ACADEMIC PROGRAM REVIEW SELF-STUDY DOCUMENT

OCTOBER 18-20, 2021

DEPARTMENT OF AGRONOMY

PURDUE UNIVERSITY

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Agronomy Review Schedule

Monday, October 18	
Time	**Event**
10:00 – 11:00 am (EST) 9:00 – 10:00 am (CST) 8:00 – 9:00 am (MDT) 7:00 – 8:00 am (PST)	**Entrance Meeting** with College of Agriculture Administration (Join Meeting) • Karen Plaut, Glenn W. Sample Dean of Agriculture • Jason Henderson, Senior Associate Dean & Director of Purdue Extension • Bernie Engel, Senior Associate Dean & Director of Agriculture Research and Graduate Education • Christine Wilson, Associate Dean & Director of Academic Programs • Jerry Shively, Associate Dean & Director of International Programs in Agriculture • Pam Morris, Assistant Dean & Director of Multicultural Programs
11:15 – 12:00 noon (EST) 10:15 – 11:00 am (CST) 9:15 – 10:00 am (MDT) 8:15 – 9:00 am (PST)	**Entrance Meeting with Department Head and Advisory Team** (Join Meeting) Ron Turco, Mitch Tuinstra, Linda Lee, Jim Camberato, Diane Wang, Shalamar Armstrong, Laura Bowling
Break	
1:15 -2:00 pm (EST) 12:15 – 1:00 pm (CST) 11:15 – 12:00 noon (MDT) 10:15 – 11:00 am (PST)	**Early and mid-career faculty (Assistant & Associate Professors)** (Join Meeting) **Facilitator**: Katy Rainey Assistant Professors: Daniel Quinn, Diane Wang Associate Professors: Shaun Casteel, Katy Rainey, Shalamar Armstrong, Mohsen Mohammadi, Davide Cammarano
2:15 -3:00 pm (EST) 1:15 – 2:00 pm (CST) 12:15 – 1:00 pm (MDT) 11:15 -12:00 am (PST)	**Graduate Programs** (Join Meeting) **Facilitator: Richard Grant** Laura Bowling, Yiwei Jiang, Mohsen Mohammadi, Tony Vyn, Cankui Zhang, Diane Wang, Davide Cammarano, Holly McIntire
3:15 – 4:00 pm (EST) 2:15 – 3:00 pm (CST) 1:15 – 2:00 pm (MDT) 12:15 –1:00 pm (PST)	**Graduate Students, Postdocs and Visiting Scholars** (Join Meeting) **Facilitator: Ana Gabriela Morales Ona, Chair AGSO** All graduate students, postdocs, and visiting scholars
4:15 – 5:00 pm (EST) 3:15 – 4:00 pm (CST) 2:15 – 3:00 pm (MDT) 1:15 – 2:00 pm (PST)	**ACRE management and Crew, ACRE Advisory Committee** **Facilitator: Rachel Stevens** ACRE Advisory Committee and other ACRE researchers
5:15 – 6:00 pm (EST) 4:15 – 5:00 pm (CST) 3:15 – 4:00 pm (MDT) 2:15 – 3:00 pm (PST)	Undergraduate Majors (Join Meeting) **Facilitator: Sherry Fulk-Bringman** Invite: Ag Ambassadors, Crops and Soils Team members and other
6:15 – 7:15 pm (EST) 5:15 – 6:15 pm (CST) 4:15 – 5:15 pm (MDT) 3:15 – 4:15 pm (PST)	**Review Committee Working Time**

Tuesday, October 19	
Time	**Event**
10:00 – 10:45 am (EST) 9:00 – 9:45 am (CST) 8:00 – 8:45 am (MDT) 7:00 – 7:45 am (PST)	Research Programs (Join Meeting) **Facilitator: Cliff Johnston** Invite: All research active faculty and staff
11:00 – 11:45 am (EST) 10:00 – 10:45 am (CST) 9:00 – 9:45 am (MDT) 8:00 – 8:45 am (PST)	Meet with Heads of Other College of Agriculture Departments (Join Meeting) **Facilitator**: Dr. Jayson Lusk (AgEon) Invited: Senay Simsek (FS), Mark Russell (ASEC), Chris Staiger (BPP), Stephen Cameron (ENTM), Linda Prokopy (HORT, Andy Mesecar (BCH), Nate Mosier(ABE), Bob Wagner(FNR), John Blanton(ANSI)
Break	
1:00 - 1:45 pm (EST) 12:00 – 12:45 pm (CST) 11:00 – 11:45 am (MDT) 10:00 – 10:45 am (PST)	Undergraduate Program (Join Meeting) **Facilitator: Lee Schweitzer** Corey Gerber, Keith Johnson, Sara Allen, Shams Rahmani, Mohsen Mohammadi, Katy Rainey, Jane Wiercioch, Dawn Bull, Sherry Fulk-Bringman, others
2:00 -2:45 pm (EST) 1:00 – 1:45 pm (CST) 12:00 – 12:45 pm (MDT) 11:00 -11:45 am (PST)	Department Admin Staff or Research Staff (Join Meeting) **Facilitator**: **Lexi Wilson** Connie Foster, Dawn Bull, Holly McIntire, Brandon Chafin, Melinda Smith, Jane Wiercioch, Niki De Armond, Marianne Bischoff-Gray, Andy Linvill, Cliff Glover, Katy Mazer, Anna Morrow, Youn Jeong Choi, Tracy Richards, Alex Angel, others
3:00 – 3:45 pm (EST) 2:00 – 2:45 pm (CST) 1:00 – 1:45 pm (MDT) 12:00 – 12:45 pm (PST)	Culture and Diversity (Join Meeting) **Facilitator: Shalamar Armstrong** Keith Johnson, Militza Carrera-Colon, Lexi Wilson, Youn ling, Cindy Nakatsu, Patrick Rich, others
4:00 – 4:45 pm (EST) 3:00 – 3:45 pm (CST) 2:00 – 2:45 pm (MDT) 1:00 – 1:45 (PST)	Extension Programs (Join Meeting) **Facilitator: Cory Gerber** Extension Staff, Indiana Climate Office, Hemp Program, Soil Health Team
5:00 – 5:45 pm (EST) 4:00 – 4:45 pm (CST) 3:00 – 3:45 pm (MDT) 2:00 – 2:45 pm (PST)	Curriculum Committee (Join Meeting) **Facilitator: Jeff Volenec** Laura Bowling, Sylvie Brouder, Cliff Johnson, Linda Lee, Mohsen Mohammadi, Katy Rainey, Lee Schweitzer, Jane Wiercioch
6:00 – 8:00 pm (EST) 5:00 – 7:00 pm (CST) 4:00 – 6:00 pm (MDT) 3:00 – 5:00 pm (PST)	Review Committee Working Time

Wednesday, October 20	
Time	**Event**
9:30 – 10 am (EST) 8:30 – 9:00 am (CST) 7:30 – 8:00 am (MDT) 6:30 – 7:00 am (PST)	**Exit Meeting** with Graduate Program Review (Join Meeting) • Bernie Engel, Senior Associate Dean & Director of Agriculture Research and Graduate Education • Melanie Morgan, Associate Dean of the Graduate School
10:00 – 10:45 am (EST 9:00 – 9:45 am (CST) 8:00 – 8:45 am (MDT) 7:00 – 7:45 am (PST)	**Exit Meeting** with Purdue Central Administration (Join Meeting) • Jay Akridge, Provost and Executive Vice President for Academic Affairs and Diversity • Steve Abel, Associate Provost for Engagement • Theresa Mayer, Executive Vice President for Research & Partnerships
11:00 – 12:00 noon (EST) 10:00 – 11:00 am (CST) 9:00 – 10:00 am (MDT) 8:00 – 9:00 am (PST)	**Exit Meeting** with College of Agriculture Administration (Join Meeting) • Karen Plaut, Glenn W. Sample Dean of Agriculture • Jason Henderson, Senior Associate Dean & Director of Purdue Extension • Bernie Engel, Senior Associate Dean & Director of Agriculture Research and Graduate Education • Christine Wilson, Associate Dean & Director of Academic Programs • Jerry Shively, Associate Dean & Director of International Programs in Agriculture • Pam Morris, Assistant Dean & Director of Multicultural Programs
Break	
1:00 - 1:30 pm (EST) 12:00 – 12:30 pm (CST) 11:00 – 11:30 am (MDT) 10:00 – 10:30 am (PST)	**Exit Meeting** with Department Head and Advisory Team (Join Meeting) Ron Turco, Mitch Tuinstra, Linda Lee, Jim Camberato, Diane Wang, Shalamar Armstrong, Laura Bowling
1:30 -3:30 pm (EST) 12:30 – 2:30 pm (CST) 11:30 – 1:30 pm (MDT) 10:30 -12:30 pm (PST)	**Review Committee Working Time**

Review Team

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Director, Plant Sciences Institute
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Scott A. Shearer, Ph.D.
Professor and Chair
Department of Food, Agricultural and Biological Engineering

Martha Mamo, Ph.D.
John E. Weaver Professor of Agronomy and Horticulture
Department Head
University of Nebraska

OVERVIEW OF THE DEPARTMENT OF AGRONOMY IN 2021

FACULTY AND STAFF

- 30 full-time tenure-track faculty / one professor in Voluntary Early Partial Retirement
- Two clinical track faculty members added
- One new tenure-track faculty member to join in February 2022
- In total, we have added six tenure track faculty but lost eight full-FTE tenure track faculty and two split appointment faculty.
- Net growth has only occurred in biophysical modeling of plant systems and work in the soil microbiome (2022), with replacement in corn extension.
- Faculty is skewed towards full professors (22) vs. associates (6) and assistants (2)
- Added seven new professional positions, including a new state climatologist, expertise in industrial hemp and soil health, and a new manager for our research farm
- Established a new management structure for Lilly Greenhouses with a new manager
- All technical/lab staff are now soft funded (a significant change)
- Business services, IT and HR processes, and support personnel have been centralized; more responsibilities have been passed to departmental faculty/staff duties.
- Departmental leadership change (new head) and new leadership structure created using a department head advisory committee.
- Promotions and tenure process realigned with better feedback to junior faculty.

Challenges

- Restore strength to our soils program.
- Reconsider our working areas to meet new needs and challenges.

SPACE AND FACILITIES

- 63,070 sq. ft. of assignable space in Lilly Hall of Life Sciences (LILY), Lilly Soils and Plant Science (LSPS), and Whistler Ag Research (WSLR) buildings, completed in 1957 and 1980, respectively.
- 30,490 sq. ft. of laboratory space. West wing of Lilly renovated in 2008; labs in the basement of Lilly and WSLR have undergone renovations, done one at a time.
- 65,000 sq. ft. LILY greenhouse (~23,108 sq. ft. to AGRY) and plant growth facility for research and teaching, shared with BPP, BIOL, and ABE. Was completed in the late 1950s. Two ranges were added in 1998.
- LILY and LSPS are rated as "poor" quality by space management, whereas WSLR has an overall rating of "average." LILY greenhouse was also rated as "poor."
- The College of Agriculture has built world-class phenotyping platforms in Lilly Greenhouse (Ag Alumni Seed Controlled Environment Phenotyping Facility) and a gantry system at our research farm, the Agronomy Center for Research and Education (ACRE).
- Added 400 acres of land to ACRE for a total of 1,600 acres available for research.
- Added 3,800 sq. ft. of office space for graduate students.

Challenges:

- Renovate the laboratory and cold rooms, seed storage spaces in Lilly Hall and LSPS. Replace Lilly Soils and Plant Science (LSPS), as it has not been renovated since it was built in the 1950s.
- Soils teaching lab and study center need to be renovated.
- A more radical approach: create a new building with modern research and teaching facilities, interactive space of museum quality for science on display. Ideally, this would be in partnership with Botany, Plant Pathology, and Entomology departments.
- Greenhouse complex and plant growth facilities need to be replaced with modern technology, usable all year.
- Fields at ACRE need tile drainage; buildings and storage need to be updated. The grain handling system is antiquated and inefficient and needs to be replaced.

DISCOVERY AND RESEARCH

- Current three working areas: Crops & the Changing Environment, Soils and Land Use, and Water, Air, and Climate.
- Faculty have expressed interest in moving to a new set of themes: Sustainable Systems, Climate Change Adaptation, Data-Intensive Agriculture, and Education.
- Extramural research support obtained is $52M over the last 5 years, at an average of $10.2M per year.
- Grant support per PI varies by our current working areas: Crops and Environment: $280,000 to $707,000; Soils and Land: $88,000 to $380,000; and Water and Climate: $196,000 to $380,000.
- Over the last three years, we have published some 439 peer-reviewed publications, at 3 to 5 publications per faculty per year.
- Lifetime citations for the faculty exceed 179,000.
- The faculty have received five patents, and the department has been home to four startup businesses.
- Agronomy faculty and staff participate in professional societies and have national exposure, including serving as panel members and managers, presidents of organizations, and book authors.
- We have provided foundational training for the next generation of scientists and educators, with a typical graduate student enrollment of 60 students.

Challenges:

- Lilly Hall is an aging research facility; we have issues with power, water, and air handling. The greenhouse complex has poor environmental control capabilities.
- We lack a robust cohort of Assistant Professors.
- A lack of new faculty in soil science makes it challenging to both teach and expand our areas of work.

UNDERGRADUATE TEACHING AND LEARNING

- Curriculum review has been completed, and revisions are suggested.
- The undergraduate student population has fluctuated between 156 and 174.
- Plant Genetics Breeding & Biotech and Agronomy, Crop and Soil Management typically make up 50-60% of our enrollment.
- Over the past 5 years, we have provided some $730,000 in scholarships and fellowships, typically providing $90,000 in support to undergrads and about $33,000 for graduate students each year.
- Female enrollment has ranged from 40 to 48%.
- URM enrollment has remained low at around 4%.
- 44 B.S. degrees were conferred in Agronomy in the 2019/20 academic year.
- Strong clubs and leadership programs are supported in the department: Purdue Agronomy Club, Agronomy Ambassadors, Intercollegiate Crops Judging Team, Intercollegiate Soils Judging Team, and Undergraduate Research Experiences.

Challenges:

- Although enrollment in Agronomy has remained steady, we need to increase our undergraduate enrollment by altering our program offerings.
- Diversity remains an issue, especially for minority students.
- Teaching space for Crops and Genetics is top-notch, but the quality, functionality, and equipment in the soil teaching areas need to be improved.
- We need to create more scholarship opportunities.

EXTENSION

- Extension faculty (6.42 FTE) and staff (4.68 FTE) have continued to provide local, national, and international impact through diverse outreach mechanisms, including online and in-person programming.
- Innovations in programing have also include Purdue Crop Chat Podcasts (~5,000 plays); Nielsen, Casteel, and Chat'n Chew Café web site (~278,000 page views annually).
- We hired a new state climatologist, an industrial hemp specialist, and a soil health/cover crops specialist.
- We replaced the Corn Extension program lead.
- The Indiana CCA Conference (3,479 attendees) and the Kentuckiana Conference (1,030 attendees) have remained our major state events.
- Diagnostic Training and Research Center Workshops have had 3,729 attendees.
- We have had interactions across the country on biosolids and land applications.
- The use of online programs continues to grow via the E-Learning Academy: Agronomy Essentials: Nutrient Management and Precision Agriculture.
- New audiences are being reached via Hemp Essentials.

Challenges:

- Restore faculty strength in soils field programs (land use, septics, etc.).

- Ensure we have expertise for recommendations in soil fertility (Tri-State Fertilizer recommendations).

INTERNATIONAL ACTIVITIES

- Over $13M in grant funds raised for international work.
- Programs in Latin America with faculty at the Universidad Nacional de San Agustin in Peru.
- Other international projects are conducted in Kenya, Zimbabwe, Colombia, Peru, Ukraine, India, Jordan, Brazil, South Africa, Netherlands, Tanzania, Niger, China, Ethiopia, Hungry, and Honduras.
- D. Wang leads a new initiative called Plant Science for Global Food Security, funded by NSF IRES, which provides undergraduate students with six-week research experiences at the Philippines' International Rice Research Institute (IRRI).

Challenges:

- Recovering from the program impacts of COVID-19 will take years.
- Creating a new position aimed at **Global Plant Breeding** that will build on an internationally recognized sorghum breeding and genomics research program.

CLIMATE AND DIVERSITY

- Women comprise 27% of the faculty, 49% of staff, 40% of graduate students, and 42.5% of undergraduate majors in 2020. Employment trends, except for faculty, have been flat over the last 5 years. In 2016, women made up 19% of the faculty.
- Women comprise 25% of the assistant and associate faculty (8) and 18% of the full professors (22).
- Minorities comprise 11% of faculty, 4% of staff, 5% of graduate students, and 7% of undergraduate majors in 2020.
- Our faculty have been awarded for their tireless efforts to promote diversity in the department and on campus.

Challenges:

- We need to increase the percentages of both women and underrepresented minorities (URM) over the next five years.
- Provide training for faculty and staff in D/E/I and work with our departmental committee to provide input and guidance and develop a strategic plan.
- Create a signature program to increases the number of URM postdocs.

FINANCIAL RESOURCES

- Over the last five years, our cumulative operations budget was $97.8M. $39M came from university funds, federal formula funds, and state line funds, and the remainder, $58M, came from grants and contracts.

- The general operating budget is currently $8.4M/y, with the majority (84-90%) of the allocation used for faculty/staff/graduate student salaries and fringe benefits.
- Support for graduate student stipends is at ~$250,000/year and is used for 12-14 TAs (typically at ¼ time) each semester.
- We also support the Patterson Endowed Chair from an endowment fund.

Challenges:

- We lack the fiscal capacity to support graduate research assistantships; almost all RAs are on grant or college level funds.

Agronomy Departmental Faculty Research Videos

Ron Turco Rachel Stevens	Agronomy Department Head Farm Manager (ACRE)	https://youtu.be/uCTq3W__tyY
Lee Schweitzer	Undergraduate Education	https://youtu.be/lXVHusASeVk
Beth Hall	Indiana State Climate Office	https://youtu.be/NaR2NNhBhC8
Diane Wang	Crop Genetics, Process-Based Modeling, and Ecophysiology	https://youtu.be/gNitEJHkCUY
Katy Rainey	Soybean Genetics and Breeding	https://youtu.be/i1X12FuoFC4
Laura Bowling	Watershed Hydrology	https://youtu.be/SNQp4Cc0Ghg
Linda Lee	Environmental Organic Chemistry and Water Research	https://youtu.be/Dtd_bm5xFDE
Shalamar Armstrong	Soil Ecosystem and Nutrient Dynamics Research Program	https://youtu.be/ayLuzTQtN6A
Mitch Tuinstra	Plant Breeding and Genetics	https://youtu.be/XJ7ggO4dcoA
Jianxin Ma	Soybean Crop Improvement and Plant Genetics	https://youtu.be/jfmE65I6jIE

1.THE REVIEW CHARGE

Thank you for agreeing to be part of the process to move Purdue Agronomy into our next phase. The review committee is asked to provide input on both our past performance and our future planned directions. As a faculty, we have discussed the department's direction, and below, we give an outline of changes in our direction. These potential changes come from the fact that we are faced with pending retirements and changes in our teaching loads and teaching structure. Still, they primarily reflect a response to meeting the needs of the ever-changing agriculture research and Extension landscape.

The Questions:

- Question 1: This is a set of questions from the College of Agriculture that directly assess past performance as a department. These questions are commonly used in departmental reviews, and we ask the team to use them as a guide in the review process.
- Question 2: We seek input on changes that need to be made to our programs around operational issues raised by an internal survey.
- Questions 3, 4, and 5: Seek specific input on issues related to improving our URM efforts, teaching loads, and operations at our research farm (ACRE).
- Question 6: Seeks your feedback and counsel on maximizing the opportunities for future growth and changes in how we frame the department for the next ten years and beyond.

Review Questions

1) **Questions from the College of Agriculture:** The college asks the review team to address the following questions related to the department's performance over the last five years.

   A. Mission

   Is the mix of research, teaching, and Extension appropriate for the department's size, and are they effective in meeting their missions?

   Is the department's research record (publications, competitive funding, graduate training, etc.) appropriate compared to peer institutions? Are they positioned to be leaders in the future?

   Does the department have a critical mass in the research areas they are focusing on? Are there areas of strength relative to peers? Is the balance of applied and basic research appropriate for the department?

   What role is the department playing in interdisciplinary international efforts? Are the department's international activities commensurate with resources provided?

   Is the undergraduate curriculum state-of-the art, and does it prepare undergraduates for future careers or graduate school? Does the undergraduate program have a robust outcomes-based assessment?

Are the teaching resources well matched with teaching expectations and equitably allocated among faculty?

Is the Extension/engagement program delivering impact for the target stakeholder groups? Are there areas of strength you see relative to peers? Are there areas where the department could improve its Extension/engagement program?

Has the department developed an appropriate strategic plan for the future? What are the strengths and weaknesses of the plan?

In a time of constrained/declining resources, are there areas in the department's educational, research, Extension, and international activities that you would recommend be de-emphasized in the future? Are there areas where the department should invest for the future?

How can the administration better support the department?

B. Culture and Climate

Has the department culture created a positive, respectful, inclusive work environment for faculty, staff and students? How can the work environment be enhanced?

Are faculty appropriately supported/mentored for success? How can the Assistant, Associate or Full Professors be better supported?

Is space and/or location a limiting factor in faculty productivity? If so, what recommendations do you have? In your view, are there other resources that are limiting the productivity of the faculty and staff?

C. Graduate Program

Please assess the graduate program in the areas listed below. The review of the graduate program should be in a format that can be easily extracted from the overall departmental review.

Quality:

What is your overall assessment of the quality of the graduate program? What are the top factors that limit the excellence of the program?

Student needs and career preparedness:

Are the academic and professional development needs of the students being met?
Are students adequately prepared to be globally competitive?
Are the goals of the graduate program aligned with placement and career goals of the students?

