated of histones, presumably resulting in gene silencing.</p> <p>Benefit: The research demonstrated that developmental exposure to ATZ affects neurodevelopment and neural function in adult male zebrafish, establishing the need for additional studies to evaluate the significance of ATZ-induced brain dysfunction.</p>	<p>7.2 Human, family, community health and well-being</p>
<p>24.</p>	<p>4-H Teen Leadership Conference</p>	<p>Issue: For positive youth development, opportunities for growth are needed in personal mindset (character, growth mindset, persistence, decision-making and ethics), social and leadership skills (ability to communicate through multiple methods, value and respect for other cultures), and universal skills (social, emotional, character and leadership skills). Many essential elements needed are positive relationship with a caring adult, inclusive environment, safe environment, engagement in learning, opportunity for mastery, opportunity to see oneself as an</p>	<p>7.3 Human, family, community health and well-being</p>

		<p>active participant in the future, opportunity for self-determination, and opportunity to value and practice service for others.</p> <p>What Has Been Done: At the 4-H Junior Leader Conference, held virtually over three afternoons, 86 high school youth from across Indiana joined for nine instruction hours. The 16-member Indiana 4-H Junior Leader Council worked with Purdue Extension to plan and implement opportunities for youth to grow personal skills and gain experience for future education and career paths. From the keynote, "Leadership and Laughter," youth learned techniques to overcome challenging situations, stay connected virtually or in person, and build personal leadership skills. Council member pairs prepared and led skill sessions where youth learned about personal leadership, team building, understanding different cultures, and healthy lifestyles. Youth learned from business and industry professionals via online networking. Professionals shared tips about educational and professional development encouraging youth to interact and learn skills to succeed in the workplace. A service project was held one afternoon where youth used an old t-shirt or pair of jeans to create a dog toy to serve as a prototype to share with other youth in their communities to provide toys for local animal shelters.</p> <p>Results: Youth completed an online survey and shared something they had learned and could use in the future. Youth shared comments about maximizing their 4-H experience. "One thing I learned is how to use my 4-H experience to its fullest potential to serve my community." "I learned how being in 4-H can you help you grow into the career you want in the future." "One thing I learned is how to use my 4-H experience to its fullest potential to serve my community." Youth shared how to make better work habits that will benefit them in their future, better plan and prepare for the future and to incorporate teamwork into their club, lead and leadership types to use, and understand differences and work together. Youth shared about interacting and connecting with people. "One thing I learned is how to communicate with people you don't know that well." "I enjoyed the networking event because we got to learn tricks of the trade and fascinating little tidbits of life advice from each of the sponsors." "I learned how to get people engaged. I will be using the icebreakers that I learned about with my campers next summer!" Youth wrote thank-you notes to conference sponsors and organizers. "Thank you for giving me this opportunity to learn and grow. This conference gave me a lot of information and tips that I will be able to use in my life." "I would like to sincerely thank all the sponsors for this wonderful and educational experience and talking to us about your careers in agriculture." "I have learned a lot and plan to use this new knowledge in my everyday life. Thank you." Youth wrote thanks for making it a virtual conference. "This was a wonderful experience. It was nice to still be part of 4-H and Jr. Leaders even though it was not in person. Thank you for making sure this happened. It was nice to learn and have fun."</p> <p>Benefit: As a result of this event, Indiana 4-H Junior Leader Council members and high school youth participants across Indiana developed knowledge and skills for leadership, teambuilding, and interacting with other cultures, and explored opportunities for future education and careers.</p>	
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<p>25.</p>	<p>“Indiana 4-H World Changers Online Hackathon”</p>	<p>Issue: International Student Assessment data on 15-year-old student math literacy show 21 countries with higher average scores than the U.S. National Inventors Hall of Fame indicated science, technology, engineering and mathematics (STEM) education puts an emphasis on preparing future generations to be successful. STEM skills prepare youth with varied interests for any industry.</p> <p>What Has Been Done: Indiana 4-H Computer Science programs and educators were supported by a National 4-H Council and Google partnership to provide opportunities for rural and under-served populations. Google provided curricula and tools for 4-H to train youth and adult volunteers. 4-H staff from five states, Indiana, California, Illinois, New York and West Virginia gathered monthly to collaborate on initiatives, events and training. An Indiana 4-H in-person, on-campus computer science event, focused on STEM and agriculture, civic engagement, and healthy living, was in the works when coronavirus closed schools. Quickly changing gears, the Indiana World Changers 4-H Online Hackathon was created. Emails to principals and posts on National Computer Science teachers Facebook promoted the event to 4-H members and all youth ages 12 to 18 from Indiana and beyond. Youth were encouraged to propose a real-world solution using coding and other technology. Problems identified were for finding quality mental health services for adolescents, helping service organizations identify food deserts or creating a service project to help solve food insecurity locally, using digital tools to identify insects/weeds/diseases in fields or forests, or helping producers in grain sales and trucking identity and calculate elevator cash bids to determine highest return. Purdue Extension provided instruction videos, FAQs and links to resources. Participating youth created a mockup, decided the coding language(s), learned needed skills, and tested their project. Final projects included a short video, screencast of the working product, audio walk through of, and reasons for, the project, the code and app. Youth had four days to produce a video in which they discussed the selected problem and how it could be solved. Youth were encouraged to seek out a mentor, family member, friend, teacher, or club leader to provide guidance to them on their projects. Projects were judged on technical aspects and on presentation skills describing the problem and why they selected it.</p> <p>Results: In its first year, the Indiana World Changers 4-H Hackathon had 85 participants and seven mentors in the program. The grand prize winner created an Indiana county mental health resource for youth. The reserve grand prize winner created an app defining a food desert and helping users find places to volunteer. This first online event launched virtual computer science activities for the pandemic year reaching 3,278 youth with the help of 303 adult volunteers and collaborating partners via a total of nearly 300 hours of instruction.</p> <p>Benefit: As a result of this hackathon, Indiana youth had opportunities during the pandemic to learn STEM skills for their futures.</p>	<p>7.4 Human, family, community health and well-being</p>
<p>26.</p>	<p>Turtle Mountain Reservation Community Development</p>	<p>Issue: The dream for Turtle Mountain was to create a substance abuse disorder recovery center that would serve the reservation and region.</p> <p>What Has Been Done: The Purdue Center for Rural Development secured a USDA Rural Economic Development Innovation (REDI) grant to support a project involving the Turtle Mountain Band of Chippewa Indians (TMBCI) in Rolette County, North Dakota. Purdue Extension Community Development, Purdue Department of Nursing, and the</p>	<p>7.5 Human, family, community health and well-being</p>

		<p>University of Kentucky collaborated on this project. Turtle Mountain Reservation covers 72 square miles next to the Canadian border.</p> <p>The REDI team developed an innovative, community development-driven approach using new tools (a system mapping technique), paradigms (a merger between community capitals and recovery capital) and culturally oriented approaches. An in-depth data snapshot for Turtle Mountain Reservation was created to showcase over two dozen variables on five themes: Quality of Life, Workforce Development, Economic Development, e-Connectivity and Technological Innovation. Purdue Extension Community Development and Purdue Nursing led a 2-day workshop to provide the local team with information and tools to begin development of a solid plan to outline goals, objectives, strategies and timetable to pursue work that aligned with one or two of the five themes. Monthly writing team calls, bi-monthly calls with REDI support personnel, quarterly webinars with USDA Rural Development, and virtual meetings and conference calls with the local team were conducted to aid in the community development. Work group activities included a funding feasibility plan; clinical design, staffing needs, and buildings and services; and a business plan including Medicaid billing and regulations details and USDA community facilities loan application information.</p> <p>During this project, another collaborating partner was added, Purdue’s Center for Community and Environmental Design. A professor and landscape design students consulted on the site for the recovery center and completed a comprehensive plan for outdoor environments capable of protecting the natural landscape, while providing opportunities to interact with the land for patients and their families. A draft master plan and detailed site designs and computer visualizations were presented to tribal leaders and staff, whose enthusiastic response led to a request for more comprehensive design. Designs include outdoor classroom spaces that serve as therapeutic gardens and learning spaces, while developing an entry experience for the Recovery Center’s main facility that provides spaces for reflection, solitude, and a welcoming garden. Several elements are already under construction, including primary roadways and patient housing, but the rest will come as the tribe finalizes funding resources and begins construction of the remaining key facilities.