Faculty engagement and preparedness:

Are faculty adequately prepared to provide exceptional graduate education?

Are faculty adequately prepared to mentor graduate students for careers in academia, industry, and government?

Culture and climate:
Is the department graduate climate welcoming and inclusive?
Is there an active plan to recruit and retain a diverse graduate student population?

2) **Critical questions on our operations raised by our faculty survey:**
Questions caused by our internal survey: As part of the review process, we surveyed our faculty and found six areas of concern. Both the survey tool and the analysis are included in Appendix L.

Concerns about both Lilly Hall and LSPS.

The quality and the general maintenance of office, laboratory, greenhouse, and cold room spaces are critical points of concern. Faculty find our buildings to be worn-out and dated locations for work. The ability to make simple renovations is limited. Chapter 5: Lilly Hall, Plant and Soils, Whistler and Greenhouse Space provides an overview of these facilities.

Concerns about our ability to purchase and/or repair lab & teaching equipment.

The department lacks a strategy for the purchase and maintenance of **jointly held lab and teaching equipment.** Creating a shared equipment program would require creating technician positions, as history shows running major equipment without management/oversight is a problem waiting to happen. The department has tried to help with repairs on an as-needed basis, and we will work to create cost-share on large equipment purchases made by individual faculty. A discussion on a universal plan for equipment maintenance via service contracts is overdue.

Concern about our level of "state-of-the-art."

The core theme concern is that we are not working with state-of-the-art tools and technology. This concern creates a problematic statement to resolve, as our net publication rates, grant support, student contact hours, and Extension contact hours over the last five years have been reasonable. Our hiring efforts and planned hires and planned hires move the department toward research that depends on state-of-the-art technology, such as crop and ecosystem crop and ecosystem modeling, high-throughput phenotyping, data-intensive decision making, agroecology, precision agriculture, resolving the makeup of the soil microbiome, etc. It is suggested that the department must implement a better model for purchasing and maintaining state-of-the-art equipment to afford to conduct research in these areas at a state-of-the-art level.

Concerns about our current equipment used for fieldwork.

Creating an equitable level of equipment for fieldwork across many faculty is a complex undertaking. Our field operations are at multiple scales: multiple plant lines in breeding plots, typical field plot studies, large-scale multi-acre plots, and rotational acres. Timing issues complicate equipment needs, as everyone requires the same equipment at nearly the same time. We have just purchased a Hagie Sprayer (STS 12), which has improved our timing and application accuracy on all of the ACRE plots.

(The ACRE farm techs typically manage weeds and pests for everyone.) We are now concentrating on creating the best seedbeds and plot setups. We will do some planting on larger research plots, but our planting is generally focused on the rotation acres. **Details on ACRE and our farm equipment is found in Chapter 14.**

Concerns about the future of our international programs focused on plant stress and Sorghum.

One example of our role in the international space is the sorghum program at Purdue University, which started in the late 1960s and continues today. The Purdue sorghum improvement program has stressed genetic improvement around several essential issues for the plant's success. Over 132 research projects have supported improvements in Sorghum, including biotic problems (disease and parasitic weed) and improving abiotic resistance (drought and cold tolerance). Financial support for the Purdue sorghum program has been nearly continuous since its start. The department wants to ensure we maintain our place in all international efforts.

We need to revisit our vision statement.

Current Vision Statement: The Department of Agronomy at Purdue University provides global leadership in plant genetics, plant physiology, meteorology, soil, and water sciences to enhance the quality of life through agronomic education that results from discovery, education, and engagement.

3) We also hope to put greater emphasis on the recruiting and development of Under-Represented Minorities (URM) students and postdocs to diversify the pool of candidates for industry and faculty jobs. This new program will require faculty and staff emphasis as we build it from concept to a fully-developed, sustainable mainstay of the department.

4) We also seek guidance from the review team on how we should structure teaching loads. Purdue Agronomy has a long history of making teaching a dominant aspect for many of our positions. We may need to look at other models.

5) Finally, we also seek input on maximizing the research capacities for Agronomy Center for Research and Education (ACRE), our research farm.

6) Input on critical areas of possible change: As outlined below (see Figure 1.1), the Department of Agronomy wants to make deliberate changes in several areas of program emphasis by creating Cross-Cutting Research and Education Themes. Our first goal is to fully embrace sustainability as a departmental theme that reaches across research, teaching, and Extension. This change will align the department with the College of Agriculture strategic plan and our own Extension group's goals. We also see sustainability as a part of the predominant national movement. Our second shift is toward research in the areas of Climate Change Adaptation in our teaching, research, and Extension. We feel this change aligns with sustainability and fits our ongoing work in plant breeding and water and soil sciences. The faculty would like to see our programs utilize a data-driven approach emphasizing analytical assessments, including digital tools and precision agriculture. We seek input from the review team regarding how best to approach this program area. These changes are addressed in our revised curriculum and are fully embraced by our Extension group.

NEW PROGRAM EMPHASIS

We plan to make changes in several areas of program emphasis by using cross-cutting themes that will better link our research, education, and Extension programs. The themes embrace the areas of sustainability, climate change, data-intensive agriculture, and education. This change will align the department with the College of Agriculture strategic plan and with predominant national movements. The use of themes provides a framework for the department operations while allowing for individual programs to maneuver across project areas and funding sources. Prevalent in our themes is a goal to achieve inclusive excellence related to diversity and approaches in all things that we do. These themes will underpin the development of a new strategic plan focused on "Growing A Sustainable Future."

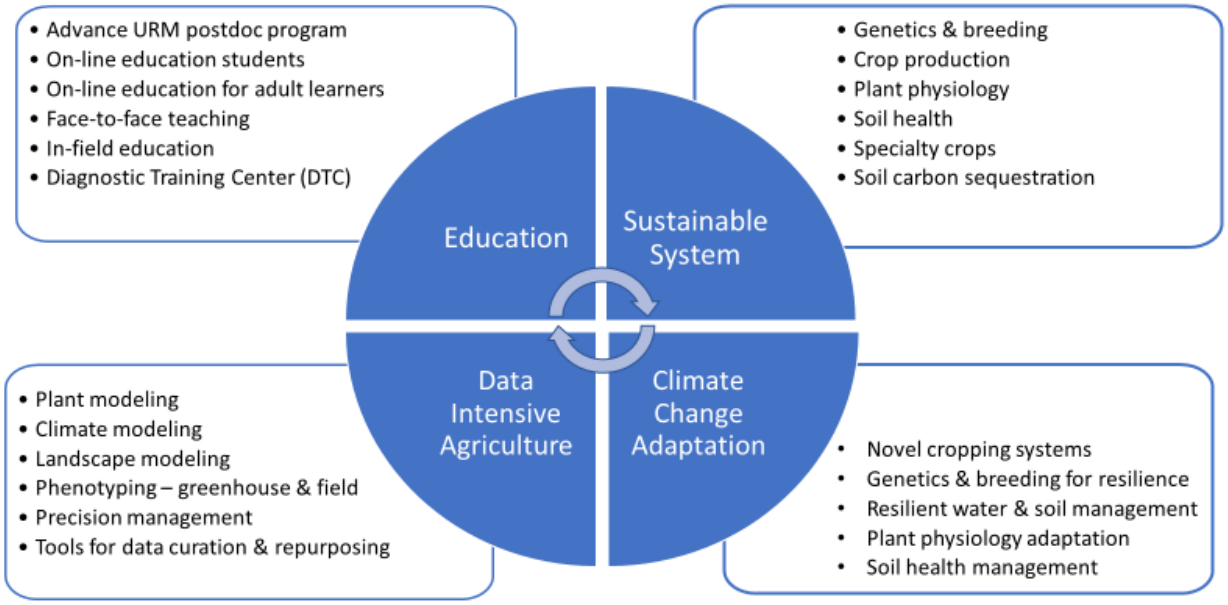


Figure 1.1. Suggested Agronomy Department themes with their associated project areas.

Themes

Education: Excellence in teaching and learning remains our highest priority in programs. Our efforts are to maximize our students' educational experience and prepare them for the job market. We also feel that education is multifaceted and takes place on many fronts and that we need to integrate our areas of research strength into our classroom settings. This includes increasing the diversity of our undergraduate, graduate, and postdoc populations and better utilizing our farm (Agronomy Center for Research and Education-ACRE) as part of our education efforts.

Sustainability: To be sustainable, agriculture production must meet the needs of present and future generations while ensuring profitability, environmental health, and social and economic equity. We feel the industry is out ahead of us in this arena and that we need to reshape our research programs to address

all aspects of sustainability. This is also part of the rationale for a newly-approved faculty position in agroecology.

Climate Change Adaptation: To reduce the risks of climate change, agricultural producers must be provided a suite of approaches to risk reduction. Tied to sustainability is the need to create resilient systems that can continue to function in the changing environment. Our goal is to create systems that can mitigate the negative effects of climate change and promote long-term sustainability as an additional income stream for agriculture.

Data Intensive Agriculture: The big data value chain is composed of three sets of players: data holders, data specialists, and data strategists. Leveraging data to improve economic and environmental sustainability requires collaboration of many—agronomists, soil scientists, biosystem modelers, engineers and computer scientists, social scientists, etc. Existing faculty, recent and imminent hires, and projected hires are interested in taking advantage of data and digital approaches to improve the efficiencies of agriculture.

2. Undergraduate Teaching and Learning

1. Enrollment and Recruitment. Recruit, retain and meet the needs of a diverse population of undergraduate students in our majors, minors, and courses.

a) Purdue Agronomy maintains a professional and welcoming atmosphere for undergraduate students and engages in a wide array of recruitment and retention activities. Recruiting outreach includes Ambassador call-nights, social media, support for high school crops and soils judging competitions, K-12 outreach at Spring Fest, and during Ag Week (see Appendix H). The department also offers excellent opportunities for scholarship support. In 2019/20 the Purdue Agronomy Department awarded $81,600 in departmental scholarships to 41 undergraduate students.

b) There were 162 undergraduate students majoring in Agronomy in Fall 2019 and 153 in Fall 2020, compared with 156 in Fall 2015 (Table 2.1). In Fall 2020, 61% majored in an Agronomy concentration, 30% in Plant Genetics, 5% in Soil and Water Science, 3% in Crop Science and 1% in Applied Meteorology. An additional 94 students from other departments minored in Crop Science or Soil Science, reflecting an increase from 79 in 2015/16 (Table 2.2).

c) Underrepresented minority students comprised 7% of undergraduate enrollment in 2019/20. c) In 2019/20, 43% of Purdue Agronomy enrollment was female. International undergraduate student enrollment was 3% of our undergraduate population in 2019/20 (Table 2.1).

d) Purdue Agronomy undergraduate students continue to perform well academically. 44% of Agronomy undergraduates earned Dean's List and/or semester honors in at least one semester in 2019/20 (up from 38% in 2015/16). In 2019/20, only 5% of Agronomy undergraduates were on academic probation for at least one semester, down from 11 % in 2015/16.

e) Forty-four (44) B.S. degrees were conferred in Agronomy in the 2019/20 academic year.

f) The average starting salary of new Purdue Agronomy B.S. degree recipients in May 2020 was $48,337, compared with the College of Agriculture average starting salary of $46,625.

Table 2.1. Purdue Agronomy Undergraduate Teaching Statistics

Academic Year	2015/16	2016/17	2017/18	2018/19	2019/20
Undergraduate Enrollment	156	177	171	174	162
Female Undergraduates (%)	40	45	43	48	43
Underrepresented Minorities (%)	1.3	4.5	2.9	5.2	6.8
International Undergraduates (%)	5	5	5	3	6
Number of B.S. Degrees Conferred	42	34	43	53	44

2. Teaching and Learning Mission: Engage undergraduate students in excellent academic courses, plans of study, and transformative experiences that develop the analytical, critical thinking, leadership, subject

knowledge, and communication skills necessary for them to achieve success in fulfilling their personal and professional goals.

Table 2.2 Enrollment by Majors /Concentration

	Fall 2017	Fall 2018	Fall 2019	Fall 2020
Agronomy:	115 (67%)	120 (69%)	106 (65%)	93 (61%)
Agronomic Bus & Marketing Concentration	44	31	17	14
Crop and Soil Management	42	51	65	44
International Agronomy	3	0	4	6
Undeclared Agronomy	26	38	20	29
Plant Genetics, Breeding & Biotech	40 (23%)	43 (25%)	40 (25%)	46 (30%)
Applied Meteorology/Climatology	3 (2%)	4 (2%)	5 (3%)	2 (1%)
Crop Science	4 (3%)	1 (0.05%)	5 (3%)	5 (3%)
Soil & Water Science	5 (3%)	5 (3%)	6 (4%)	7 (5%)
Turf - Moved to Horticulture Dept.	4 (2%)	1 (0.05%)	--	--
Total	171	174	162	153

Goals:

a) Increase undergraduate enrollment to 200 by 2026/27.

b) Expand recruitment of female and underrepresented minority students. The Purdue College of Agriculture is formulating plans to increase investment in recruitment efforts under the leadership of our new Associate Dean and Director of Academic Programs, Christine Wilson.

c) Increase social media outreach and expand participation of departmental Extension specialists in recruitment for our undergraduate programs.

3. Value and Vision of Courses and Curricula: Maintain and increase the quality, value, and vision of our undergraduate courses and plans of study to prepare students for personal and professional success. Support students' preparation for and successful placement in high-value internships while in school and fulfilling professional positions or graduate school opportunities post-graduation.

a) Purdue Agronomy offers a wide array of courses and seven plans of study/majors/concentrations (Table 2.2), covering traditional and emerging topics to meet the needs of undergraduates and their employers.
b) Agronomy offers two plans of study for undergraduates minoring in Agronomy to enhance primary degree coursework in preparation for their professional futures. (See plans of study in Appendix H.)
c) Table 2.3 shows the total contact hours generated by the department over the last 8 years.

Table 2.3. Total contact hours by year

Year	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Contact Hours	5,976	5,811	6,016	6,262	6,196	6,447	7,029	5,897

d) Purdue Agronomy students are well-supported and highly successful in gaining internship and full-time positions. Purdue University's excellent Center for Career Opportunities offers a wide array of resume and interviewing resources. The College of Agriculture hosts over 150 companies each fall at one of the premier Career Fairs in the nation, where interaction with company reps provides multiple interview opportunities leading to internship and professional positions.

e) All Purdue Agronomy undergraduates complete a freshman, sophomore, and senior professional development seminar series. The series reinforces the students resume and interviewing skills and addresses career and life planning through interaction with faculty. Successful alumni serve as role models, give invited presentations, and interact with students. In addition, all Agronomy undergraduates are paired with a faculty mentor with whom they meet once per semester to discuss career opportunities, goals, and transformative experiences.

f) Purdue Agronomy students and graduates are in high demand for professional internships as students and for full-time positions upon completion of their degrees. In 2019/20 graduating seniors averaged three or more professional internship experiences prior to completing their B.S. degree.

g) Purdue Agronomy graduates self-reported that greater than 90% are employed (not seeking employment) or continuing their education in graduate school (about 20%) post B.S. degree conferral in 2019/20 and in each of the preceding four years.

Goals:

a) Broaden faculty participation in teaching. The department is transitioning to at least a model of every faculty member teaching on at least a 20% teaching appointments for new faculty hires, intending to decrease the number of faculty with larger teaching appointments. In the past, the Agronomy Department has relied on faculty with primary teaching appointments, and we are adopting a more distributed teaching model. Faculty hires and teaching assignments are to be aligned dynamically as indicated by a needs assessment.

b) Continue to provide well-coordinated academic advising and mentoring for undergraduate students through robust faculty and peer engagement, undergraduate research direction and student organizational activities. In 2016/17 the department transitioned from faculty advising to professional academic advising (Jane Wiercioch) and added a successful faculty mentoring program to enhance faculty engagement with undergraduate students. In addition to the excellent personalized academic advising provided by Jane Wiercioch, a total of 32 faculty members mentored our 162 undergraduate Agronomy students in 2019/20.

4. Leadership and Entrepreneurial Skills: Develop student leadership and entrepreneurial skills, dedication to service and ability to critically assess and effectively lead in solving business, professional and public policy challenges.

a) **Purdue Agronomy Student Activity, Kohnke Fund, Bradford Fund and Allman Funds.** Voluntary contributions by individuals provided approximately $12,000 in 2015/16 and $12,511 in 2019/2020 in support of student activities.

b) **Purdue Agronomy Club**. Membership numbered 40 active undergraduate members in Spring 2021. The Agronomy Club was named the Purdue College of Agriculture Outstanding Option Club in three of the past five years. Club members are active statewide in community outreach/recruitment, e.g., the Purdue Agribusiness Science Academy (PASA) minority program for middle school and high school students, high school crops and soils judging contests, Food Finders, Indiana Veterans Home, multicultural efforts to end sexual assault, and children's programs during the holidays. Club members have won numerous honors through Students of Agronomy, Soils and Environmental Sciences (SASES), the undergraduate program of the ASA-SSSA-CSSA. Current SASES 2020/21 Corresponding and Recording Secretaries are Purdue Agronomy Club members Riley Garner and Jessica Peterson.

c) **Agronomy Ambassadors**. Continuing a successful program, 18 undergraduates were selected to serve as Agronomy Ambassadors in 2019/20. These students boost recruitment for Agronomy undergraduate programs and provide public relations and service benefits to the department. The leadership skills and communications abilities of these young adults are refined as they support the department through their important role.

d) **Purdue University Student Chapter of the Soil and Water Conservation Society (SWCS).** The approximate average monthly attendance in 2019/20 was 18, including faculty, graduate students, undergraduates and community members. Two current members are recipients of SWCS state scholarships.

Goal: Increase funding for and student participation in leadership development experiences, including participation in departmental, college and campus-wide student organizations.

5. Other Student Programs and Transformational Experiences:

a) **Intercollegiate Crops Judging Team.** Purdue Agronomy supports Intercollegiate Crops Judging as an academic course, with participation averaging 14 students per semester. Competitions include the ASA's Collegiate Crops Judging Contests (Kansas City American Royal Crops Contest and the Chicago Collegiate Crops Contest) and the North American Colleges and Teachers of Agriculture (NACTA) Judging Conference crops contest.
b) **Intercollegiate Soils Judging Team.** Purdue Agronomy fields a highly successful collegiate soils team averaging 10 to 20 students annually. Competitions include a four-state regional contest

among schools from Illinois, Indiana, Michigan and Wisconsin, the ASA Collegiate Soils Contest, and the NACTA Judging Conference collegiate soils contest.

c) **American Forage and Grassland Conference Forage Bowl.** In 2019 and 2020 Purdue Agronomy sent teams of four undergraduate students to compete in the collegiate "Jeopardy"-type forage knowledge and live plant ID competition. No competition was held in 2021. Teams will be sent again in 2022 when the competition resumes.

d) **Travel-Study and Study Abroad.** In 2019/20, 10 students participated in travel study courses or semester-plus study abroad. All undergraduate students are required to complete 9 or more credit hours of International Understanding, which can be attained through internationally focused courses, foreign language, or study abroad.

e) **Undergraduate Research Experiences.** In 2019/20 Agronomy faculty directed 16 undergraduate students on research projects and/or as employees in their research programs.

Goals: To increase student experiences, we would like to expand undergraduate student participation in intercollegiate soils, crops and forage teams, study abroad, travel-study, and faculty-directed research experiences.

B. Courses

1. New Courses. Since 2015/16, to meet emerging demand, several new undergraduate and dual-level courses have been added under permanent numbers. These include AGRY 120 Water and Food Security, AGRY 123 Genetics and Society, AGRY 485 Precision Crop Management, AGRY 518 Plant Physiology & Biotechnology Research. Several developmental classes are currently active under temporary numbers (e.g., Plants, Data and Computational Thinking; Crop Management Drone Flight and Imaging; Soils and Civilization).

2. Service Courses with Broad Enrollment from Across the College and University: Several courses in the department meet the needs of a diverse student population and are sometimes required on the plan of study of other programs. These include AGRY 105 Crop Production, AGRY 120 Water and Food Security, AGRY 125 Environmental Science and Conservation, AGRY 255 Soil Science, AGRY 270 Forest Soils, AGRY 285 Crop Adaptation and Distribution, and AGRY 337 Environmental Hydrology. AGRY 125 and AGRY 285 are core Purdue University Science Technology and Society classes, which means they satisfy one of the Purdue University Foundational Learning Outcomes. AGRY 285 is also listed as the College of Agriculture International Understanding (IU) core. Other service classes are AGRY 320 Genetics, AGRY 321 Genetics Laboratory, AGRY 350 Global Awareness (IU core), AGRY 375 Crop Production Systems, AGRY 505 Forage Crop Production, and AGRY 585 Land Use Planning.

Goals: New course proposals will be considered as needs arise, advised by the Curriculum and Teaching Committees and approved by the faculty in concurrence with planning for future new hires. The department will continue to develop a vibrant blend of traditional and emerging topic courses to include digital, sustainable and precision soil, crop, water, atmospheric and data sciences and management.

Faculty will utilize new remote digital and hybrid teaching strategies developed during the pandemic as effective tools to further enhance teaching, both now and in the future.

C. Student and Faculty Awards

a) **Student Awards –** In 2020, Agronomy student Stephen Schwartz was awarded the David Ross Outstanding Senior Man, one of the top academic honors at Purdue University.

b) **Faculty Awards –** The department has produced 10 recipients of the College of Agriculture's top undergraduate teaching award and four recipients of the College of Agriculture's top academic advising award. Six Purdue Agronomy faculty have been recognized with the Amoco Foundation/Charles A. Murphy Award, Purdue University's top undergraduate teaching award. Six Purdue Agronomy faculty members are Fellows of the Purdue Teaching Academy, and nine are in the Purdue University Book of Great Teachers. NACTA, the American Society of Agronomy, the Crop Science Society of America, and the Soil Science Society of America have recognized several Purdue Agronomy faculty nationally as top educators.