</p> <p>Results: The clinical plan and the business plan have been completed. The REDI team will continue to work with stakeholders in Turtle Mountain to complete an action plan focused on the development of the recovery-oriented system of care (ROSC). Continuing assistance will focus on creating funding strategies, and organizational and workforce development. Due to pandemic restriction delays, the final REDI plan and ongoing support will continue into 2021. The completed, final landscape design is expected in early summer 2021. The design will be used by the tribe to coordinate with local design, engineering, and construction firms to plan site development.</p> <p>Benefit: The Turtle Mountain Recovery Center will be a 100-acre campus with a central facility, supportive residences, confidence course, equine therapy stables, sweat lodge, medicinal garden and walking trails for the Turtle Mountain Band of Chippewa Indians in Rolette County, North Dakota.</p>	
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<p>27.</p>	<p>“Navigating Difference” and Cultural Awareness Workshops Build Cultural Competence for Indiana Residents</p>	<p>Issue: The U.S. has an ethnically diverse population. Dramatic shifts in population have occurred. By 2045, the Census Bureau estimates the U.S. will become a “majority minority” country.</p> <p>What Has Been Done: Navigating Difference is a cultural competency training developed by Washington State University. Purdue Extension provides the program across Indiana for those who want to deepen their knowledge, skills and appreciation for connecting across diversity with clientele, coworkers and community members. Its five modules include elements from social justice, intercultural communication and organizational development. Purdue Extension also offers a half-day interactive workshop on the first module, cultural awareness. When Indianapolis Public Library System’s (IPLS) director of human resources attended, she knew it would help IPLS improve outreach and service to underserved and vulnerable populations, homeless patrons, new immigrants and refugees, low-income families and individuals, and people with disabilities, including mental illnesses. Over three years, all 600+ staff completed the program. All managers and supervisors (108) completed three-day intensive training and 500 staff built cultural awareness skills in a half-day workshop. Other groups across Indiana completing the training were community leadership programs in seven counties, Retired Senior Volunteer Program (RSVP) and Community School staff.</p> <p>Results: On post-surveys after the three-day training, 75% of IPLS managers reported increased confidence taking steps to effectively navigate cultural competence. In the last year, 336 cultural competence workshop participants reported increases from before to after the workshop: 78% improved their recognition of how power, privilege, and oppression may affect their work with people from cultures other than theirs, 76% improved how motivated they feel to act to build their cultural competence and 69% improved their understanding of the barriers to intercultural communication.</p> <p>Benefit: Representatives of these organizations improved their cultural competence, which they may apply in interactions with clients, customers and residents in their communities across Indiana.</p>	<p>7.6 Human, family, community health and well-being</p>
<p>28.</p>	<p>“On Local Government” COVID-19 Response</p>	<p>Issue: In March 2020, over a few days, local governments in Indiana had to quickly respond to COVID-19, including closing buildings, providing services in a modified/virtual way, communicating with communities about the crisis and forecasting how revenues would be impacted. This situation was completely different than anything local officials had dealt with in the past, and it seemed like overnight they needed a whole new skill set to serve their communities. And, social distancing made local officials more isolated and siloed in their town/city, department or county, adding to the difficulty to collaborate with other units/agencies to identify best practices to resolve challenges raised.</p> <p>What Has Been Done: Purdue Extension provided a central location for local governments as they worked to keep their constituents healthy, safe and well informed. Extension collaborated with Indiana local government associations to provide a website for webinars and resources, to offer seven webinars to fill skill and knowledge gaps in economic outlook, State Board of Account (SBOA) updates, Department of Local Government Finance (DLGF) and SBOA Q&A sessions for townships, crisis communication, programming with online platforms, and navigating grant opportunities. Nearly 1,300 local government officials and community leaders participated. Purdue Extension hosted</p>	<p>7.7 Human, family, community health and well-being</p>

		<p>weekly COVID-19 roundtable discussions where collaborations and networking opportunities were created among participants. These one-hour roundtables offered a time for regional leaders to meet virtually to share information, questions, and ideas about COVID-19 impacts and responses. Meetings focused on the current operation status of the “Indiana Back on Track” plan, challenges, helpful tips, what to do differently, current county needs, and next big steps. Each week Purdue Extension facilitated discussion between libraries, townships trustees, State Representatives, cities, towns, and others. In some, a state perspective of pandemic impact on local units was provided by State Representatives and to help participants generate ideas about how to address community issues.</p> <p>Results: Participants gained knowledge about topics that helped them address the pandemic. One library participant was particularly grateful for our walk virtually. She planned to quickly implement to continue programs for patrons. Purdue Extension forged new relationships with the DLGF and SBOA providing advice for virtual Q&A sessions and budget workshops. Over 60 participants increased their knowledge on where to get personal protective equipment (PPE) and shared methods to help reduce pandemic spread in public buildings and services. In Northwest Indiana, the group wanted to continue conversations and collaborated with Purdue Extension to restructure. A new forum resulted on leadership development and non-duplicative collaboration opportunities for communities in transition to post-pandemic. In Eastern Indiana, Purdue Extension partnered with Blackford County Economic Development (BCED) to gather information from business owners concerning COVID-19 impacts. Of 21 reporting, 71% reported financial difficulty due to COVID-19 shutdown and half had to furlough employees and/or close temporarily. Also, an assessment was conducted with local officials who identified needs for funding for PPE and other COVID-related expenses. Based on needs, grant applications were submitted to the Indiana Office of Community and Rural Affairs (OCRA) for COVID-19 Relief Funds. OCRA awarded over \$426,000 for PPE, COVID-19 testing, for the local food pantry, and BCED for job retention to assist hardest-hit manufacturers and closed businesses.</p> <p>Benefit: Purdue Extension provided opportunities for local governments to learn and connect during the pandemic. These efforts helped communities and businesses with information, collaboration and funding during challenging times and economic hardships.</p>	
<p>29.</p>	<p>Three programs face mental health and build support in the community</p> <p>“Weathering the Storm in Agriculture”</p>	<p>Issue: Mental health and substance use issues are widespread concerns and often perceived differently from physical health. This can perpetuate shame and stigma discouraging individuals to seek or accept help. This stigma also affects families and communities. Half of chronic mental health conditions develop by age 14 affecting youth. Farming is chronically plagued with stressors of weather, regulations, input costs, and market prices. Net farm income has declined 71% since 2013 and commodity prices have not exceeded the break-even point for over four years. This increasing financial strain results in chronic stress, anxiety, and depression for farm families and threatens the livelihood and heritage of family farms. The COVID-19 pandemic compounded emotional and financial trauma on farm families and operations.</p> <p>What Has Been Done: Purdue Extension provided mental health education. “Youth Mental Health First Aid” is for adults interested in learning about mental health issues affecting youth (ages 12-17) and covers signs and symptoms of mental health and substance use issues, and tools for first-aid level assistance to adolescents experiencing crises.</p>	<p>7.8 Human, family, community health and well-being</p>

<p>“Communicating with Farmers Under Stress”</p> <p>“Youth Mental Health First Aid”</p>	<p>This eight-hour, in-person course includes topics on anxiety, depression, substance use (including opioids), trauma, and deliberate self-harm. Participants learn how to be a resource and provide support to youth at risk for mental health and/or substance-use issues. Youth Mental Health First Aid was delivered 12 times reaching 193 adults. Of those reporting (191), participants were female (74%), age 25-44 years old (48%), and Caucasian/White (85%).</p> <p>Purdue Extension delivered two farm stress management workshops developed by Michigan State University. “Weathering the Storm in Agriculture,” a 60-minute workshop, helps farmers and families understand signs and symptoms of chronic stress, builds skills in recognizing and responding to mental health concerns in themselves and others, and shares where to go for more help and resources. “Communicating with Farmers Under Stress,” a four-hour workshop, is for agricultural organization representatives and others who work, or interact, with farmers. Lenders, vets, inspectors, breeders, those in seed/feed sales, Farm Bureaus, and many others may have first glimpse if something is amiss with farmers. Others could be health care workers, mental health professionals, and faith leaders, but they may not fully understand stress related to agriculture. Workshop participants learn to recognize signs of stress, and techniques for identifying, approaching and working with stressed farmers. Purdue Extension has delivered 52 workshops reaching 1,550. Participants were ages 16 to 82, residing in 89 Indiana counties, including farmers, family members, agribusiness representatives, health professionals, and government agency workers.