3. Discovery

The Department of Agronomy features research work in plant genetics, plant breeding, crop production, agricultural water resources, and soil science, focusing on soil health, microbial systems, watersheds and hydrology, tile drainage, and climate. However, many program areas are integrated, often with Extension, and it is not easy to pick one specific title to describe the efforts. Trying to create a single research direction for a group as diverse as the Department of Agronomy is something of a futile effort. However, over the past five years, we have operated under the following three topic areas: **Crops & the Changing Environment, Soils and Land Use,** and **Water, Air, and Climate.**

Some brief examples of work under the topic areas include:

Crops & the Changing Environment: Encompasses efforts from fundamental plant genetics to plant breeding to working with farmers to enhance management options that lead to sustainable increases in yield.

Dr. Ma's group has focused on the genetic and molecular dissection of various traits of agronomic importance in soybean and recently cloned *Rps11*, a giant chimeric "R" gene in soybean that confers unique, broad-spectrum resistance to the pathogen *Phytophthora sojae.*

Dr. Hudson's efforts are focused on soybean and oil production with an eye toward high oleic acids.

Dr. Rainey has been working on field-based high-throughput phenotyping platforms in soybean and other crops. She has developed the capacity to rapidly assess thousands of plots in a field to screen for high yield performance.

Dr. Casteel's efforts to understand how sulfur deficiencies impact soybean yields have shed new light on an overlooked yield barrier.

Dr. Mohammadi has been working to identify trait loci for Fusarium head blight (FHB) resistance from different sources to help provide effective protection against FHB.

Dr. Anderson's program has developed wheat lines that are highly resistant to barley and cereal dwarf viruses and studies the mechanism of this resistance.

Dr. Scofield's group developed virus-induced gene silencing (VIGS) tools for functional genomics in wheat and employs these to dissect disease resistance pathways for cereal pathogens.

Dr. Rocheford has shown that corn genotypes with high levels of carotenoids, when fed to chickens, can increase the macular carotenoid concentrations in egg yolks, improving the opportunity to increase the carotenoid levels in the standard American diet.

Dr. Tuinstra's group is working with new phenotyping technologies, such as ear photometry to assess yield components that can be scaled to breeding programs. His program has strong national and international efforts.

Dr. Vyn's aims to understand how corn yield in alternate genotype x management production systems is impacted by balancing nitrogen inputs to maximize nutrient uptake and minimize losses to greenhouse gases.

Dr. Nielsen's efforts in crop production and applied corn research have continued to benefit Indiana's farmers.

Dr. Quinn's program is starting to build around corn production and cropping system efficiencies. **Dr. Johnson** works to assess forges for use in animal production. His most recent efforts are in conjunction with Dr. Tuinstra on forage value of dhurrin-free sorghum.

Dr. Ejeta's group remains focused on understanding the genetics of resistance to drought, diseases, and the parasitic weed *Striga* in sorghum; the integration of these traits into improved cultivars; and finding opportunities for their deployment where needed, mostly in developing countries.

Dr. Zhang's lab has a shared interest in drought stress responses and has a program looking at vascular proteins and plant performance.

Dr. Jiang's group is working on plant stress, primarily investigating salt, drought and flooding responses in diverse perennial grasses.

Dr. Volenec investigates input (nutrients, water, radiation) use efficiencies, stress tolerance, and climate adaptation of crops. He recently co-led efforts (with Dr. Brouder) to encourage data curation and repurposing using FAIR standards.

Dr. Wang's group is bringing biophysical and other models to her research efforts, making the role of data and data curation critical. Other work under this area includes

Dr. Erickson's focus on education; he administers the longest-running, most comprehensive survey of digital agriculture adoption in the U.S., which is published each year in CropLife.

Soils and Land Use: Encompasses efforts from fundamental soil structure and clay mineralogy, to understanding the soil microbiome's fundamentals, to looking at the impacts of soil management for agriculture and other uses on soil health.

Dr. Armstrong's program leads the way on cover crops and regenerative agricultural systems. His recent studies have focused on next-generation cover crops management to improve environmental quality while maintaining or increasing cash crop production, reducing fertilizer inputs, and adoption cost.

Dr. Brouder investigates nutrient cycling in agriculture, the evidence base for nutrient management diagnostics, and recommendations for profitability and stewardship in a changing climate. She has also worked to create standards and workflows for agricultural data management, synthesis and reuse.

Dr. Camberato is developing and improving N, S, and K recommendations for major agricultural row crops to improve farmers' ability to manage these nutrients sustainably from an economic and environmental perspective.

Dr. Cammarano works with models to understand the spatial and temporal optimal N fertilizer rates to reduce nitrate leaching while improving grain yield and quality in grains. His work has become an essential means of understanding how to work across the landscape.

Dr. Crawford uses remote sensing technologies to better understand plant responses to the environment, as well as how management practices might impact yields.

Dr. Huang has worked to realize erosion control approaches and most recently worked on root morphology traits variations and how they affect soil detachment capacity in different landscapes.

Dr. Johnston's group uses his fundamental understanding of soil surface reactions to examine the mechanisms of soil organic matter stabilization, the bioavailability of toxic pollutants sorbed on soil particles, and the influence of climate change on soil health.

Dr. Kladivko has been building from her fundamental knowledge of soil drainage processes to understand the ties between soil management practices and soil health. She also recently finished a legacy project on drainage spacing, nitrate leaching, and cover crops.

Dr. Nakatsu has been working on plant and soil-associated microorganisms as an untapped resource for intentional microbiome manipulation to enhance crop performance and sustainability.

Dr. Penn has better understood the processes that control dissolved phosphorus (P) with P removal structures. His group has been looking at waste materials as a resource of P recovery.

Dr. Schulze has taken his fundamental knowledge of soil clays and chemistry to a new level by working on legacy soil data that contains agronomic information that can be used to improve yields and environmental sustainability. He also leads an effort to make digitized soils data available on hand-held devices.

Water, Air, and Climate: Encompasses efforts from better understanding climate change impacts, to modeling water resources, to understanding agricultural management's effect on water quantity and quality.

Dr. Bowling's group is assessing how changes to water resources supply and demand are critical to all sectors of the economy. Her group is also exploring alternative management of subsurface drainage that can improve water quality while increasing climate change resilience due to changes in the timing and quantity of water available in the Indiana environment.

Dr. Gonzalez assesses the interaction of management practices, including tillage, cover crops, gypsum, and manure, in soil health, water quality, and crop production. Also, he is assessing char material to remove contaminants from water.

Dr. Grant's work on nitrous oxide emissions from agricultural soils has centered on open-path Fourier-transform infrared spectrometer edge-of-field gas sampling and measurement. His group's findings have altered our understanding of the magnitude of the gas loss.

Dr. Hall Dr. Hall monitors the state of the climate both for Indiana and across the Midwest region with particular focus on the growing season, agricultural and water resources impact, and through the development and delivery of decision-support climate-based online tools. She also leads the management, data acquisition, and data delivery for the Purdue Mesonet – a network of 9 weather stations across Indiana that monitors and collects soil and weather data to help support agricultural and applied climate research.

Dr. Lee is transforming our understanding of the fate of per- and polyfluoroalkyl substances in environmental, municipal, and agricultural systems. Her group is at the forefront of discovery in this area, including creating novel remediation and mitigation technologies.

Dr. Rao's group incorporates work across multiple scales and areas of investigation, all geared towards maintaining the performance of infrastructure-dependent systems in the face of unknowable risks.

Dr. Turco's group looks at the interactions of agricultural systems on soil and their effects on soil health and soil microbiology.

Outputs:

Background: Of the 30 tenure track faculty with a 50% or higher appointment in Agronomy, fourteen received their Ph.D. before 1990, six received their Ph.D. between 1990 and 2000, and the remaining ten faculty received their Ph.D. after 2001. Six faculty have significant responsibilities in Extension, one has significant teaching responsibilities, and the remaining 23 have research, teaching, and Extension responsibilities.

Faculty Accomplishments: Data in Table 3.1 show a complete catalog of our faculty's 2-page C.V.s, and a research program slide for each faculty member is available.

Publications: Each faculty member was asked to prepare a Google Scholar page (reached by following the links on individual names in Table 3.2). The goal is to help the reviewers understand the networks and

linkages our work creates. Data provided in Table 3.2 also show the patterns for publication for the last three years and an h-index value and lifetime citation values for each faculty member who has created a Google Scholar page. H-index values range from 3, for our newest faculty member, to 84, for Dr. Suresh Rao, a joint appointment and Distinguished Professor. Most faculty are at or near the commonly-suggested goal of 1 point per year post-Ph.D. Only seven of the faculty who reported an H-index received a value below the suggested 1 point per year post-graduation. Variations related to major appointment areas of research versus Extension and teaching are also noted. Faculty with less publication-intensive responsibilities, namely Extension and teaching, tend to fall under the one-point-per-year guideline.
In terms of **lifetime citations**, across our three sub-areas, Crops and the Changing Environment (Crops Env), Soil and Land Use (Soil Land), and Water, Air, and Climate (Water Air), total lifetime citations break down as 64,435; 46,487; and 68,312, respectively. For the faculty who have recently left Purdue, lifetime citations were 27,183, for a total of 206,417 for all citations. This number is unadjusted for joint authorships.

Grant Support: Data in Tables 3.2 and 3.3 breaks down extramural funding by year (F.Y. 2016 to 2020) for our three sub-areas: Crops and the Changing Environment (Crops Env), Soil and Land Use (Soil Land), and Water, Air, and Climate (Water Air). The data are taken from Purdue sources (SPS) and reported for only faculty and professionals who report to Agronomy as their primary home (partial and ARS faculty are excluded). Over the review period, the department submitted 406 proposals as P.I. and 284 proposals as co-PI, at an estimated request level of $142,646,794 and $51,064,409, respectively. As a department, we were successful on 195 proposals as P.I. and 88 proposals as co-PI. As a result, we attained $43,976,297 and $8,290,125 as P.I. and co-PI, respectively. Total support generated by the department was $52,266,423 over the five years. The P.I.s in the Crops and the Changing Environment group generated 68.4% (or $35,744,147) of the total departmental funding. The P.I.s in the Soil and Land Use group generated 18.45% of our funding ($9,644,153), and P.I.s in Water, Air, and Climate acquired 13.4% of our support ($6,848,123) (Table 3.3). The Crops and the Changing Environment group, typically comprising at least 15 faculty, tend to generate the most outside support per FTE. Ten individual faculty members (tenure track and others) generated 77% (~$40.5M) of our five-year funding. An additional ten individuals generated the next 18% (~$9.3M), while the final 12 people generated 4.9% (~$2.5M).

Press releases: Appendix G contains links to press releases about work in the department.

Patents and Startups: Data in Table 3.4 shows the information on the eight disclosures and patents from the Department of Agronomy activities over the last five years. Table 3.5 shows the information on the five startups developed by the Agronomy faculty.

Table 3.1 Linkage Table for Faculty CV and Research Slide.

Agronomy Faculty C.V.s and Research Slides			
Sara Allen	Undergraduate Teaching & Learning	CV	Research Slide
Joe Anderson	Plant Genetics and Distance Education	CV	Research Slide
Shalamar Armstrong	Environmental Soil Science	CV	Research Slide
Laura Bowling	Watershed Hydrology	CV	Research Slide
Sylvie Brouder	Plant Mineral Nutrition	CV	Research Slide
James Camberato	Soil Fertility	CV	Research Slide
Davide Cammarano	Precision Agriculture & Crop Modeling	CV	Research Slide
Melba Crawford	Earth Observation & Director of LARS (Civil/AGRY)	CV	Research Slide
Gebisa Ejeta	Sorghum Genetics& Breeding	CV	Research Slide
Bruce Erickson	Distance Education & Outreach	CV	Research Slide
Corey Gerber	Purdue Diagnostic Training & Research Center	CV	Research Slide
Richard Grant	Agriculture & Applied Meteorology	CV	Research Slide
Javier Gonzalez	**USDA** – Soil Health & Water Quality	CV	Research Slide
Beth Hall	Climate, Weather, & Earth Science	CV	Research Slide
Chi-Hua Huang	**USDA –** Soil Erosion & Water Quality	CV	Research Slide
Karen Hudson	**USDA** - Soybean Seed Development	CV	Research Slide
Yiwei Jiang	Turfgrass & Perennial Plant Physiology	CV	Research Slide
Keith Johnson	Forage Management	CV	Research Slide
Cliff Johnston	Soil Inorganic Chemistry & Mineralogy	CV	Research Slide
Eileen Kladivko	Soil Physics & Soil Health	CV	Research Slide
Linda Lee	Soils & Environmental Water Chemistry	CV	Research Slide
Jianxin Ma	Comparative Plant Genomics & Soybean Genetics	CV	Research Slide
Mohsen Mohammadi	Small Grains Breeding & Genetics	CV	Research Slide
Cindy Nakatsu	Molecular Microbial Ecology	CV	
Robert Nielsen	Corn Production	CV	Research Slide
Chad Penn	**USDA** – Soil, Water & Agriculture Chemistry	CV	Research Slide
Daniel Quinn	Corn Extension and Production Management	CV	Research Slide
Katy Martin Rainey	Soybean Breeding & Genetics	CV	Research Slide
Suresh Rao	Structure/Functions of River Networks	CV	Research Slide
Torbert Rocheford	Maize Genetics & Genomics	CV	Research Slide
Darrell Schulze	Soil Mineralogy	CV	Research Slide
Lee Schweitzer	Plant Physiology	CV	Research Slide
Steve Scofield	**USDA** - Cereal Functional Genomics and Disease Resistance	CV	Research Slide
Gary Steinhardt	Waste Disposal & Soil Classification	CV	Research Slide
Mitch Tuinstra	Maize Genetics & Plant Breeding	CV	Research Slide
Ron Turco	Soil Microbiology Department Head	CV	Research Slide
Jeffrey Volenec	Crop Physiology & Ecology	CV	Research Slide
Tony Vyn	Cropping Systems	CV	Research Slide
Diane Wang	Genotype x Environment Modeling	CV	Research Slide
Cankui Zhang	Crop Physiology	CV	Research Slide

Table 3.2. Faculty of Agronomy, h-index (2021), and publication patterns 2018-2020 from Google Scholar.

Faculty	Academic Rank	Publications			h-index	Lifetime Citations
		2018	2019	2020	2021	
CROPS AND THE CHANGING ENVIRONMENT						
Joe Anderson	Professor	0	0	0	28	2788
Shaun Casteel	Associate Professor					
Gebisa Ejeta	Distinguished Prof.	1	6	4	49	7817
Bruce Erickson	Clinical Assoc. Prof	3	2	0	13	632
Corey Gerber	Clinical Assoc. Prof					
Karen Hudson	USDA-ARS				15	1204
Yiwei Jiang	Professor	6	7	8	29	3646
Keith Johnson	Professor	0	0	1	-	-
Jianxin Ma	Professor	5	5	1	44	14,843
M. Mohammadi	Assoc. Professor	1	7	6	15	755
Robert Nielsen	Professor	0	0	2	17	1491
Katy M. Rainey	Associate Professor	3	7	8	18	1291
T. Rocheford	Prof, Patterson Chair	4	4	5	48	10,248
Lee Schweitzer	Professor					
Steven Scofield	USDA-ARS				27	4926
Dan Szymanski	Professor, BPP (25%)	2	0	0	31	3736
Mitch Tuinstra	Prof & Wick. Chair	3	5	9	40	6021
Jeff Volenec	Professor	4	4	6	51	6600
Tony Vyn	Prof. Wallace Chair	4	7	4	48	7309
Diane Wang	Assistant Professor	1	2	8	12	727
Daniel Quinn	Assistant Professor	-	2	1	3	19
Cankui Zhang	Associate Professor	5	5	5	19	1619
SOIL AND LAND USE						
S. Armstrong	Associate Professor	4	1	4	11	384
Sylvie Brouder	Prof & Wick. Chair	1	1	4	35	3738
James Camberato	Professor	7	7	8	28	2959
D. Cammarano	Associate Professor	9	9	8	37	6091
M. Crawford	Professor, CIVL (25%)					
Chi-Hua Huang	Adjunct Prof. - ARS					
Cliff Johnston	Professor	7	5	8	53	9831
Eileen Kladivko	Professor	3	2	2	37	6516
Cindy Nakatsu	Professor	3	5	7	49	7639
Chad Penn	Adjunct Prof. - ARS				32	2915
Darrell Schulze	Professor	0	2	4	42	6414
Gary Steinhardt	Professor					
WATER, AIR, AND CLIMATE						
Laura Bowling	Professor	3	3	12	36	4498
Javier Gonzalez	USDA - ARS				19	1030
Richard Grant	Professor	3	2	5	28	3214
Linda Lee	Professor	2	7	6	46	6930
Suresh Rao	Disting. Prof. CIVL(25%)	12	15	9	84	24,360
Ronald Turco	Professor & Head	0	3	2	43	12,444
Qianlai Zhuang	Professor EAPS (25%)	1	3	0	56	15,836
Recent Retirements or Departures						
Dev Niyogi [FF]	Univ. Texas-Austin	8	20	32	64	15,954
Cliff Weil [FF]	Retired (NSF)	1	3	2	28	3018
Jason Ackerson [FF]	Soil Health Inst.	1	0	0	6	214
M. Mashtare [FF]	Penn State	-	-	-	-	-
Tim Filley [FF]	Oklahoma State	-	-	-	42	7997

Table 3.3 Distribution of funding by year, group, and role (P.I. or Co-Pi).

Group	PI-Count	Submitted				Funded			
		As P.I.		As Co-PI		As P.I.		As Co-PI	
FY2016		#	$	#	$	#	$	#	$
Crops Env	16	43	14,837,978	17	3,351,829	28	10,058,708	9	1,257,751
Soil Land	7	15	3,622,052	27	3,335,852	7	527,611	6	93,839
Water Air	5	20	4,277,794	22	5,255,844	9	1,099,372	4	165,107
	28	78	22,737,824	66	11,943,524	44	11,685,691	19	1,516,697
FY2017									
Crops Env	16	48	22,547,323	26	10,189,822	24	3,958,208	7	531,825
Soil Land	7	20	5,146,332	31	7,629,980	10	1,053,609	9	614,772
Water Air	5	16	5,236,577	11	2,053,583	5	711,284	6	271,771
	28	84	32,930,232	68	19,873,385	39	5,723,102	22	1,418,368
FY2018									
Crops Env	14	30	9,794,812	13	6,853,479	24	7,215,299	8	441,009
Soil Land	8	24	2,492,013	17	2,354,611	17	2,131,940	8	915,946
Water Air	5	11	2,609,163	12	2,588,878	7	802,396	4	324,811
	27	65	14,895,988	42	11,796,968	48	10,149,635	20	1,681,766
FY2019									
Crops Env	15	31	6,867,704	25	6,853,479	22	4,317,509	9	2,074,961
Soil Land	8	25	17,074,499	19	1,265,772	9	1,885,113	3	444,654
Water Air	5	10	15,444,499	10	2,588,878	6	1,142,563	4	222,094
	28	66	39,386,702	54	10,708,130	37	7,345,185	16	2,741,709
FY2020									
Crops Env	15	32	24,605,765	18	4,855,725	16	5,270,394	6	648,482
Soil Land	9	22	4,300,087	22	1,699,483	7	1,976,319	1	350
Water Air	5	14	3,790,195	14	3,208,406	4	1,825,971	4	282,753
	29	68	32,696,047	54	9,763,614	27	9,072,684	11	931,585
Sum		406	142,646,794	284	51,064,409	195	43,976,297	88	8,290,125

Data was collected from the sponsored program services (SPS) database. The database contains data for all grants, contracts, and sponsors.

Table 3.3 Summation of funding by groups across the five-year review period.

Group	Submitted				Funded				
	As P.I.		As Co-PI		As P.I.		As Co-PI		Total
	#	Amount ($)	#	Amount ($)	#	Amount ($)	#	Amount ($)	Amount ($)
Crop Env	184	78,653,582	99	26,397,081	114	30,820,119	39	4,954,028	35,774,147 (%68.4)
Soil Land	106	32,634,983	92	8,949,529	50	7,574,592	24	2,069,561	9,644,153 (%18.5)
Water Air	139	31,358,229	116	15,717,799	58	5,581,587	23	1,266,536	6,848,123 (%13.4)
Total		142,646,794		51,064,409		43,976,297		8,290,125	52,266,423

Data was collected from the Sponsored Program Services (SPS) database. Tables include all forms of support to P.I.s.

Table 3.4. Disclosures and Patents from Department of Agronomy activities.