</p> <p>Results: “Youth Mental Health First Aid” participants (96%) were confident they could reach out to youth having mental health problems, substance-use challenges or crises, and 94% were confident in recognizing signs of mental health problems, and in asking adolescents whether they are considering killing themselves. Participants indicated, “It is a course that is needed in all schools,” “Definitely useful training that will help me in my volunteer role,” and “Good info for first responders.”</p> <p>For the farm stress workshops, there were 735 (98% white, 54% male) post-survey respondents. Participants reported an increase in understanding the impact of stress on the body (100%), confidence identifying signs and symptoms of stress in someone (99%), knowing where to send someone for help (99%), confidence communicating with someone experiencing stress (99%), understanding warning signs of suicide (98%) and understanding the current agricultural financial situation (97%). Participants reported learning about the physical impact of stress and the tips for managing stress: “All of the different ways (not just mental) that stress can affect our bodies.” “Pay more attention to how stress can affect my body and taking a negative thought and turning it in to a positive (self-talk).” Participants reported learning coping and communication skills. “I learned a good breathing technique that helps release tension and reduce stress.” “The suicide information was valuable, because just something not in my vocabulary, so I had no clue how to have that conversation.” “How to talk to someone and be positive and be empathetic.” “How to approach a stressed farmer and high stress situation on a farm setting.”</p> <p>Benefit: These results affirm the value of training adults who care for and support the mental health of Indiana’s youth. As a result of the farm stress workshops, farmers, their families, those in agriculture-related businesses/organizations, and other professionals better understand the physical impact of stress, know tips to manage stress, recognize signs of stress, and know how to approach and talk with those in distress. These gained abilities create a support system for farmers in our Indiana communities.</p>	
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<p>30.</p>	<p>Indiana adults take control of their personal finances with Where Does Your Money Go?</p>	<p>Issue: According to the Federal Reserve Bank, personal savings rates dramatically increased from 7.5% in April 2019 to 33.5% in April 2020. This dramatic increase is attributed to COVID-19 pandemic economy shut down. In 2018, American households spent 65% of their income for housing and health care. A 2017 survey from CareerBuilder found a large percentage of U.S. workers (78%) living paycheck to paycheck. Workers (25%) do not set aside money for savings and nearly 75% are in debt.</p> <p>What Has Been Done: Extension Educators in 28 Indiana counties presented “Where Does Your Money Go?” to 260 adults virtually or in person. Program modules were also available through Facebook Live and recorded videos. This financial program, delivered via one or two instructional sessions, covers how small purchases add up to large expenses over time and determining “needs” versus “wants.” Adults discover their spending leaks (repeatedly spending money in certain areas without thought) and identify financial priorities. They also develop skills to make spending plans (budget) tailored to financial needs and to achieve personal goals.</p> <p>Results: Most adults (n=243) responded on the session one post-evaluation survey. Results demonstrated an increase in intended behavior change of personal financial management. Over 90% reported they could have more money if they made different spending choices. Over 80% reported they are thinking differently about how they manage their money. Median amount for spending leaks was \$4,413, and adults indicated that money could be used to start saving or pay off bills. Participants stated, “Made me realize things like the fact that making coffee at home is a lot cheaper than purchasing a cup of coffee out every day,” and “Absolutely no more pay-day loans and rent-to-own items.” After session two, 113 survey respondents indicated they had written a financial goal (81%), found bills easier to pay because of new spending choices (80%), saved money since the first session (48%), and decreased debt since the last session (31%). Responses (n=15) to a three-month follow-up survey found adults had reduced their spending leaks, were managing their money better, and had developed a spending/savings plan. One stated, “I realized how much we were spending/wasting on eating out. We now limit to once a month and save at least \$200/month.”</p> <p>Benefit: Indiana adults and their families are benefiting from the financial skills acquired to help them spend and save money more effectively.</p>	<p>7.9 Human, family, community health and well-being</p>
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