Project Leader	Title, Year, and Patent Number	Abstract
Ma, Jianxin (Project leader), Duan, Jingbo, Ren, Bo, Wang, & Xutong	Regulation of Plant Nodulation by Rhizobial tRNA-Derived Small RNAs **Provisional-Patent has been issued**	Nitrogen-fixation is often the limiting factor for plant growth and crop yield, because nodulation is hindered by inefficient interactions between Rhizobial bacteria and plants. This technology uses tRNA-derived small RNAs to increase root hair curling and nodule number in legumes. Through gene editing of plants with the tRNA-derived small RNAs, the number of productive Rhizobial infections is dramatically increased. Genetic engineering of plants to promote nodulation has applications in enhancing nitrogen-fixation in legumes and in extending nitrogen fixation capabilities to non-legumes.
Lee, Linda S. (Project leader) & Zenobio, J. E.	Activated Supported NiFe Nanoparticles for Transformation of PFOS and Associated Chemical Class (2017) **Patent Number: 11,045,676**	Perfluoroalkyl acids (PFAAs) such as perfluorooctanesulfonate (PFOS) are globally ubiquitous, environmentally persistent, and recalcitrant to typical environmental degradation processes. Researchers at Purdue University have developed particles that can transform perfluorooctane sulfonate and associated compounds in aqueous solutions. The technology described attacks both linear and branched PFOS isomers under conditions that can be used for in-situ remediation technology. It has shown 55% PFOS degradation, including the linear isomer, which is the hardest to degrade by any technology.
Ma, Jianxin (project lead); Ping; Jieqing Fitzgerald; Joshua C., Zhang; Chunbao, Lin; Feng, Bai; Yonghe, Rehman; Maqsood, Crasta; Oswald, Aggarwal; Rajat, Acharya; Ananta	Genetic locus associated with phytophthora root and stem rot in soybean. (2017) **Patent Number: 10,995,377**	The present subject matter relates to methods and compositions for identifying soybean plants that having increased Phytophthora root and stem rot resistance. The methods use molecular markers to identify and to select plants with increased Phytophthora root and stem rot resistance or to identify and deselect plants with decreased Phytophthora root and stem rot resistance. Soybean plants generated by the methods disclosed are also a feature of the present subject matter.
Schulze, Darrell G (Project leader), Glotzbach, R., Kong, N.N., & Luke, E.M M.	Educational Tool for Understanding Soil Properties (2016) **Patent Number: TXu 2-020-117**	at Purdue University have developed an application that allows users to view highly detailed maps of soil properties on a tablet device. This application is designed primarily to support teaching and learning at the university level by allowing users to zoom in and see details or quickly zoom out to see map overviews. By switching between the various maps and zoom levels, users better understand the complex interactions between soil properties and the landscapes where they occur. This application could also be used for other applications.
Owens; Phillip Ray (project lead)	Functional soil maps (2020)	The functional soil map may be used to assist users in agriculture to improve management techniques. In

Winzeler; Hans, Libohova; Zamir & Ashetkar; Jenette	**Patent Number: 10,830,750**	some embodiments, the functional soil maps are integrated into management systems to adjust irrigation, pesticide application, and the like based on the functional characteristics of the landscape.
Ejeta, Gebisa (Project leader) & Lemming, T.R.	Sorghum Germplasm (2017) ***Disclosure, no patent assigned***	Researchers at Purdue University have developed a new line of sorghum seeds with enhanced properties.. Several ideal plant properties have been achieved in this parent seed line, including mold-resistance, drought tolerance, and ability to mature earlier than traditional seeds. The Purdue seed kit includes a set of sixteen sorghum germplasm seeds and four specialized pollinators to ensure success in crop management.
Tuinstra, Mitchell R. (project lead); Krothapalli; Kartikeya Dilkes; & Buescher	Genetic mutations that disrupt *dhurrin* production in sorghum (2016) **Patent Number: 9,512,437**	Sorghum produces many secondary metabolites, including the cyanogenic glucoside dhurrin. Cyanogenic glucosides belong to a class of plant-produced antibiotics called phytoanticipins. Embodiments of the present invention generally relate to new forage crops and methods of creating new forage crops. In a specific embodiment, the present invention relates to new varieties of sorghum that do not produce dhurrin.
Scofield; Steven R., (project lead) Gillespie; M.E. Brandt; A., Trick; H.N. & Dahleen; L. S.	Transgene construct to improve Fusarium head blight resistance in wheat and barley (2016) **Patent Number: 9,506,081**	Plants transformed with the construct exhibit increased resistance to FHB and other Fusarium-related diseases in comparison to a non-transformed control plant. The transgenic plants may be produced from any plant, tissue or cell which is capable of regeneration, by transformation with the construct. Transformed plants, plant tissue or plant cells comprising the construct are selected, and the transgenic plant is generated therefrom.

Table 10.5 Startup companies associated with the Agronomy Department.

Dr. Torbert Rocheford (https://professortorberts.com/)	**NutraMaize** is on a mission to transform the United States' largest staple crop—corn—into a platform for delivering better nutrition on a population-wide scale. NutraMaize is a high-growth early-stage company commercializing a more nutritious, better-tasting variety of non-GMO Orange Corn.
Dr. Katy Rainey (https://www.plotphenix.com/)	**Progeny Drone,** optimized for processing high-resolution, high-overlap imagery of small plot trials on minimal hardware, this elegant combination of speed & flexibility enables you to quickly convert thousands of images of many different trials into plot clips™ & metrics labeled according to your own field diagram on a regular basis.

Dr. Mitchell Tuinstra (https://www.gryfn.io/)	**Gryfn** Automated Sorghum Phenotyping and Trait Development Platform. GRYFN offers precise geomatics solutions for coaligned and repeatable multi-sensor UAV data collection for research and commercial applications. Their core vertical application empowers plant breeders in major commodity crops with precise, repeatable data and analytic solutions for high throughput phenotyping in the field.
Dr. David S. Ebert, Dr. Christian Butzke and **Dr. Phillip R. Owens** (https://www.vinsense.net/)	**VinSense** is an Indiana LLC formed in March 2015 by three Purdue University professors to offer an innovative decision support software system that allows high-value perennial crop growers to make better crop management decisions during the growing season.

4. Extension Programs

Mission

The mission of the Purdue Agronomy Extension group is to develop, integrate, and extend agronomic information and technology that is timely and relevant to the agricultural and environmental concerns of our diverse clientele from Indiana, the nation, and the international community.

Table 4.1. Extension Programs (FTE*e* based on Fall 2020 data)

Agricultural Meteorology and Climatology

			FTE*e*
Beth Hall	Faculty	State Climatologist	0.75
Jonathan Weaver	Professional	Climatology Outreach	1.00

Crop and Soil Management/Water and Environmental Quality

Jason Ackerson[a]	Faculty	Spatial Soil Mapping, Sensing & Management	0.65
Marguerite Bolt	Professional	Industrial Hemp Management Systems	1.00
Sylvie Brouder	Faculty	Plant Nutrition, Soil Fertility, Ecology	0.50
James Camberato	Faculty	Soil Fertility	0.65
Shaun Casteel	Faculty	Soybean Management Systems & Small Grains	0.60
Bruce Erickson	Faculty	Bruce Erickson	0.00[b]
Corey Gerber	Faculty	Crop Diagnostic Training & Research Center	0.59[c]
Keith Johnson	Faculty	Forage Management Systems	0.50
Eileen Kladivko	Faculty	Cover Crops, Drainage	0.15
Robert Nielsen	Faculty	Corn Management Systems	0.85[d]
Daniel Quinn	Faculty	Corn Management Systems	0.60[e]
Gary Steinhardt	Faculty	On-site Waste Disposal & Youth Education	0.35
Ron Turco	Faculty	Department Head	0.33
Jeffrey Volenec	Faculty	Crop Ecophysiology	0.10
Tony Vyn	Faculty	Cropping Systems, Tillage Systems	0.40

Professional Staff

Jason Deitrich	M/P Professional	Facilities Manager	0.20
Sherry Fulk-Bringman	Professional	Laboratory & Outreach Coordinator, K-12 Soils Education	0.30
Tom Pluimer	M/P Professional	Network System Administrator	0.15
Joseph Rorick	Professional	Conservation Cropping Systems Agronomist	0.50
Ron Steiner	Service	Plant Growth Facilities Coordinator	0.33
Lexie Wilson	Support	Senior Program Coordinator	0.70

Total FTE

Faculty FTE	6.42
Other FTE	4.68

[a] No longer at Purdue; Now at the Soil Health Institute

[b] Funding primarily from Distance Education and teaching funds.

[c] Funding primarily from State Line that rolls up into Extension funds.

[d] Began half-time in January 2020.

[e] Hired 2021 as a replacement for Nielsen.

Impacts and Major Events (2016-2020)

The lists below include significant events and impacts led by Agronomy Extension or others with significant participation by Agronomy. Attendees are sums typically over 5 years for annual events, but not in all cases.

Conferences

Indiana CCA Conference (3,479 attendees); Ackerson, Bolt, Camberato, Casteel, Gerber, Hall, Johnson, Kladivko, Nielsen, Rorick, Scott, Vyn, Wilson

Annual Heart of America Grazing Conference (142 attendees); Johnson, Wilson

Kentuckiana Conference (1,030 attendees); Ackerson, Bolt, Camberato, Casteel, Gerber, Johnson, Kladivko, Nielsen, Rorick, Vyn, Wilson

Workshops/Programs/Courses/Field Days

Nutrient Management Planning and Soil Sampling Workshops (160 attendees); Ackerson, Gerber, Rorick, Wilson

Crop Management Workshops (4,750 attendees); Camberato, Casteel, Gerber, Nielsen, Wilson

Diagnostic Training and Research Center Workshops (3,729 attendees); Ackerson, Bolt, Camberato, Casteel, Gerber, Hall, Johnson, Kladivko, Nielsen, Rorick, Turco, Volenec, Vyn, Wilson

Beef Basics Program (85 participants); Johnson

Grazing School 102 (86 attendees); Johnson

Master Cattleman Program (108 attendees); Johnson

Hemp Essentials On-line Course (17 attendees); Bolt

UAV Technology Program (190 attendees); Scott

Onsite Sewage System Installers Program; Steinhardt

4-H/FFA Soil Judging program (middle and high school students); Steinhardt, Fulk-Bringman

Soil Health and Cover Crops trainings and workshops; Rorick, Kladivko

Non-traditional audience program participation including K-12, Master Naturalists, Master Gardeners, 4-H Academy, High School Science Teachers; Fulk-Bringman

Numerous county-level workshops and field days in which Agronomy participates.

Publications

Revision of the Tri-State Fertilizer Recommendations; Camberato

Diagnostic Training and Research Center Guides and Apps (135,820 sold); Ackerson, Brouder, Camberato, Casteel, Gerber, Johnson, Kladivko, Nielsen, Rorick

Forages-An Introduction to Grassland Agriculture (Chapter 5): Environmental aspects of forage management; Volenec

Forages-The Science of Grassland Agriculture (Chapter 4): Carbon metabolism in forage plants; Volenec

Development of peer-reviewed and numbered Extension publications with video component available; Kladivko and Johnson

Dataset publications useful to others for decision-making, compiling alfalfa variety trials; Brouder, Volenec

Numerous newsletter articles, extension postings on Agronomy Extension website

Podcasts/Web Presence

Purdue Crop Chat Podcasts (~5,000 plays); Nielsen, Casteel

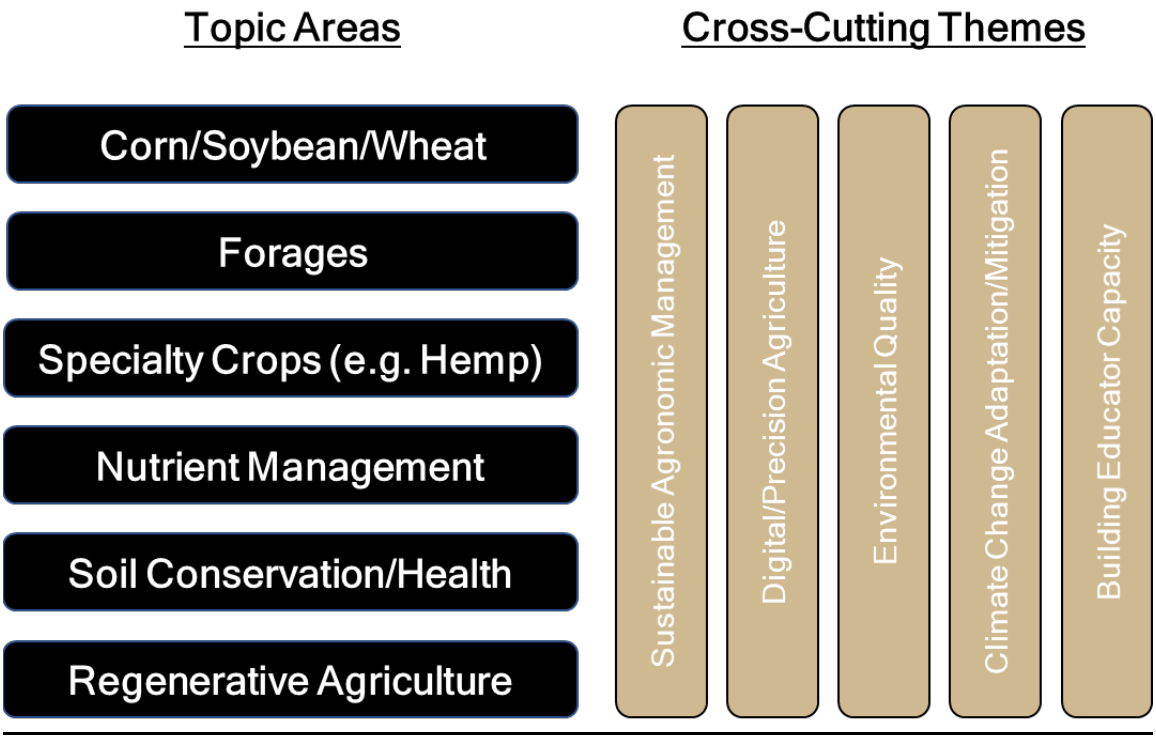
Chat'n Chew Café web site (~278,000 page views annually); Nielsen

Current and Future Directions

To serve Indiana agriculture now and into the future, we recognize both the current cropping systems and management practices along with new and emerging cropping systems and challenges. Indiana is one of the nation's leaders in agricultural productivity due to the favorable climate and productive soils, but there will be new challenges to productivity and environmental quality as the climate changes. As discussed in the Indiana Climate Change Impacts Assessment, some of these challenges will arise from wetter springs, potentially drier summers, other changes to precipitation patterns, and warmer nighttime temperatures. Other challenges and opportunities are arising with the development of new technologies, consumer preferences, shifting environmental priorities, and changes in modes of educational delivery. Agronomy Extension will continue to serve Indiana agriculture in both current and emerging areas. We must address issues with Climate Change Adaption, Sustainability and unique cropping systems. We will also collaborate with Extension specialists in weed science, entomology, plant pathology, animal sciences, and engineering.

Agronomy Extension works in five main topic areas and hopes to add a sixth (aspirational) topic area, given appropriate resources. Cross-cutting themes run across all these topic areas, and some of these are

expected to increase significantly by 2030. Brief descriptions of the topic areas and the cross-cutting themes are given below.



Topic Areas

Corn, soybeans, and wheat comprise the vast majority of 13 million acres of cropland in Indiana and will continue to do so for the foreseeable future. Agronomy Extension educates on all aspects of crop production and management of these crops. All the cross-cutting themes are part of this outreach.

Forages for livestock production are an essential part of Indiana agriculture. This includes grazing on permanent and rotation pastures, hay production, and grazing of cover crops. More outreach is needed in these areas, especially as producers with little or no livestock experience begin to integrate cover crops into their systems with the hope of grazing opportunities. The forages area is a vital component of the aspirational regenerative agriculture topic area as well.

Specialty Crops (Hemp) is a new topic area with tremendous growth in interest and activity. Agronomy currently has an MS-level agronomist serving as the Hemp outreach specialist, and demand is likely to increase for this crop over the following number of years.

Nutrient management sustainable economic and environmental practices are essential for crop production, water and air quality, and climate change. Agronomy Extension will educate about improved nutrient management practices, including proper rates, application methods and timings, efficiencies possible with precision equipment, changes needed with changing weather/climate conditions, etc.

Soil conservation and soil health education collaborate with the Natural Resources Conservation Service (NRCS), the Conservation Cropping Systems Initiative (CCSI), and other conservation partners in the state. The demand for education in this topic area has skyrocketed over the last few years and is likely to

continue to increase over the next decade, in part due to sustainability emphases from corporations and as a result of NRCS programs. Topics include cover crops and no-till along with accompanying nutrient management. This topic is also foundational for the aspirational regenerative agriculture topic.

Regenerative agriculture/ Agroecology in various forms has growing interest among our clientele. This topic area can include many specific topics but overall encompasses agroecological principles to improve soil and crop health and environmental quality by generating more of the crop's nutrient and pest management needs within the farming system itself. Regenerative agriculture could include using legumes (cover crops or rotational crops) to fulfill N needs of the cash crop, integrating livestock back into more Indiana farms, managing beneficial and pest insects, controlling weeds with cover crops, improving soil health, and reducing nutrient losses from agricultural fields. Organic agriculture could be one subset of a regenerative agriculture approach. Agronomy Extension needs to be an essential contributor to this emerging area.

Cross-Cutting Themes

Sustainable Agronomic Management: Nearly all work done in Agronomy Extension has an underlying goal of making our agronomic systems more sustainable over the long term.

Digital/Precision Agriculture: Development and use of new technologies in digital agriculture and precision agriculture apply to all the topic areas of Agronomy Extension. This area needs more resources and attention to capitalize on the potential gains in productivity and efficiency. Although several Agronomy Extension specialists have worked a lot in this area, more is needed, especially as some of the newer research faculty develop tools and approaches that could be used in Extension programming.

Environmental Quality: As with sustainable agronomic management, much of the work by Agronomy Extension has an underlying co-goal of improving environmental quality. This fits more explicitly with nutrient management and soil conservation/health. Agronomy Extension will continue to articulate the improvement of environmental quality as a critical goal.

Climate Change Adaptation/Mitigation: Developing management practices that make our cropping systems more resilient to climate stresses has been and will continue to be an essential part of our applied research/Extension. As discussed in the Indiana Climate Change Impacts Assessment report, the anticipated changes in precipitation and temperature require further research and education to prepare our stakeholders to continue to adapt their management practices to meet new conditions.

Building Extension Educator Capacity: County Extension Educators are an essential part of the outreach team for reaching producers in their local areas. We must continue to help these Educators learn and relate the scientific findings of the on-campus specialists to their local clientele.

Opportunities and Challenges

Managing time and expectations of Extension clientele for Extension faculty who take on greater teaching responsibilities. Although 22 faculty and staff have partial Extension appointments, there are <10 FTE of faculty and professional staff directly involved in Extension programming. Most faculty with Extension responsibilities have teaching and research responsibilities as well. Extension faculty will have greater teaching responsibilities even as the demand for Extension programming remains the same or increases. To continue excellent Extension programming, maintaining a core of Extension specialists (row crop and forage agronomists, soil scientists, and climatologists) with primary Extension appointments and minimal or flexible teaching appointments is recommended.

Maintaining base funding for in-state travel for primary Extension personnel. This is necessary to provide the level of service our clientele expect—familiarity with current crop conditions and issues as the basis for timely information and recommendations, delivering programs at workshops, field days, county and regional meetings, and occasional problem-solving.

Establishing consistent and sufficient funding for research that supports economically and environmentally sustainable agronomic recommendations. Strong research-based recommendations are crucial to providing timely, reliable, unbiased information for our clientele to base their decisions on.

Continued development and refinement of remote learning tools and approaches. Remote learning may provide Extension programming to a broader audience, perhaps more efficiently. Maintaining or improving effectiveness is at least as important as saving money (or more critical). Funding, support staff, and infrastructure are needed to improve remote learning. This includes websites as well as webinars.

Expansion of in-service training for specialists of county Extension Educators. This will enable specialists to provide more local agronomic education programming and recommendations and provide a more robust conduit for informing specialists of clientele needs.

Major new Challenge - Developing the Purdue Mesonet

A “mesonet” is a mesoscale network of automated weather observing stations that measures a variety of atmospheric and soil parameters for monitoring, research, and decision-making purposes. These stations are typically either 3-m or 10-m tall with sensors measuring a variety of parameters (e.g., temperature, humidity, wind, solar radiation, precipitation) at varying heights and depths (e.g., soil temperature and moisture). Mesonets often refer to observation networks covering sub-national scales – from a county or counties, to a state, to a collection of states. Most are managed and operated within university programs such as state climate offices (e.g., Missouri, Michigan, Nebraska) or state surveys (e.g., Illinois).

The Purdue Mesonet – a network of weather observation stations at the eight Purdue Agricultural Centers (PACs) and Agronomy Center for Research and Education (ACRE) – has been collecting data for over 20 years. These data have been utilized for agricultural and climate research and monitoring applications. All stations currently collect temperature, relative humidity, wind speed and direction, solar radiation, 4” soil temperature, and precipitation. In 2021, soil temperature and moisture sensors will be installed at four depths (5-cm (~2”), 10-cm (~4”), 20-cm (~8”), and 50-cm (~20”)) and additional temperature sensors will be installed at three heights (0.5m, 1.5m, and 3.0m) to capture low-level inversions.

The Purdue Mesonet is a valued, historical and near-real-time data resource for climate monitoring and agricultural research applications involving weather and soil conditions. Emerging agricultural concerns and research opportunities have increased the demand for additional data that is located near agricultural production. The Purdue Mesonet provides operational and historical climate data for climatological research, monitoring, and funding opportunities.

5. Graduate Education

Graduate Student Recruiting and Admissions

Active recruiting for the department occurs only at the Agronomy Society/Crop Science Society/Soil Science Society (ASA/CSSA/SSSA) annual meeting. At this meeting, we take six graduate students to answer questions at our graduate program recruiting table. Typically about 40 prospective students visit the recruiting table. Visitor information is provided to the faculty for their specific program recruiting.

Table 5.1: Graduate Recruiting.

Academic Year	Applications	New students directly into AGRY	Foreign	Non-resident	Resident	New students (including IESE designating AGRY)
2020	38	1	1	0		6
2019	45	5	1	1	3	7
2018	37	10	1	3	6	11
2017	34	2	1	1		6
2016	50	12	8	4		14

Admissions into the departmental programs is primarily controlled by the graduate faculty. Applications are not evaluated by the graduate program faculty committee. All faculty receive lists of completed applications meeting minimum departmental admissions requirements, with any student-determined potential faculty advisors indicated. Faculty are responsible for determining which students they wish to have in their programs, with offers created after the faculty indicates how the new student will be funded. New applications and admits are listed by year in Table 5.1. While the number of applications has been steady, the matriculating student population has declined (Table 5.1). A number of students are typically in the IESE (Interdisciplinary Ecological Sciences and Engineering) and PULSe (Purdue University Interdisciplinary Life Science) programs; they are not identified with the department until their ePOS (electronic Plan Of Study) is completed (6 in Fall 2020). Therefore, the most recent year's new student population count is always lower than those students advised in the department (Table 5.1).

Graduate student enrollment (Table 5.2) has been consistent for most of the five years but declined last year. Part of this decline was due to deferred matriculation for several foreign graduate students (4) to 2021 due to COVID-19, and part due to reduced funding of faculty (see funding patterns below). Also, the database is not accurate, as there were two continuing students whose registration we confirmed in 2020 but were not included. The intent to reverse this student population decline in terms of improved departmental visibility and increased programmatic offerings are indicated in the future directions below.

Graduate Student Funding Patterns

Availability of graduate student funding is generally based on research project funding provided by individual faculty research projects; research projects funded 73% of matriculating students between 2018 and 2020. In addition, we typically have 2 Ross Fellowships, 1 ARGE (Agricultural Research and Graduate Education) Diversity Assistantship, and 1 Bilsland Dissertation Fellowship to augment project-funded students. Over 2018-2020, 4 Ph.D. students were funded through fellowships they attained themselves, and 2 M.S. and 1 Ph.D. students were self-funded or funded by their companies. We typically

have two students/year on Indiana Corn Marketing Assistantships. Since the department does not have a pool of funds for undesignated research assistantships, increasing the graduate student population requires increased success by faculty in research funding. Efforts to help reverse the decline in the student population are addressed in the plans below.

Table 5.2: Graduate Student Enrollment and Demographics.

	Fall 2016	Fall 2017	Fall 2018	Fall 2019	Fall 2020
Graduate Enrollment	60	60	62	59	37
M.S.	23	20	25	29	15
Ph.D.	37	40	36	29	22
Demographics					
Female	43.3%	45.0%	41.9%	40.7%	48.6%
Male	56.7%	55.0%	58.1%	59.3%	51.4%
Foreign	40.0%	45.0%	33.9%	33.9%	37.8%
Non-Resident	28.3%	33.3%	35.5%	27.1%	24.3%
Resident	31.7%	21.7%	30.6%	39.0%	37.8%
URM	11.7%	10.0%	8.1%	5.1%	2.7%
2 or more races	1.7%	0.0%	1.6%	1.7%	0.0%
American Indian or Alaska Native	3.3%	3.3%	3.2%	1.7%	0.0%
Asian	1.7%	1.7%	3.2%	0.0%	0.0%
Black or African American	1.7%	1.7%	0.0%	0.0%	0.0%
Hispanic/Latino	5.0%	5.0%	3.2%	1.7%	2.7%
International	41.7%	45.0%	33.9%	33.9%	40.5%
Native Hawaiian or other Pacific Islander	0.0%	0.0%	0.0%	0.0%	0.0%
Unknown	1.7%	0.0%	0.0%	0.0%	0.0%
White	43.3%	43.3%	54.8%	61.0%	56.8%

Enrollment Metrics, Demographics

Demographics of the graduate student enrollment has changed in the past five years (Table 5.2):

- the female graduate student population has increased
- resident (Indiana) students have increased
- the proportion of white students has increased
- the proportion of URM students has decreased
- the proportion of international students has been approximately constant

The Agronomy graduate student population was compared against Purdue student populations and the membership demographics of the two dominant professional societies that faculty are members of (ASA/CSSA/SSSA and ASPB-American Society of Plant Biology). Comparing the 2020 AGRY enrollment to various target populations (Table 5.3):

- the international percentage is consistent with overall Purdue and College of Agriculture (CoA) graduate student populations
- the domestic white percentage is higher than the overall Purdue and CoA graduate student populations and the mean for the two professional society memberships (ASA/CSSA/SSSA and ASPB)
- the URM percentage is lower than Purdue CoA and overall graduate population and ASA/CSSA/SSSA society but consistent with the ASPB society membership.

The intent to reverse the decline in the non-white and URM student population through promotion, programs, and funding is addressed in the plans below (objective 2).

Table 5.3: Graduate student enrollment targets.

		Breakdown of Domestic (%)[1]			International (%)
Population	**Year**	**White**	**URM**	**Other ethnicity**	
AGRY	**2020**	**97.3**	**2.7**	**0.0**	**40.5**
US domestic enrollment in graduate and post baccalaureate programs	2018	69.0	11.0	30.0	10.6
Purdue Graduate School enrollment	2019	72.4	15.1	12.5	44.3
Purdue CoA	2020	74.3	8.8	16.9	44.5
ASA/CSSA/SSSA[2] membership	2021	66.4	6.7	26.9	
ASPB[3] membership	2021	63.9	2.0	34.1	40.0

1: Sums to 100%
2: American Society of Agronomy / Crop Science Society of America / Soil Science Society of America
3: American Society of Plant Biology

Preliminary Examination process

The preliminary examination is a comprehensive review of the student's knowledge in the area in which he/she is seeking a Ph.D. degree. Coursework must be mostly completed before the examination. The purpose of the preliminary examination is to determine if: 1) the student possesses the requisite knowledge to be admitted to candidacy for the Ph.D., 2) the student should enroll in additional course work to fill in gaps in requisite knowledge, or 3) the student should be encouraged to change degree program from the Ph.D. to a non-thesis M.S. Material covered is not to include that already tested in formal course work, but rather to evaluate the student's ability to reason and perform a synthesis of numerous facts to arrive at a logical conclusion or answer. The decision to require additional coursework may or may not correspond with a failed preliminary exam.

The examination consists of at least three written examinations from faculty serving on the advisory committee and an oral examination by the entire advisory committee. Professors giving written exams will give instructions on any reference material the student may use during the exam. Each written examination will be open-book and require between 3 and 12 hours of effort over a period of up to one

week. All written examinations are taken within a period of six weeks. The Oral Examination may cover material in the written examination and any other topic that indicates the ability to reason and perform a synthesis of numerous facts to arrive at a logical conclusion or answer. A condensation of the oral and written exams rubrics, excluding the criteria for the evaluation of performance, are provided in Table 5.4. Rubrics with criteria for levels of performance for each assessment (Does not meet expectations/Meets expectations/Exceeds expectations) are provided in the *Graduate Student Handbook* (see Appendix I).

Graduation Data:

Over last 5 years we have graduated a total of 68 students – 39 M.S. and 29 Ph.D.

Table 5.4: Ph.D. Preliminary Exam Metrics.

Attribute	Oral Exam assessments	Written Exam assessments
Written Communication		Writing quality Grammatical & spelling errors Organization
Oral Communication	Organization Verbal communication Presentation of visuals	
Advance Knowledge and Scholarship	Responses to questions Arguments Knowledge in the subject area	Understanding of subject matter & literature Understanding of theoretical concepts Evidence of discovery Linkage to previous research Theoretical or applied significance Publication potential
Critical thinking and problem solving	Depth of knowledge Critical thinking skills Ability to draw knowledge from across disciplines	Formulation of arguments Objectives Critical thinking skills Creativity and insight
Ethical conduct	Limitations in data interpretation & analysis Attribution of sources & colleagues	Regulatory compliance Limitations in data interpretation & analysis Attribution of sources & colleagues

Graduate student curriculum

Four graduate degree programs (including the combined BS/MS program) are available. Requirements for each program follow.

MS thesis and combined BS/MS:

- 24 course credits (cr) [total of 30 cr required including research]. Among the course credits, there must be Professional Development (PD) experiences consisting of 'Introduction to Graduate Research' (AGRY 601, 1 cr) and one interactive seminar course (1 cr). Coursework credits can include no more than 6 cr of upper-level courses and at most 9 cr at dual-level or graduate-level courses that were not part of the Baccalaureate degree.
- Documented attendance at 5 AGRY seminars (PD experiences).
- A thesis proposal (≥ 10 pages) approved by the advisory committee using a formative rubric provided to the student (rubric with criteria for levels of performance are provided in the *Graduate Student Handbook*). The proposal must be presented (20-30 min) to the public (PD experience).
- A thesis and final oral examination with the first part of the oral examination open to faculty and students (50 min.) The second part of the oral examination, open only to the committee (≤ 2hrs). Summaries of the rubrics used to evaluate both oral and written components are reported back

to the student (rubrics with criteria for levels of performance are provided in the *Graduate Student Handbook*).

MS (non-thesis):

- 33 course credit hours. Among the course credits there must be PD experiences consisting of AGRY 601 (1 cr) and one interactive seminar course (1 cr). There can be no more than six cr of upper-level courses and a maximum of nine cr at dual-level or graduate level courses that were not part of the Baccalaureate degree.
- Documented attendance at 5 AGRY seminars (PD experiences).

PhD:

- Pre-requisite core science requirements provide background in the major sciences and mathematics: A minimum of 3 cr in basic biology, chemistry, physics and math; plus, an additional 9 cr in some of the areas for a total of 21 cr.
- 36 cr of coursework [total of 90 cr required including research]. Among the coursework credits there must be: 1) Two statistics courses (6 cr)—one involving graduate level probability and statistics, and one applied statistical reasoning/thinking; 2) PD experiences including AGRY 601 (1 cr,) and 2 interactive seminar courses (2 cr). Coursework can include no more than 6 cr independent study (not directed by the student's advisor(s)) and can include 24 credit hours from a prior MS degree.
- Documented attendance at 14 seminars: at least 9 AGRY seminars, at most 5 regular seminars in other departments or Distinguished Professor seminars (PD experiences).
- A thesis proposal (≥ 10 pages) approved by the advisory committee using a formative rubric provided to the student (rubrics with criteria for levels of performance are provided in the *Graduate Student Handbook*). The proposal must be presented (20-30 min) to the public (PD experience).
- A preliminary examination after the student has: 1) presented and received committee approval on their research proposal and 2) has completed almost all course requirements. Summaries of the rubrics used (Table 5.4) to evaluate both oral and written components are reported back to the student (rubrics with criteria for levels of performance are provided in the *Graduate Student Handbook).*
- Dissertation and a final oral examination. The first part of the oral examination is open to faculty and students (50 min). The second part of the oral examination is open only to the advisory committee (≤ 2hrs). Summaries of the rubrics used to evaluate both oral and written components are reported back to the student (rubrics with criteria for levels of performance are provided in the *Graduate Student Handbook).*

Graduate Student Experiences - Preliminary Exam

Graduate student experience is assessed by an oral exit interview (since 2018). We do not specifically ask about the preliminary exam during exit interviews or in an exit questionnaire, but we do ask open-ended questions whose answers could include information on this issue. Questions in the exit interview include: 1) What was the hardest part of your time as a graduate student? 2) What would make the graduate student experience better? and 3) What would you like to tell me that I have not already asked about? The preliminary exam has never been mentioned. Over the past five years, five graduate students have failed their first preliminary exam (two failed the oral exam only). All five students passed their examination on the second try.

Graduate Student Organization

The Agronomy Graduate Student Organization (AGSO) was officially founded as a university recognized graduate student organization in December 2019; however, the group had been functioning unofficially for many years previously. The group meets twice per semester. AGSO objectives include 1) provide enrichment experiences, 2) promote academic and social communication among students and faculty, and 3) provide a forum to voice concerns and expectations. Major initiatives have included:

- Peer-to-peer mentoring of matriculating international students (AY 2017-18, 2018-19).
- A near-weekly Seminar Series (AY 2019-2020 attended by 15-40) featuring up to 12 student presentations each semester (used for research proposal presentations described above).
- A 4-part Professional Development Series and the AgRACEiculture workshop (82 attendees across CoA) in response to the need for expanding diversity, equity, and inclusion-related conversations in our agricultural community (2020).
- Various community building activities including coffee/donut hours, virtual-game nights, intramural sports teams, tailgating, and cultural lunches.

Activity funding generally comes from annual fundraisers (chili cookoff, silent auction/photo contest, and pancake breakfast). An ARGE Grant in 2019 was provided to help fund a proposed *Agriculture Grows Here* Symposium (planning postponed due to Covid-19 pandemic).

Future direction objectives:

1) Expand the graduate education portfolio.
    a. Develop a non-thesis master's program with directed coursework for
        i. Preparation for non-research industry/government employment (Extension and/or technician).
        ii. Enhanced background/training for employees of agricultural companies.
    b. Develop distance education courses/certificate programs in basic crops, soils and hydrology, such as Certified Crop Advisor (CCA) that may be combined with other programs for 'stackable' degrees (e.g. Data Science).
2) Increase the number of graduate students.
    a. Increase the number of URM applicants through incentivized involvement with undergraduate research programs (e.g., summer Research Opportunities Program and Summer Undergraduate Research Fellows) and enhanced engagement with students and faculty at Historically Black Colleges and Universities for targeted recruiting (possibly through virtual meetings).
    b. Increase promotion and support for adaptation of required student research proposals to applications to external graduate training fellowships from agencies such as NSF, NIH and USDA (supported by PD course described below).
    c. Develop graduate training programs through NIFA and NSF for cross-disciplinary topics.
    d. Increase nominations to CoA fellowship programs through better communications.
    e. Create endowments for graduate research assistantships to provide funding for new students with great promise but no chosen advisor.
3) Promote and increase the professional development opportunities for students.
    a. Formalize the temporary 'Proposal development and writing' professional development course.
    b. Improve diversity and inclusion training depth – currently limited to 2 hours in AGRY 601 for all matriculating students.

c. Increase the number of graduate students gaining experience in Extension and teaching activities.

4) Increase research profile and marketability of graduate students.
   a. Promote quality presentations (best conference/workshop papers/posters).
   b. Double the research publications of students within the first two years after completing degree.

6. International Programs

International activities are a critical and well-supported part of the Agronomy Department's mission. Table 6.1 shows the pattern of support for declared international effort taking place in the department. This table may underestimate the total support for international work, as the data are collected from projects that explicitly claim an international scope of work.

Table 6.1 International Program Support in the Department of Agronomy.

2016	2017	2018	2019	2020	Total
$0.91 M	$1.2M	$6.95M	$1.61M	$2.8M	$13.5M

Highlights of our programs and areas of operations

Our faculty conduct significant research and outreach programs that address global issues in Latin America, Africa, and Asia. Many of these programs represent project-based efforts of faculty and students contributing to proposals based on personal and professional interests. Recent examples include a significant program in Latin America with faculty at the Universidad Nacional de San Agustin in Peru, led by Tim Filley with individual research projects led by Moshen Mohammadi, Cankui Zhang, Laura Bowling, and Darrell Schulze. Other international projects are conducted in Kenya, Zimbabwe, Colombia, Peru, Ukraine, India, Jordan, Brazil, South Africa, Netherlands, Tanzania, Niger, China, Ethiopia, Hungry, and Honduras. Many of these programs are largely on hold due to restrictions associated with COVID.

Longer-term research and agriculture development activities also play a key role in the department's research, education, and outreach portfolio and include the sorghum and maize breeding programs. Crop improvement programs in sorghum have focused on adaptation to biotic and abiotic stresses and improved nutritional value in collaboration with international partners in eastern and western Africa (see below for more detail). Crop improvement programs in maize have focused on biofortification for pro-vitamin A with partners in eastern and southern Africa and adaptation to heat and drought stress tolerance with public and private sector partners in South Asia.

Student exchange and study abroad programs provide opportunities to enhance the international understanding of our faculty and students. International students represent a key component of our graduate and undergraduate programs. These students enrich our programs and add value to educational efforts. A recent example of these contributions includes Stefanie Griebel from Germany. Dr. Griebel made substantial contributions to the educational mission of the Department of Agronomy as a Teaching Assistant in the AGRY 321 Genetics Laboratory while completing a Ph.D. in plant breeding. She was awarded the Graduate Teaching Award, the Outstanding Graduate Teaching Award, and the Graduate School Excellence in Teaching Award, the highest award for a graduate student teaching at Purdue.

Efforts are being made to add international agricultural issues into our educational efforts to enrich our curriculum. This includes classes on Global Food Security and the use of world crops for foods.

New opportunities

International agricultural research and development are receiving renewed political and public support. New potential funding sources for global engagement continue to emerge from federal, foundation, and

industrial sources. These resources may allow our faculty and students to pursue international engagement in education, research, and Extension. Distance education may provide unique opportunities to engage our global partners.

Discussions are underway about mobilizing global linkages to enhance the impact of science for development. More work is needed to determine how to organize the efforts of the department to address the food systems agenda. To meet the demands of feeding an increasingly interconnected world, the next generation of U.S. scientists and thought leaders must reach beyond national borders to find and implement effective solutions. To contribute to the development of globally engaged young scientists, D. Wang leads a new initiative called Plant Science for Global Food Security, funded by NSF IRES, that provides undergraduate students with six-week research experiences at the International Rice Research Institute (IRRI) in the Philippines. Beyond impacts on the student participants themselves, this program is anticipated to strengthen existing ties and cultivate new collaborations between Purdue and IRRI scientists.

Future directions

An effort to create a position aimed at **Global Plant Breeding** will build on an internationally recognized sorghum breeding and genomics research program. Numerous projects have generated external support to improve sorghum for biotic (disease and parasitic weed) and abiotic resistance (drought and cold tolerance). The background is a pattern of continuous work to improve nutritional quality and growth characteristics that are critical to maintaining productivity. Purdue remains a significant repository for genetic resources that have backstopped programs across the world. As a result, our program has an immense potential value and ongoing impact in developing countries and the developed world.

The international sorghum-breeding and genetic research program at Purdue University was started in the late 1960s, continues today, and must continue in the future. Dr. Gebisa Ejeta has led the sorghum program for the past two decades. The program has received continuous funding for over 22 years, supporting 132 research projects toward genetic improvements in sorghum, including resistance to biotic and abiotic stresses. Since the late 1960s, the sorghum research program at Purdue has generated in excess of 20 million dollars in external funding, including support from the International Crops Research Institute, the Agency for International Development, the U.S. Department of Energy, the USDA, McKnight Foundation, and Bill & Melinda Gates Foundation. The Purdue sorghum improvement program has stressed genetic improvement around several essential issues related to improving the crop's success. Key sorghum program highlights include:

- Identification of sorghum genotypes with high protein digestibility has altered the end use of the crop, including the discovery of chemical types and nutritional effects of the sorghum tannins (polyphenols).
- Recognition of the importance of increased lysine content in grain. Identification of two forms of high lysine sorghum and the impact on improving the diets of people who depend on sorghum as a staple.
- Discovery and deployment of the mechanisms of resistance of sorghum to Striga (*Striga hermonthica*).
- Successful completion of the first sorghum transformation experiments in the world. These advancements have implications for future genetic and genomic engineering projects.

- Establishment of the first sorghum research and crop improvement program in the world to investigate grain mold resistance.
- Identification of quantitative trait loci associated with pre- and post-flowering drought tolerance.
- Development of low lignin sorghum plants that substantially enhanced the nutritional value of the crop for forage and grazing application.
- Development of dhurrin-free sorghum to enhance crop safety when used as a forage.

7. Global, National Leader, Measures of Excellence

Overview

In order to determine the relative performance of any academic unit, there should be standard and robust metrics to capture the complex nature of a given department. Ideally, robust metrics to capture the core mission areas of research, extension/engagement, and teaching could be uniformly applied then compared to a large sample set. However, it is challenging to find a single set of metrics that will capture the status and reputation of a given department relative to other departments across the country. The mixture of roles and responsibilities (teaching, Extension, and discovery) is variable in each department, and every department is different. Moreover, the number of schools with a declared Department of Agronomy structured like Purdue's is extremely limited. To the best of our abilities, the success and impact of our programs based on broad qualitative and quantitative measures (e.g., leadership contributions, patents, participation in societies, international activities, as well as awards and recognition) are listed here.

The agronomy faculty play keys roles in many campus leadership roles.

Faculty Leadership Efforts Outside of Agronomy

Agronomy faculty serve in many essential university roles that significantly extend the impact of programs.

Purdue Soybean Center (https://ag.purdue.edu/agry/soybean/Pages/PurdueSoybeanCenter.aspx)

Dr. Katy M. Rainey uses her expertise with soybeans to lead the Purdue Soybean Research Center. The Center has consulted with faculty and staff members and representatives of the soybean industry in developing a strategic plan for research and Extension that engages Purdue faculty and staff in critical issues of the soybean "value chain."

Natural Resource Environmental Sciences (NRES) (https://ag.purdue.edu/nres)

Dr. Laura Bowling uses her background in hydrology and water resources modeling to lead the NRES undergraduate program. NRES is an interdisciplinary program and a unique and exciting major for students who want to contribute to environmental change in the world.

Purdue Center for Global Food Security (PCGFS) (https://www.purdue.edu/discoverypark/food/)

Dr. Gebisa Ejeta leads the PCGFS mission to *address a range of global food security challenges and contribute to research and policy-making and human and institutional capacity-building.*

Ecological Sciences and Engineering (ESE) (https://www.purdue.edu/gradschool/ese/)

Dr. Linda Lee leads ESE, an interdisciplinary graduate program at Purdue University. ESE students work to create an understanding of the processes that link human activity and ecological systems to improve natural resource management.

Plant Science 2.0 (https://ag.purdue.edu/plantsciences/plant-sciences-2-0/)

Dr. Mitch Tuinstra is the Science Director for the Plant Sciences 2.0 program. Plant Sciences 2.0 is part of Purdue's Next Moves program and will expand Purdue Agriculture's expertise in phenotyping and the use of other technologies to build capacity in our food supply.

Distance Education

Dr. Joe Anderson is the Director of distance education for the College of Agriculture. This program works to remove barriers in the creation of online resources for teaching and research.

In Table 7.1. we show the key highlights from our faculty. These data demonstrate a continued willingness to engage with the broader community.

Table 7.1 Key Highlights of the faculty

Faculty	Expertise	Highlights
Shalamar Armstrong	Environmental Soil Science	• Director of the Purdue Accelerated Underrepresented Minority Post-Doctoral Program (2021) • Award for Exceptional Teaching and Instructional Support by Purdue Teaching Academy (2021) • **Outstanding Graduate Mentor/Teacher (2020 Purdue University)** • **Faculty Unsung Diversity Hero Award (2019 Purdue University)**
Laura Bowling	Watershed Hydrology	• Board Member - University Council on Water Resources (2021) • Mentoring Award, American Society of Agronomy (2021) • **Pfendler Outstanding Counselor, College of Agriculture (2020)** • Experiment Station Section National Excellence in Multistate Research Award (team award) USDA- Multistate Research (2018) • University Faculty Scholar (2017)
Sylvie Brouder	Plant Mineral Nutrition	• **World Bank and 10 member LGU Consortium. "The Future of Food: Global Food System Innovation Partnership" (initial focus on Africa; summer 2016 – present)** • Certificate of Appreciation from USDA (2020) • Global Food Ethics Project of Johns Hopkins Univ. Berman Institute of Bioethics, Bloomberg School of Public Health and the School of Advanced International Studies • UN FAO/CGIAR. Independent expert/evaluator for the Independent Evaluation Arrangement for CGIAR Research Programs (CRPs) and for the Independent Science and Partnership Council (ISPC) • **President American Society of Agronomy (2018)** • Innovators Hall of Fame Inductee (2018, 2019 Purdue Research Foundation) • Millionaire Award (2018 Purdue University)

		• IPNI: International Plant Nutrition Institute (IPNI)- Member • CFPN: Israeli-based Center for Fertilization and Plant Nutrition • **Fellow American Association for Advancement of Science (AAAS) (2017)**
James Camberato	Soil Fertility	• **Outstanding Paper Award American Society of Agronomy No. 4 of Top 10 cited papers in Agriculture in the last 2 years MDPI Agriculture Journal (2020)** • Purdue Cooperative Extension Specialist Association Team Award Purdue Cooperative Extension Specialist Association (2018) • American Society of Agronomy Extension Education Community Award - Digital Decision Aids American Society of Agronomy 2017)
Davide Cammarano	Precision Agriculture & Crop Modeling	• Associate Editor in Chief – European Journal of Agronomy (2021) • Associate Editor of Precision Agriculture (2021) • Associate Editor of Crop and Pasture Science (2021) • Vice-Chair (ASA) Chinese Academy of Sciences President's International Fellowship (2015)
Melba Crawford	Earth Observation & Director of LARS (Civil/AGRY)	• Co-Chair Purdue Engineering Initiative (2021) • Director – Laboratory for Application of Remote Sensing (2021)
Gebisa Ejeta	Sorghum Genetics& Breeding	• Lowell S. Hardin Award for Excellence in International Agriculture (2020) • **Certificate of Excellence in Research and Research Leadership, Ethiopian Institute of Agricultural Research (EIAR) (2016)**
Bruce Erickson	Distance Education & Outreach	• Outstanding Paper, Natural Sciences Education Journal (2020 American Society of Agronomy) • Awards for Excellence in Distance Learning at Purdue University (2015. 2017, 2018) • **Educator/Researcher of the Year, Award of Excellence, Precision Ag Institute (2018)** • Awarded Excellence in Distance Learning (2017, 2018 Purdue University)
Corey Gerber	Purdue Diagnostic Training & Research Center	• Outstanding Teacher Award for Clinical Faculty and Continuing Lecturers Agronomy Department (2020) • Team Award PUCESA (2018) • **ASA Educational Materials Awards Program American Society of Agronomy (2017)**

		• Indiana Forage Council Maurice E. Heath Award Indiana Forage Council (2017)
Richard Grant	Agriculture & Applied Meteorology	• Member, American Meteorological Society (AMS) (2020) • Bravo Award (2018)
Javier Gonzalez	**USDA** – Soil Health & Water Quality	• Electronic Communications Committee – Clay Minerals Society • Associate Editor – Soil Science Society of America Journal • Associate Editor – Agronomy Journal
Beth Hall	Climate, Weather, & Earth Science	• Director - Indiana State Climate Office (2019-present)
Chi-Hua Huang	**USDA –** Soil Erosion & Water Quality	• Acting Associate Area Director, USDA-ARS Midwest Area at Peoria, IL (2019) • U.S. coordinator for the Sino-US Joint Centers for Soil Erosion Environmental Protection between USDA and Chinese Ministry of Science and Technology (present)
Yiwei Jiang	Turfgrass & Perennial Plant Physiology	• Associate editor, Grass Research (2021) • Associate editor, Crop Science (2019) • **Tengtou Agricultural Science Award. American Society of Agronomy (2018)** • Guest Professor Mongolia Agricultural University of China (2015)
Keith Johnson	Forage Management	• Outstanding Affiliate Forage Council American Forage and Grassland Council (2021) • **Career Award, Purdue University Cooperative Extension Specialists (2018)** • Maurice E. Heath Award, Indiana Forage Council (2018) • Purdue University Cooperative Extension Service Leadership Award (2017) • National Association County Agricultural Agents Search for Excellence in Livestock Production Award – Indiana Master Cattleman Program National Association County Agricultural Agents (2016) Distinguished Grasslander American Forage and Grassland Council (2016)
Cliff Johnston	Soil Inorganic Chemistry & Mineralogy	• **Brindley Lecturer, The Clay Minerals Society (2018)** • The Seed for Success Award (2018 Purdue University) • Organizing Committee for the Oil Sands Clay Meetings, Edmonton, Alberta (2017) • Named the Andrew Main Lecturer. The University of Alberta, Canada (2015)
Eileen Kladivko	Soil Physics & Soil Health	• **Fellow, American Society of Agronomy (2019)** • **No-Till Innovator Award (2018)**

		• 2018 Experiment Station Section National Excellence in Multistate Research Award (team award) USDA- Multistate Research (2018) • Team Award Purdue University Cooperative Extension Specialists Association (PUCESA) (2018) • Best Research Paper for Impact and Quality Honorable Mention Soil and Water Conservation Society (2018) • S.H. Phillips Distinguished Lecture in No-Till Agriculture University of Kentucky (2017)
Linda Lee	Soils & Environmental Water Chemistry	• Purdue Center for the Environment Executive Board (2021) • Purdue Seed for Success (2017, 2018, 2019, 2020 Purdue University) • College of Agriculture's First Unsung Diversity Hero 2016 College of Agriculture)
Jianxin Ma	Comparative Plant Genomics & Soybean Genetics	• Seeds for Success Award, Purdue University (2020) • **Elected Fellow, American Association for the Advancement of Science (2018)** • **Purdue Agriculture Research Award (2017)** • Co-organizer, Taishan Scientific Forum (2016)
Mohsen Mohammadi	Small Grains Breeding & Genetics	• Chair, U.S. eastern region, National Wheat Improvement Committee (2021) • Review Committee, US Wheat and Barley Scab Initiative (2020)
Cindy Nakatsu	Molecular Microbial Ecology	• Chinese Academy of Sciences President's International Fellowship (2015)
Robert Nielsen	Corn Production	• Honorary Master Farmer - Indiana Prairie Farmer Magazine and Purdue College of Agriculture (2020) • NACAA Service to American/World Agriculture Award Nat'l Assoc. County Ag. Agents (2019) • PUCESA Team Award Purdue University Cooperative Extension Specialist Assoc. (2018) • Distinguished Service Award - Indiana Crop Improvement Assoc. (2018) • Extension & Education Community Award for Digital Decision Aids American Soc. Agronomy (2017) • **Frederick L. Hovde Award of Excellence in Educational Service to the Rural People of Indiana (2016 Indiana Farm Bureau)** • Beck's Beyond the Fence Ag Education Outreach Award Beck's Hybrids, Indiana Corn Marketing Council, Indiana Soybean Association (2015)

Chad Penn	**USDA** – Soil, Water & Agriculture Chemistry	• P.E. Harrill Professorship in Crop Science (Oklahoma State University 2016)
Katy Martin Rainey	Soybean Breeding & Genetics	• Millionaire's Club Award (2017 College of Agriculture Purdue University) • Seed for Success Award (2017 Purdue University) • **Director of the Purdue Soybean Research Center** • Founder of Progeny Drone
Torbert Rocheford	Maize Genetics & Genomics	• Professor and Patterson Endowed Chair in Translational Genomics for Crop Improvement, Purdue University • **Cofounder and Chief Technology Officer, NutraMaize LLC**
Darrell Schulze	Soil Mineralogy	• Fellow, Indiana Academy of Science (2021) • **Fellow Soil Science Society of America (2020)** • Seed for Success Award (2018) • National Cooperative Soil Survey Cooperative Achievement Award. (2017)
Lee Schweitzer	Plant Physiology	• Honorary – Purdue University Mortar Board (2020) • Outstanding Servant Leadership Award (2020 Purdue Agriculture Student Council/Student Choice Award) • Faculty Honor - Academic Achievement Banquet Farmhouse Fraternity (2018) • Spotlight Educator - Student Choice Award (2017 Purdue Agricultural Student Council)
Gary Steinhardt	Waste Disposal & Soil Classification	• Office of Engagement Jefferson Award (2019 Purdue University) • Indiana Military Veterans Hall of Fame (2019) • George T. Kilovos Alumni Award Theta Chi Fraternity (2018)
Mitch Tuinstra	Maize Genetics & Plant Breeding	• **Scientific Director, Institute for Plant Sciences, College of Agriculture, Purdue University (present)** • Agronomy Outstanding Teacher Department of Agronomy (2020 Purdue University) • Heat Tolerant Maize for Asia. Annual Review and Planning Meeting & Project Steering Committee Meeting. • Seed for Success Award (2019, 2016 Purdue University) • David C. Pfendler Outstanding Undergraduate Counselor Award Department of Agronomy (2017, 2018) • **Fellow American Society of Agronomy (2017)** • **Fellow Crop Science Society of America (2017)** • Heat Tolerant Maize for Asia External Advisory Panel (2016) • Spotlight Educator Agricultural Council Student Choice Award (2016)

Ron Turco	Soil Microbiology & Biochemistry, Department Head	• Department Head (2017-present) • **President-Elect Soil Science Society of America** • Board of Directors, Soil Science Society of America, Program Planning Officer • Administrative Advisor to NCRE-59 (Soil Organic Matter) (2011-present) • Director of Purdue Water Community (2011-2016) • Director, Indiana Water Resources Research Center (2008-2016) • External Science Advisory Committee, UCLA Center for the Environmental Implications of Nanotechnology (2015)
Jeffrey Volenec	Crop Physiology & Ecology	• **Board of Directors, Council for Agriculture Science and Technology, Plant Sci. Board Rep. (2018, 2021)** • **President-elect, President, Past-president of the American Society of Agronomy (2019, 2021)** • Trustee, Agronomic Science Foundation, Chair of the Board of Trustees (2018, 2016) • Board of Directors, American Society of Agronomy (2018) • Board of Directors, Crop Science Society (2018) • Board of Directors, Soil Science Society of America (2018)
Tony Vyn	Cropping Systems	• **Corteva Agriscience Henry A. Wallace Chair in Crop Science (2018 and present)** • PUCESA Team Award (2018 Purdue Cooperative Extension Association) • Associate Editor Field Crops Research (2018)
Diane Wang	Genotype x Environment Modeling	• Associate Editor, Crop Science (present)
Cankui Zhang	Crop Physiology	• American Society of Plant Biologists • Crop Science Society of America

Benchmarking

Purdue University has invested in Academic Analytics (AA) data analysis software and services to benchmark and rank individual units. Working with the Agriculture Research Programs and Graduate Education (ARPGE) office, we used the service in the Spring of 2021 to compare Agronomy to a set of peer institutions. The peers were selected using a combination of subject area expertise and opinions of the faculty in Agronomy and default units identified by AA with overlap to our programs. In total, 25 peer institutions were compared to Purdue Agronomy. However, only four of the peers described themselves as “Agronomy,” with others using terms like Crops, Soils, and Environmental Sciences. The primary difference seems to be where the soils group is located. For example, the University of Florida hosts Agronomy and Soil and Water Science departments, the University of Wisconsin and the University of

Arkansas have Agronomy and Soil Science departments. In contrast, Iowa State, Kansas State, and the University of Nebraska combine Agronomy and Soil Science in one unit. There are also variations in where plant breeding and genetics are housed; for example, at Cornell, Crops and Soil Science is combined, while Plant Breeding is a separate department. We also must note substantial variations in faculty sizes with our peer institutions reflecting the depth of activity in given areas.

Below are the overall rankings, SRI score, and percentile data for the Department of Agronomy (Tables 7.1 to 7.4). We did not attempt to break down our departmental areas or make more direct comparisons, to choose to maintain a faculty unit under Agronomy. Overall, Purdue Agronomy has a Scholarly Research Index (SRI) score of -0.1 and a rank of 15 out of 24 with a percentile of 46.15 (Table 7.1).

The algorithm that Academic Analytics uses is proprietary, but a rough guide to how these figures are calculated and how the metrics are determined and weighted can be found at the end of this section. When we looked at the AA data, we became aware of several issues. Specific caveats to the data and analysis include:

1) The AA approach is based on a per-person assessment that counts total journal articles, citations, books, grants, grant dollars, awards, and conference proceedings. The Agronomy faculty has a diverse set of emphases, including Research, Teaching, and Extension. The emphasis on research outputs undervalues faculty with heavy appointments in teaching and Extension.
2) Grant awards and dollars include federal funding only and miss out on commodities boards, foundations, state support, industry support, and gifts, which are a significant portion of our sources. We have numerous faculty who tend to be supported by multiple smaller grants from a mixture of sources.
3) We are a department that is distributed toward either late-career or early-career faculty.
4) It was unclear how the data aggregation was done and over what exact periods it was taken.
5) While research outputs (paper and grants) are counted, the impact is not assessed all that well with the AA approach.
6) As stated earlier, the construct of the departments used in the analysis was not an exact match, as critical areas of work may have had minor or more prominent roles than at Purdue. Our internal analysis shows that research areas emphasizing plant breeding faired far better in grant support, student numbers, and output as used in the AA methods.

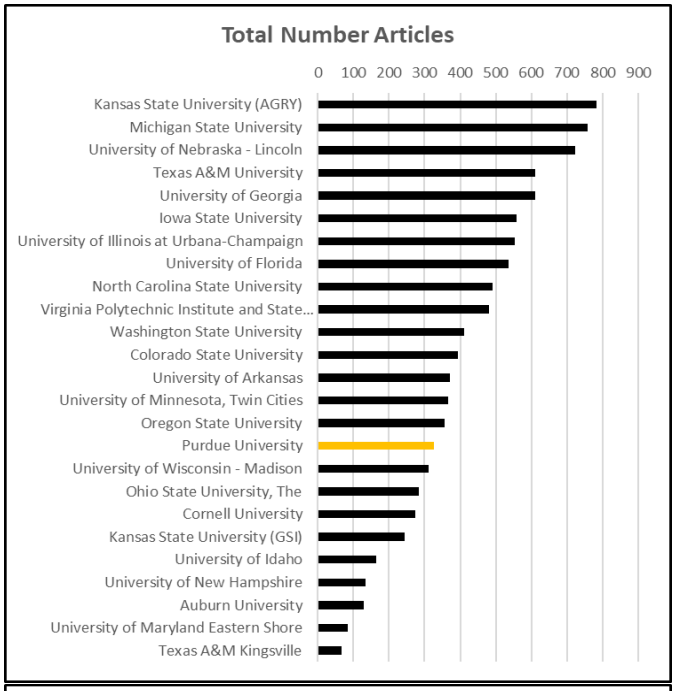
Table 7.1 Purdue Agronomy compared to ALL Peer Departments.

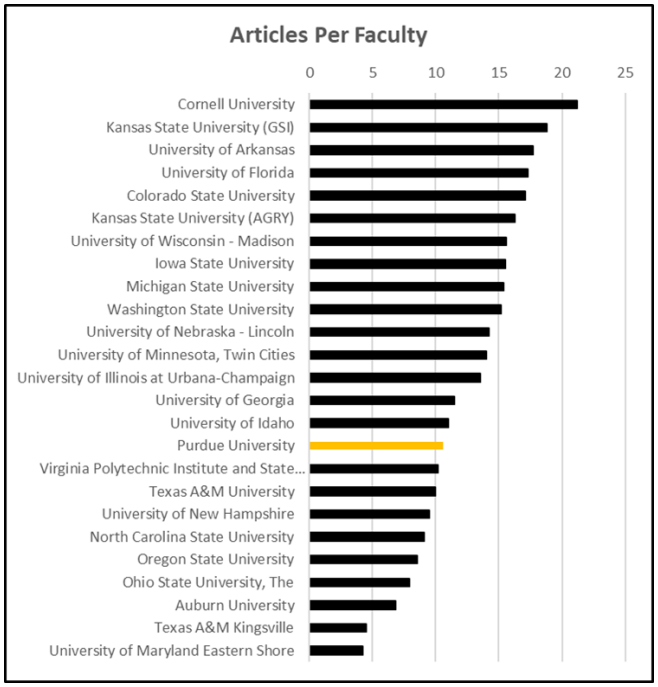
Institution	Unit	SRI	Percentile	Rank
Cornell University	Soil and Crop Sciences	0.8	100	1
Colorado State University	Soil and Crop Sciences	0.6	96.15	2
Iowa State University	Agronomy	0.5	92.31	3
University of Minnesota, Twin Cities	Agronomy and Plant Genetics	0.4	88.46	4
Kansas State University (GSI)	Grain Science and Industry	0.4	88.46	4
Washington State University	Crop and Soil Science	0.3	80.77	6
University of Florida	Agronomy	0.3	80.77	6
University of Wisconsin - Madison	Agronomy	0.3	80.77	6
University of Arkansas	Crop, Soil & Environmental Sciences	0.3	80.77	6
Michigan State University	Plant, Soil, &Microbial Sciences	0.2	65.38	10
Univ. of Illinois at Urbana-Champaign	Crop Sciences	0.2	65.38	10
University of Nebraska - Lincoln	Agronomy and Horticulture	0.2	65.38	10
Kansas State University (AGRY)	Agronomy	0.1	53.85	13
Virginia Polytechnic Institute	Plant & Environmental Sciences	0	50	14
Texas A&M University	Soil and Crop Sciences	-0.1	46.15	15
University of Georgia	Crop and Soil Science	-0.1	46.15	15
Purdue University	Agronomy	-0.1	46.15	15
University of Idaho	Soil and Water Systems	-0.1	46.15	15
University of New Hampshire	Agriculture, Nutrition, & Food Systems	-0.2	30.77	19
Ohio State University, The	Horticulture and Crop Science	-0.4	26.92	20
North Carolina State University	Crop and Soil Science	-0.5	23.08	21
Oregon State University	Crop and Soil Science	-0.5	23.08	21
Auburn University	Crop, Soil, & Environmental Sciences	-0.8	15.38	23
University of Maryland Eastern Shore	Agriculture, Food & Resource Sciences	-0.9	11.54	24
Texas A&M Kingsville	Agriculture, Agribusiness, & Environmental Science	-0.9	11.54	24

Rankings Based on Publication and Funding Metrics

In the following tables, the individual metrics used by AA to create their ranking are displayed. We were compared to 24 other departments. In the displayed tables, the total value is compared to the normalized (per faculty) value.

Table 7.2 Publications – Articles.





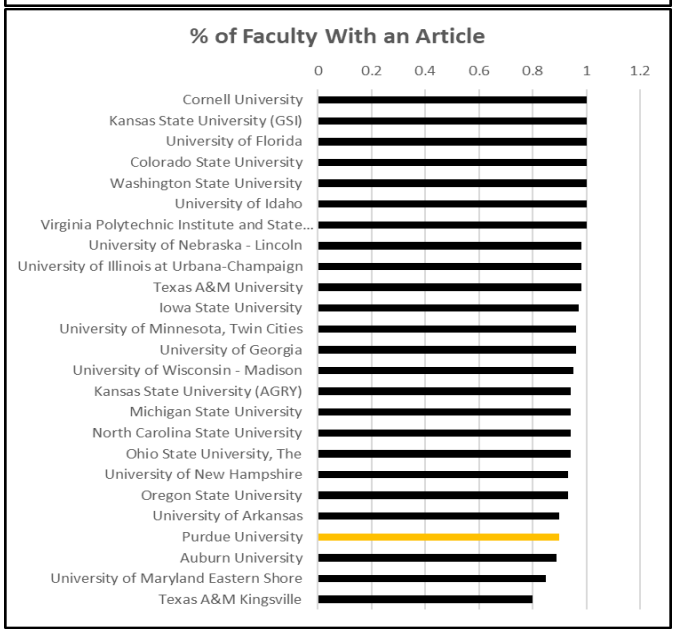
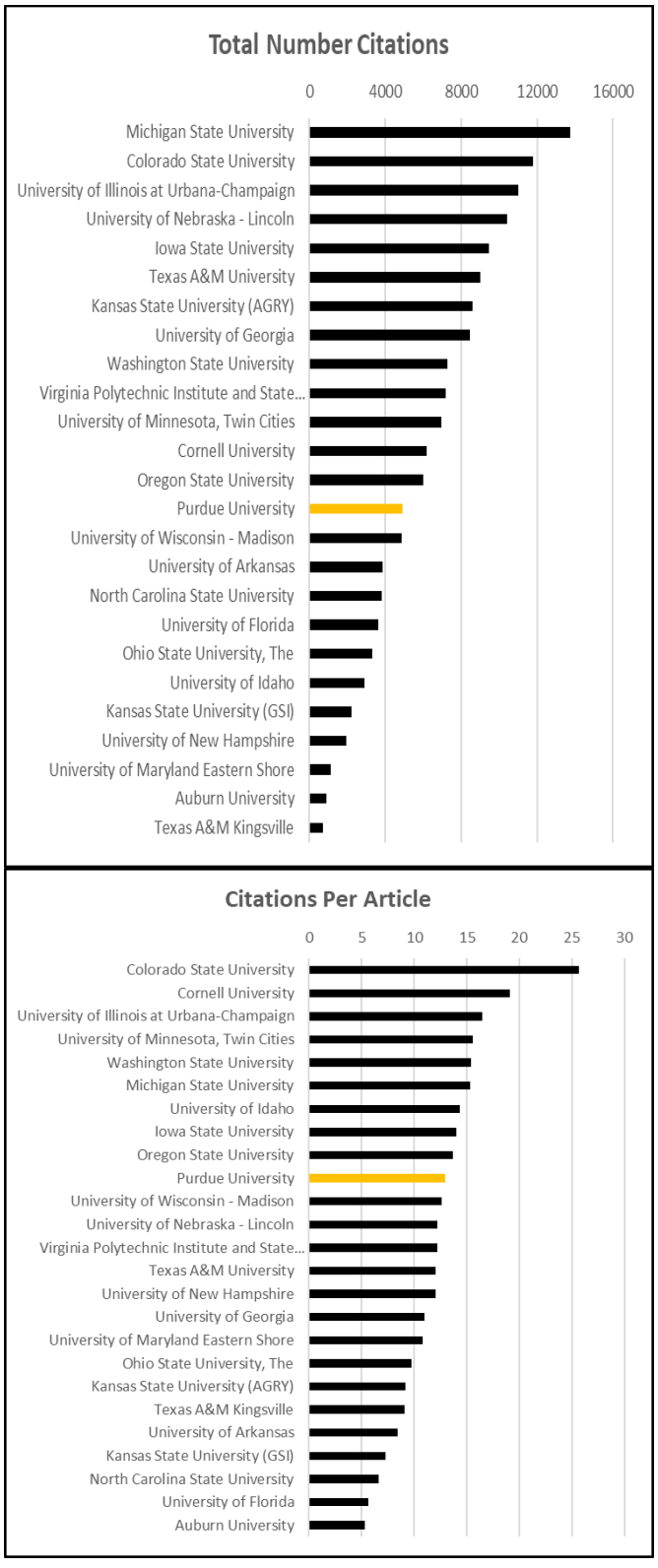


Table 7.3 Citation data.



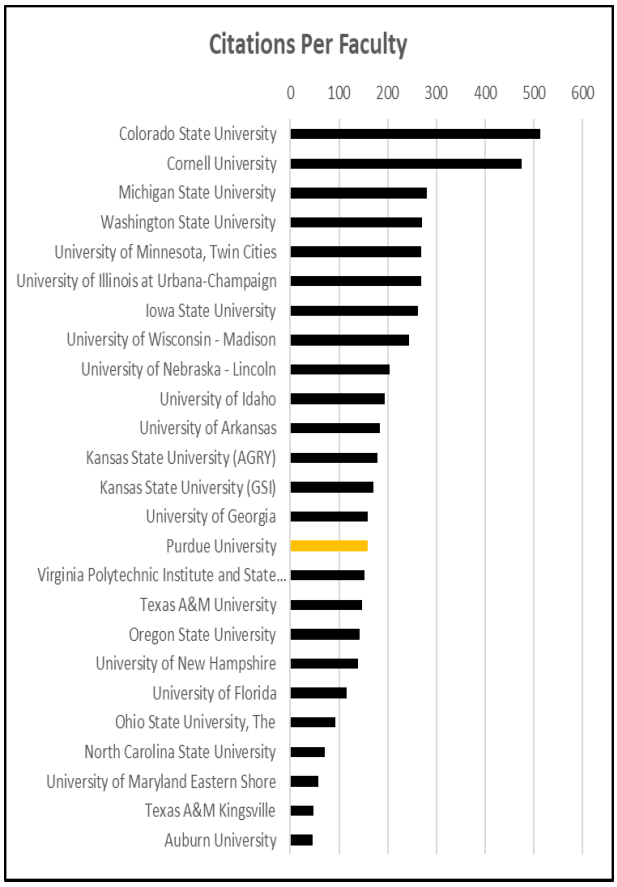
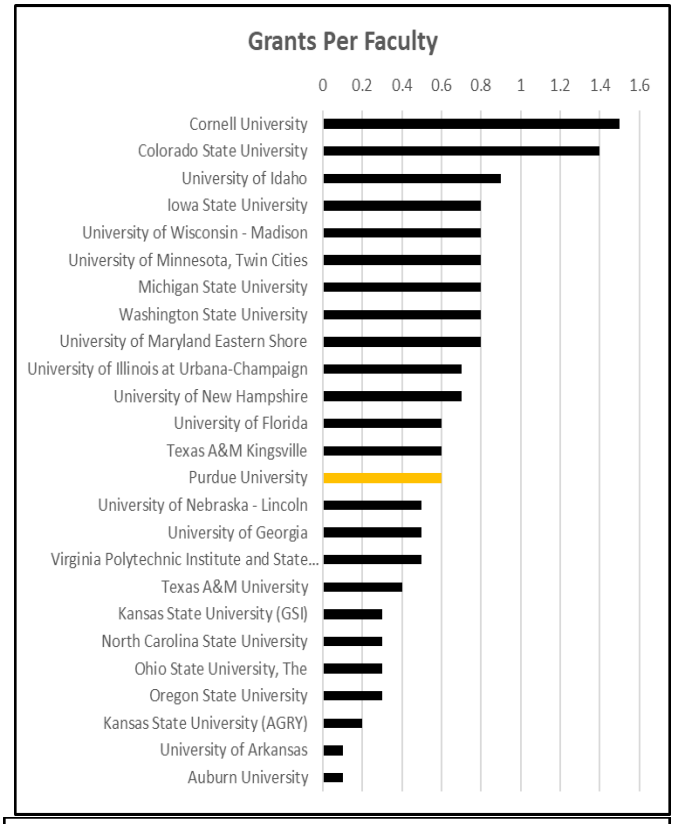
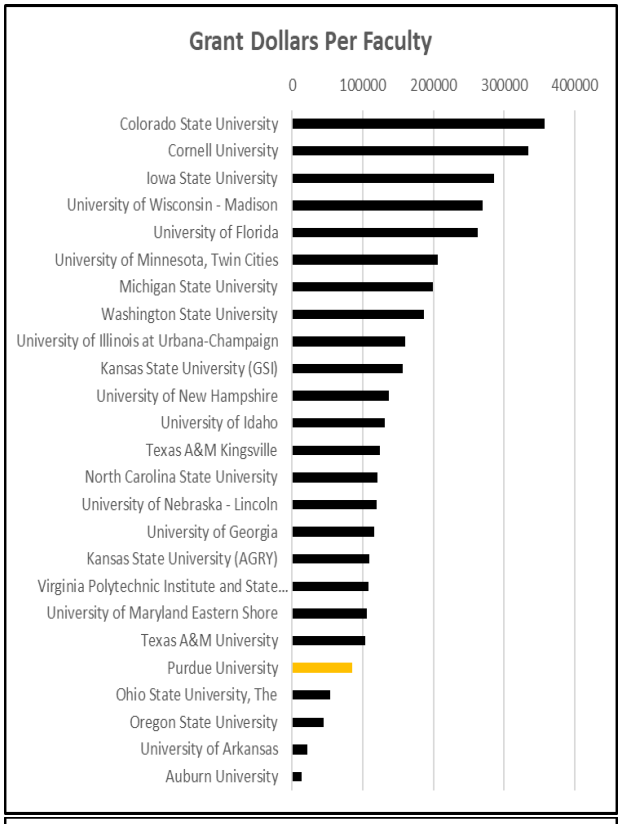
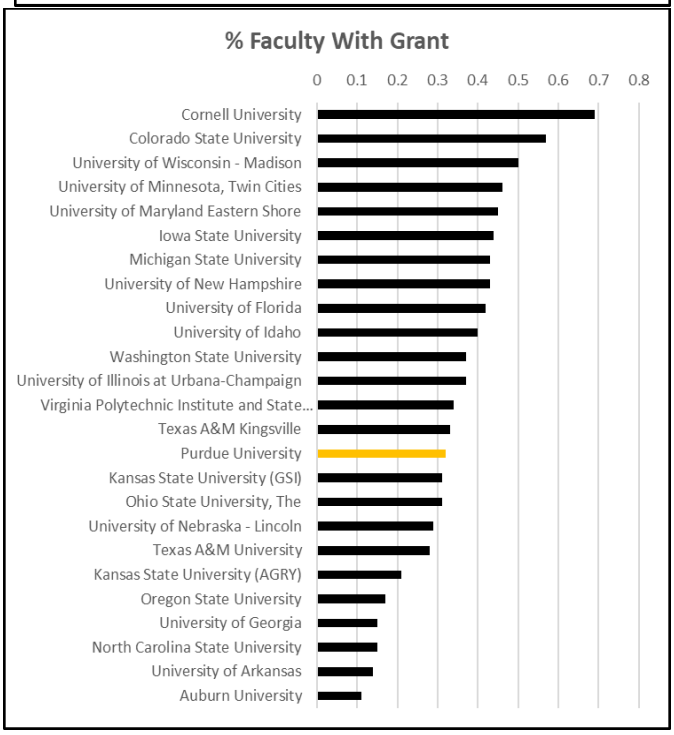
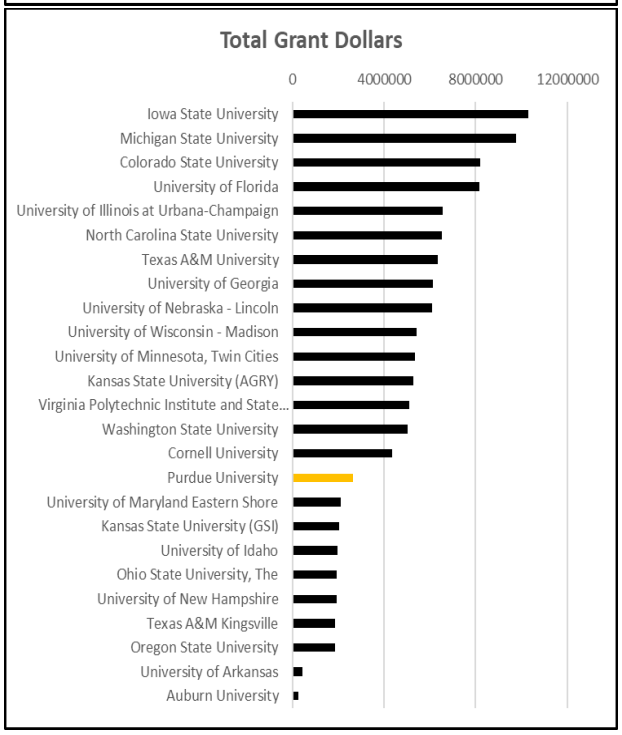


Table 7.4 Grants data.









Academic Analytics - Scholarly Research Index (Peer Analysis/Benchmarking)

Academic Analytics calculates the unit level Scholarly Research Index (SRI) based on the mean SRI scores of individual faculty members within the unit. Thus, the SRI of each unit or other level of aggregation – program, department, broad field, institutions, etc.- is the average of the deduplicated faculty who comprise that unit.

Metrics for Faculty-Based Scholarly Research Index (Default Metrics)

Metrics for the person-based Scholarly Research Index are:

Total Journal Articles
Total Citations
Total Books
Total Grants
Total Grant Dollars
Total Awards
Total Conference Proceedings

Academic Analytics utilizes a weighting scheme for these metrics, which varies across taxonomic classifications.

Scholarly Research Index (SRI) Methodology Description

The Scholarly Research Index (SRI) is a patented methodology to provide comparative context for faculty or unit research activity compared to taxonomy peers. This comparison is based on the metrics Academic Analytics collects and maintains for the peer analysis/benchmarking tools.

Person level SRI is a composite score, based on the metrics weighed in the faculty member's unit taxonomic classification. The composite score is displayed on a Z-Score scale, but it is NOT a composite Z-Score. SRI is derived in this manner because the practice of using Z-Scores to identify possible outliers can be misleading, particularly as it relates to variable or small sample sizes. This methodology ensures the SRI is scaled based on the number of faculty in the taxonomy.

Within each taxonomy, Academic Analytics calculates each faculty member's rank on each of the metrics and multiplies each of those metric ranks based on the respective metric weights. Academic Analytics sums the weighted ranks for each person and calculates the Z-Score of the summed weighted ranks for each faculty member within the taxonomy. That Z-Score is displayed as the SRI score in the peer analysis/benchmarking tools.

Scholarly Research Index (SRI) Calculation Steps

1. Rank the total metric counts for each faculty member in the taxonomy
2. Calculate the number of faculty in the taxonomy
3. Calculate each faculty member's rank within the taxonomy, for each metric
4. Multiply each metric rank by the metric weight
5. Sum the weighted ranks for each faculty member
6. (Total Weighted Rank - Discipline Total Weighted Rank Mean)/Discipline Total Weighted Rank Standard Deviation = Scholarly Research Index (SRI)

8. Diversity, Equity, and Inclusion (DEI)

Data in Table 8.1 indicates our five-year trends for both underrepresented minority (URM) and female populations. The data demonstrate small increases in the URM numbers (except grads) but remains below the State of Indiana population level of ~16% URM. Stepping back, the percentage of URM in the USA is closer to 30%, and the Department is far off from these levels. As a result, the Department is not reflecting the demographics of Indiana or the USA.

Table 8.1 Year-to-year trends in URM and female members of Agronomy.

	2016	2017	2018	2019	2020
Faculty					
%URM	5.6	5.9	6.0	6.5	11.1
%Female	19.4	20.6	21.2	19.35	26.7
Staff					
%URM	2.3	2.6	1.5	1.6	3.8
%Female	45.3	44.1	42.4	44.4	49.1
Undergraduate					
%URM	1.3	4.5	2.9	5.2	6.8
%Female	40.4	44.6	42.7	48.3	42.6
Graduate					
%URM	10.9	11.7	10	8.1	5.1
%Female	38.2	43.3	45	41.9	40.7

Student Efforts towards Diversity, Equity and Inclusion

All undergraduate students in the College of Agriculture are required to take three credit hours of course material aimed at broadening their awareness of the United States domestic, multicultural environment. Students can select from a short list of courses that have been evaluated by the Diversity Action Team in Agriculture (DATA) to meet a list of eight learning outcomes (https://ag.purdue.edu/oap/Pages/core_multicultural.aspx). The University Core Curriculum is currently considering proposals to incorporate a DEI requirement into the core curriculum for all Purdue students, which may necessitate a change in the college's multicultural requirement.

The Agronomy Graduate Student Organization (AGSO) is committed to fostering an environment of equity and inclusion in agriculture by uplifting the voices of our student members. In October 2020, the AGSO collaborated with the College of Agriculture's Office of Multicultural Programs to develop a Discussions in AgriCULTURE Series beginning with "AgRACEiculture, The Race is Silent" presentation with the goal of learning and discussing how the fields of agriculture and agronomy have been shaped by racism, as well as strategies for developing racially just practices in these areas. The AGSO is committed to bringing seminars and panel speakers from diverse backgrounds (race, gender, orientation, first-generation, US citizen/international, academic/industry/government, etc.), providing opportunities for students to gain insights from different perspectives.

Faculty Efforts towards Diversity, Equity and Inclusion

The Department members have participated in several programs and projects to increase diversity. Michael Mashtare is a founding member of the ASA-SSSA-CSSA LGBTQ community (started in 2017). Shalamar Armstrong has worked through the ACS528 Minorities in Agronomy committee within ASA-SSSA-CSSA. He also participated in the Gateway Scholars program, inviting 47 students and 1 teacher from local high schools to attend the annual conference and be exposed to Agronomy. Armstrong has also hosted URM students during multiple recruitment programs facilitated by the College of Agriculture Office of Multicultural Programs and the Environmental Sciences and Engineering Interdisciplinary Graduate Program. He also served as a host and mentor for 15 URM high school students for one week with the Purdue Agribusiness Science Academy. He exposed students to basic soil science principles, career avenues in soil science, and a rainfall simulation experiment in the National Soil Erosion Research Laboratory. As a departmental function, Richard Grant initiated discussions for diversity and inclusion training of graduate students and attended a meeting with Florida A&M University faculty and administration on graduate program admissions. Department Head Ron Turco also made a recruitment visit to the Department of Natural Resources and Environmental Design at North Carolina A&T State University in Greensboro, working with Drs. Beatrice Dingha, Arnab Bhowmik, and Louis Jackai. Work with NC A&T led to a publication due to shared interest in hemp: Dingha B., L. Sandler, A. Bhowmik, C. Akotsen-Mensah, L. Jackai, K. Gibson, R. Turco. 2019. Industrial hemp knowledge and interest among North Carolina organic farmers in the United States 11:2691 *Sustainability.*

In 2019, Armstrong was awarded the Faculty Unsung Diversity Hero Award by the Purdue Agriculture Diversity Action Team. This award recognizes contributions that are “below the radar” but are long-term and measurably impactful. In 2020, Dr. Linda Lee also won the Faculty Unsung Diversity Hero Award for her work as a mentor, graduate student recruiter, and promotor of diversity across all aspects of her mission as a faculty member and director of the Environmental Sciences and Engineering (ESE) interdisciplinary graduate program.

Moving forward, the Department has been actively creating new opportunities. A new program funded by NSF called Plant Science for Global Food Security (PSGFS), led by D. Wang, aims to expose diverse undergraduates to new experiences in international research. The three-year program (2022-2024) will recruit 24 students (8 per year) selected from Purdue and five partner institutions, including three HBCUs (Historically Black Colleges and Universities) and one AANAPISI (Asian American and Native American Pacific Island-Serving Institution) to conduct research over six weeks at the International Rice Research Institute (IRRI) in the Philippines. While more research is needed on the direct impacts of study abroad experiences on minority students, there is growing evidence that these experiences can improve graduation rate and general learning outcomes. As IRRI is home to hundreds of long-term and short-term researchers from around the world, PSGFS participants will have exciting opportunities to interact with scholars of diverse cultural and academic backgrounds.

We are in the early stages of the **Purdue Agronomy Accelerated Underrepresented Minority Post-Doctoral Program,** developed by Dr. Armstrong. The program’s goal is to bring together underrepresented minority agricultural scientists ready to fill assistant professor positions in Agronomy or the College of

Agriculture, or with our funding partners around the state. Through partial extramural funding from Drs. Shalamar Armstrong and Davide Cammarano, the first cohort of the Accelerated Program brought together two postdoctoral scholars. The first scholar, who is Latino, brings expertise in soil fertility, agronomy, and conservation from the Department of Crop Science at the University of Illinois. The other scholar, who is African American, has expertise in soil biogeochemistry, statistics, and mathematics from the School of Natural Resources and Soil Science at the University of Missouri. The postdocs were selected to excel in scholarship, teaching, and extension within the land grant mission. They were also selected due to their value to the Agronomy Department and the College as potential faculty members, or as contributors to the agriculture industry in Indiana.

Upon their arrival to campus, the scholars were welcomed to the department through introductions to the faculty and their research programs and the Agronomy department head. The orientation also included an introduction to CoA deans and the provost's office, as well as tours of Purdue's campus, farm facilities, and statewide partners. After the orientation, each scholar selected a mentoring committee of two faculty members and Dr. Armstrong. The mentoring committee will provide the scholars intensive guidance and community to help them excel. Furthermore, the program includes performance targets, set by the mentoring committee, based upon promotion expectations typical of an assistant professor. As a part of the mentoring program, the scholars will complete the Diversity Bootcamp of the National Center of Faculty Development and Diversity. The Bootcamp advances the proposal writing and scientific publications of young scholars. Scholars who meet performance targets may qualify for a hiring opportunity within the College. Initial funding was a combination of Provost and grant support at a total of ~$200K.

Goals:

We aim at building a more diverse, equitable, and inclusive workplace that fosters belonging, innovation, and growth. Our ongoing efforts include:

- Providing training and learning opportunities to build cross-cultural competency, strengthen allyship, and cultivate inclusive behaviors and practices. Training will be codified in 2022, when the entire department will take part in an Intercultural Development Inventory (IDI), an education program sponsored by the College of Agriculture.
- Attempt to diversify our "talent pipeline" further by building relationships with local and national organizations and creating internal sources of skilled individuals.
- Revisit how we run our hiring process; ensure an inclusive hiring process.
- Ensure accessible and disability-friendly office space and a more flexible work culture.

9. Departmental Fiscal Resources

The Department of Agronomy receives an annual budget allocation from the College of Agriculture, using a historical or traditional budget model based upon previous expenditures. (Purdue does not use a Responsibility Center Management model.) Substantial changes in our overall departmental budget are not observed over the last five years, other than having fringe benefits and grad fee remits transferred into our accounts rather than being held at the college level. Any budget increases that result in new monies to Agronomy, including faculty hires, start-up packages, or retention offers, arise from direct negotiations between the Department Head, the Dean, and the CoA Financial Manager. As indicated in other sections of the report, in recent years the College restored funding for a greenhouse complex manager (M. Woodard), helped us hire an extension coordinator for Industrial Hemp Programs (M. Bolt), provided partial support for a Statewide Soil Health Coordinator (J. Rorick), and was supportive of a new funding model for the Indiana State Climate Office (Beth Hall). Increases in our allocation can also be associated with mid-year, strategic merit increases and retention packages. Annual merit increases for the faculty and staff are provided centrally and have typically been about 2% per year during the past five years, with no merit increases in 2020. Due to the pandemic, we also suffered an 8.2% reduction in funding for FY21 (data not shown).

The current overall Purdue operations budget shows the West Lafayette campus with total revenue of $2,274M (https://www.purdue.edu/business/budgetfp/Operating%20Budget/FY22-Operating-Budget-presentation.pdf). The base Agronomy budget is supported by a combination of university funds, federal formula funds, and state line funds. For the five years, our total operating budget was $97.8M. The base revenue for the department from university, federal formula funds, and state line funds were $39M (Figure 9.1). The university's general fund changes from FY17 to FY18 reflect how the university handled fringe benefits, shifting them from central administration to the departments. The change also reflected increased health care costs. Over the past five years, university funds contributed 77% to our base, while federal formula funds and state line funds supported 17.5% and 5% of our operations, respectively (Figure 9.1). It should be noted that state line funding was used to support staff at ACRE. Over the five years, gifts, grants, sales and services, royalties, tuition, and fees contributed an additional $59M to our total budget. Data in Figure 9.2 shows the general trends in all our major funding categories. Over the five years, base revenues (Figure 9.1) make up 39% of our total funding, while grant dollars contribute 50%, and other sources, including sales of grain and endowments, made up the remainder of our total revenue. Our base funding is now ~$8.4M/year. Typically more than 85% of our base funding goes to salary and fringe benefits (Figure 9.3).

When grants are included, salaries, wages, and fringes make up 62% of our total spending over the five years. The department expended 27% of our funds on supplies and equipment but only 1.2% on capital equipment, mainly for items for ACRE. Overall, the department contributed 8.9M dollars to Purdue overhead (Figure 9.4). Indirect costs recovered from sponsored projects and grants expenditures are not returned directly to the department or the faculty. The College of Agriculture provides a modest F&A return to the departments through a formula that includes research and teaching activities. We hold the funds and use them as part of general operations, especially lab renovations, etc. A comparison of expenditure by the broad areas of Teaching, Extension, and Research is provided in Figure 9.5. Data does not include expenditures from grants, cooperative agreements, and gifts. Because of appointments and

the associated salaries and fringes, 53% of the expenditures are in research, followed by teaching (30%) and Extension (17%). Expenditures for supplies and expenses include costs for IT, operation of the greenhouse complex, equipment repairs and some service contracts, office supplies, printing, and everything else required to run a program. Some of these costs are fixed and non-negotiable, such as the "Common Good" university IT charge of $40–50k/y.

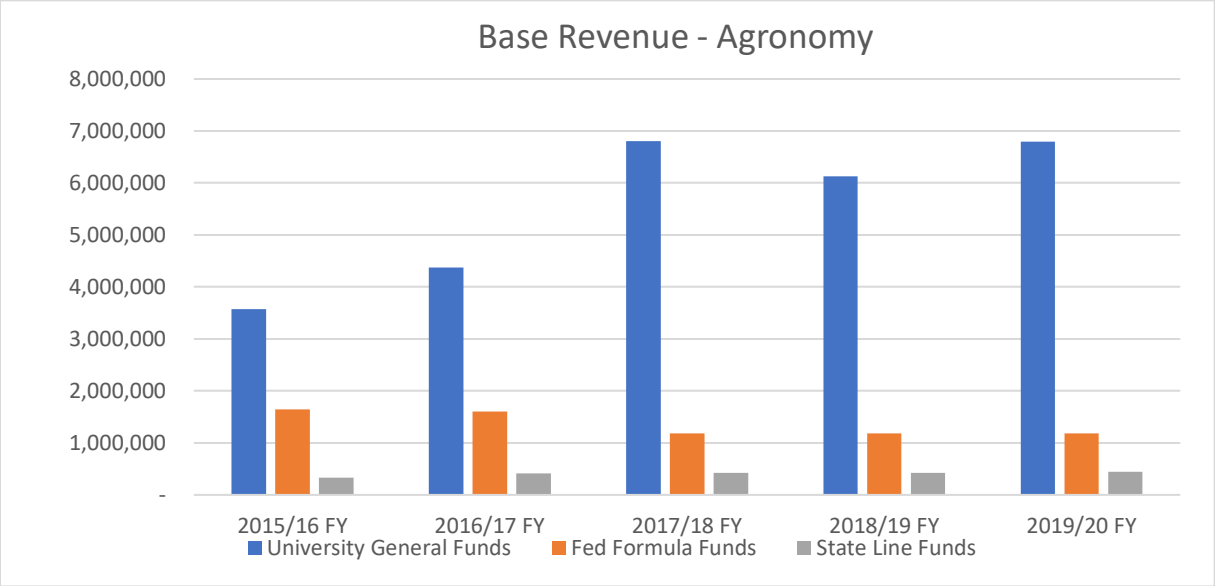


Figure 9.1 The five-year pattern of base funding for the Department of Agronomy.

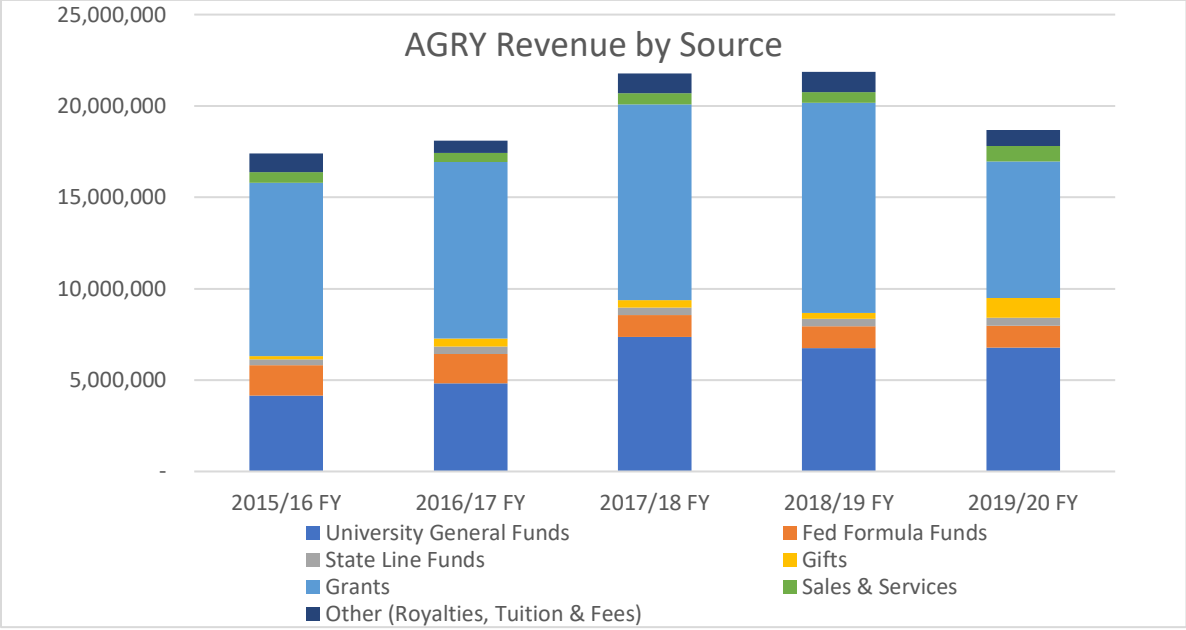


Figure 9.2. All revenue sources for the Department of Agronomy.

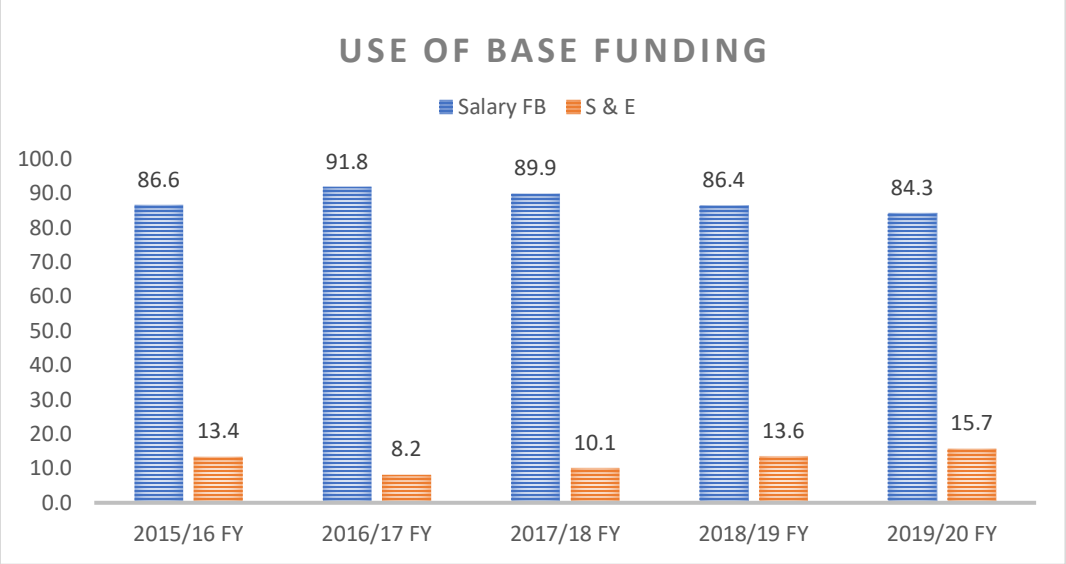


Figure 9.3 Base funding expenditures by source for the Department of Agronomy.

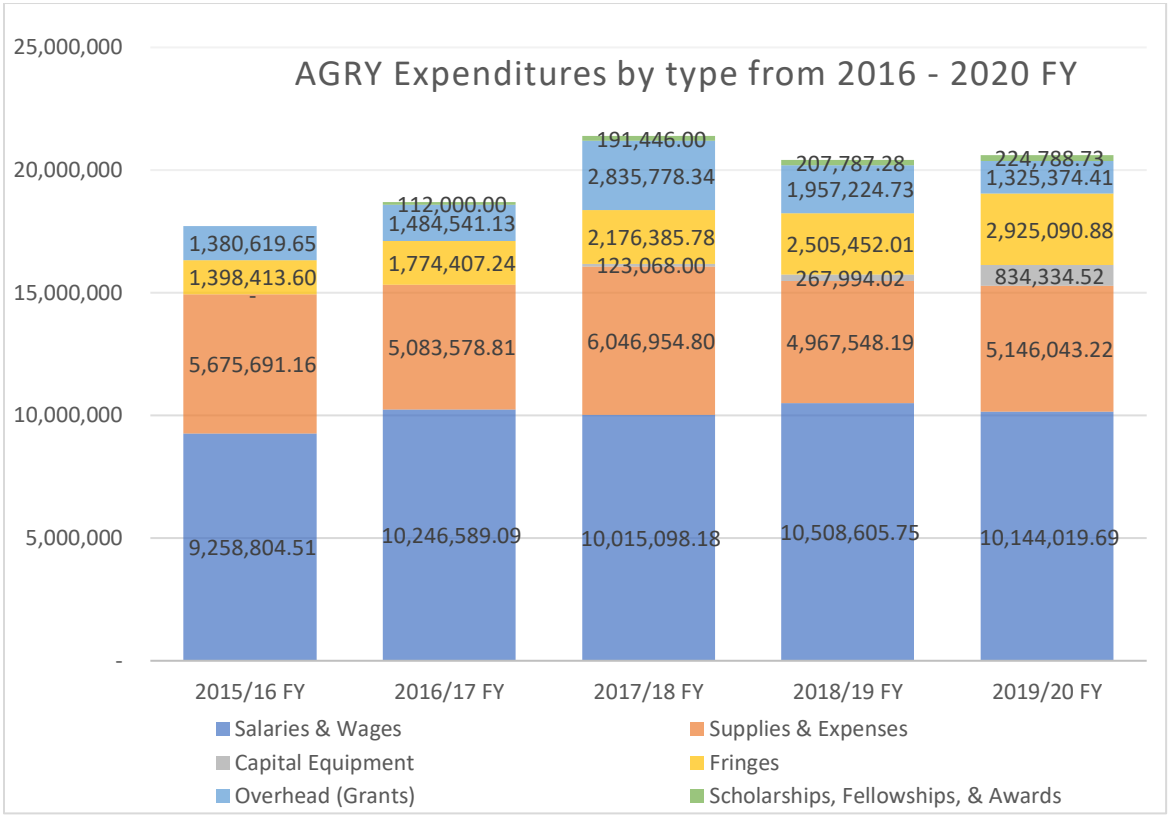


Figure 9.4 All expenditures by source for the Department of Agronomy.

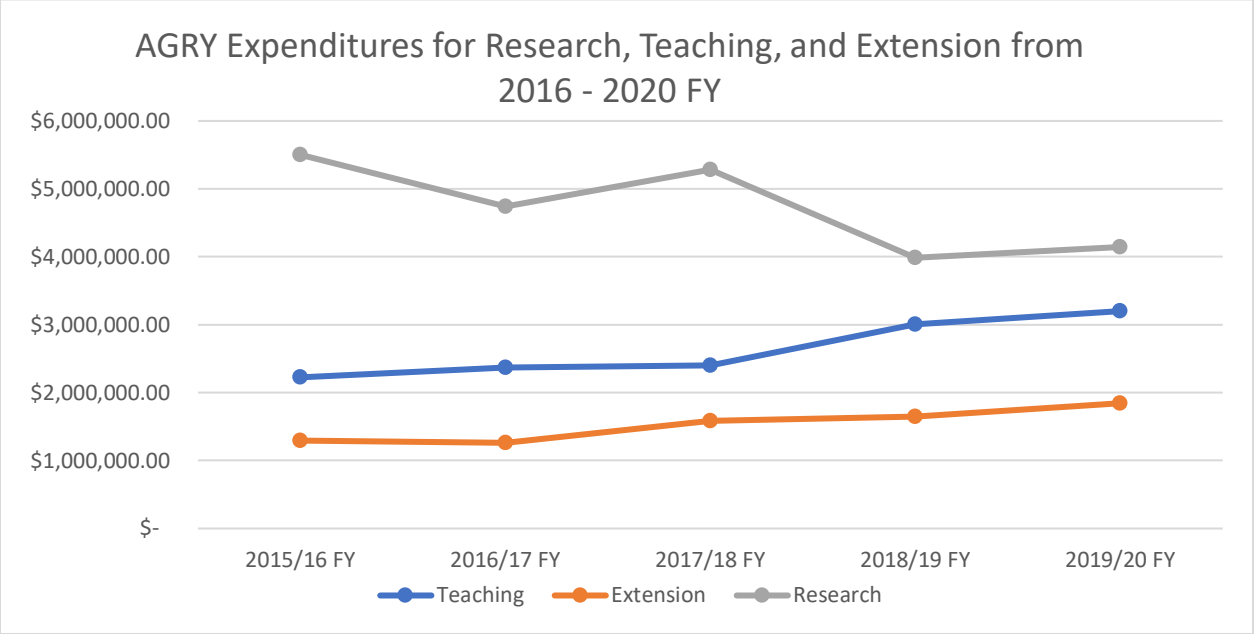


Figure 9.5. Expenditures by our three general categories. This figure does not include expenditures from grants, cooperative agreements, and gifts.

For us to expand our operations, we must increase grant activity. University general funds and federal formula funds are flat, while state line item money only supports ACRE operations. Increasing the number of faculty in the soil & land and water & air groups should increase grant activity. At ACRE, with the combination of state line money for salaries and our ability to generate some revenue from the sale of grain, we can continue to offset the cost of operations. However, this approach limits our ability to expand into different areas, as we typically only break even.

Over the past five years, we have used revenue from our ~36 internal endowments (centrally managed) to fund graduate student travel to meetings, scholarships, and one endowed chair. Over the five years, we have contributed $736,022 to scholarships and fellowships, typically providing $90,000 dollars in support to undergraduates and about $33,000 for graduate students each year. The money is divided among 46 awards for undergrads and 13 awards for graduate students. All our support is merit-based; we are not providing any need-based aid. We also have a generous travel allowance for graduate students to attend the American Society of Agronomy (ASA) meetings. We support one trip to ASA during a student's M.S. program and one trip during a student's Ph.D. program. In addition, each year we support about 5 students to work our graduate student recruitment table at the meeting, so a student can get support to attend an extra meeting. Proceeds from two turfgrass funds have been transferred to Horticulture. An endowment also supports the Patterson Chair (~$100,000/year). However, because our internal endowments are small and primarily directed at student support, few dollars outside the Patterson Chair directly support faculty activities.

10. Agronomy Spaces Lilly Hall, Plant, and Soils, Whistler and Greenhouse

Lilly Hall (LILY, 395,250 sq. ft.) houses faculty, staff, and students from three Colleges and six departments of Purdue University. Construction of Lilly Hall began in 1951 and continued in phases until 1957. Besides Agronomy, LILY houses the Botany and Plant Pathology Department (first and ground floors), Agricultural Sciences Education and Communication Department (third floor), Biological Sciences in the College of Science (parts of first and basement and ground floors), as well as the College of Health and Human Sciences (basement). The floor plans for Lilly Hall are found in Appendix D (Floor Plans and Condition Assessments).

Lilly Hall (Figure 10.1) holds most of the Department of Agronomy's offices and laboratories (Table 10.1). In addition, a 71,283 sq. ft. greenhouse is associated with Lilly Hall, where AGRY typically uses about 21,000 sq. ft. Most Agronomy Department functions are located on the 2nd and 3rd floors of the West wing of Lilly Hall, but we have laboratory and office space in the basement (B480, B368 & B350, B365 Lee) and on the ground floor (G122, G123 & G124, Turco). The Lee lab space in the basement is the most recently renovated Agronomy research space in Lilly Hall and was part of the general renovation of the basement that occurred six years ago (Figure 10.2). Most of the Agronomy teaching and research spaces are found on the 2nd and 3rd floors of the West wing, which was partially renovated 23 years ago. Since then, we have undertaken several renovations, typically when a new faculty member is hired, but we have not made any wholesale changes since the 1990s, nor are any currently planned. An example of a teaching renovation is the creation in 2016 of the Beck's Genetics Laboratory (2-417) and the Beck Crops Resource Center (2-407, Figure 10.3), which are utilized for genetics and crop teaching. Both renovations were funded by outside support. A similar renovation is critically needed in the soils laboratory (3-427) and the soils teaching space (3-419). Most of our soil classes use 3-419, especially Soil Sciences AGRY 255.

Figure 10.1 The main entrance to Lilly Hall.


Figure 10.2 Dr. Lee's lab is the most recently renovated


Figure 10.3 Beck's Genetics Teaching Lab.

Last year, we acquired space (Lilly 3-400, 3,800 sq. ft.) in the former Lilly Hall Library, which was converted into our primary graduate student office space (Figure 10.4). The move freed up space for faculty, staff, and other uses and created a better student environment. We can now host ~45 people in the current 3-400 configuration, including study tables. We maintain a second graduate student office space (25 desks) on the 2nd floor (2-448) and a smaller room in the basement (B-365). All our students and postdocs are now housed in one of these three spaces.

Figure 10.4 Graduate student space.

Table 10.1. Agronomy space distribution by building location

Location	Teaching	Research	Office	Shared	ΣAgronomy
			--- sq. ft. ---		
Plant and Soils		7,166	1,828	5,457	14,451
Greenhouse		19,857		3,250	23,108
Lilly Hall	4,852	24,211	17,229*	2,346	48,636
Whistler Hall		932	635	235	1,803
Total	4,852	50,347	19,691	11,288	86,178

*includes faculty, staff, and graduate student offices

Plant and Soils Building (LSPS, 34,459 sq. ft.) is a shared facility with about 21,000 sq. ft. of dry and wet labs and storage (seed, refrigerator, and freezer) space. Floor plans and space conditions are found in Appendix D. A limited amount of the area in LSPS, primarily associated with USDA labs, has been renovated (LSPS 217 Scofield), but most of the space in LSPS is the same as when it was built in 1959. Most of the dry labs in LSPS are used for seed processing or seed packaging for nursery work. We have some soils processing capability in the space and some research space (LSPS 216, Grant). BPP also maintains labs on the 1st floor for research and the Plant and Pest Disease Diagnostic Lab (PPDL). Cold storage for both soils and seeds is a significant need for Agronomy as well as BPP. The old "meat locker cold storage" styled space found in the basement of LSPS (Figure 10.5) needs to be renovated (replaced), or the functions need to be moved to a different location. The systems are inefficient, overcapacity, and are frequently in need of repair. In all cases, the cost of new cold storage could exceed $1.8 M.

Figure 10.5 Typical cold room

Whistler Hall (WSLR, 90,728 sq. ft.) is a shared building managed by the Dean's office and located a block from the LILY complex (see Appendix D). The research-only building houses Entomology and many plant biology faculty. WSLR was built in 1980, and laboratory spaces have been renovated individually over the years as departmental and university R&R funds became available. Agronomy is assigned about 1,800 sq. ft. of lab office and shared space for one PI, Dr. Ma and his group. Dr. Ma's lab was renovated three years ago.

Lilly Greenhouse and plant growth facility (LSR, 71,283 Ft^2) for research and teaching was completed in the late 1950s, with two ranges added in 1998 (See Appendix E assessments and bench plans). Three departments (AGRY, BPP, and BIOL) and two colleges are responsible for this facility. Space assignment data from June 2018 shows 57,541 sq. ft. of working space (greenhouse and preparation). Agronomy currently uses 40% of the area for critical work, including plant breeding, seed increases, and disease trails. The original greenhouse facility was divided into 14 ranges, with each range containing three to four separate rooms. Ranges 1 through 12 dates back to the 1950s; ranges 13 and 14 were added in 1998. Most of our greenhouse space is >50 years old, and the design reflects its construction period, as it was not designed with a flexible format and does not meet our current research and teaching needs. In 2016, range 2 was removed, and the Ag Alumni Seed Controlled Environmental Phenotyping Facility was constructed in the space. An assessment of greenhouse and plant growth conditions, space utilization, and management structure for the LILY greenhouse complex was conducted in Spring 2018 and shared with the College of Agriculture leadership (Appendix E: The Lilly Hall Greenhouse Assessment). The current greenhouse space is, for all practical purposes, fully allocated and fully utilized during the peak growing season of January-April.

Ag Alumni Seed Controlled Environment Phenotyping Facility (7,300 sq. ft.) is a state-of-the-art growth facility and imaging platform made possible through the Plant Sciences-1 Initiative. It is located in the former range 2 space of Lilly Greenhouse. It began operations in spring 2018 (https://ag.purdue.edu/cepf/). The facility was designed, built, and managed by the College of Agriculture, and Dr. Yang Yang is the Director. The Ag Alumni CEPF allows rapid, non-destructive imaging and phenotyping of both above- and below-ground portions of various crop plants to explore and quantify traits (e.g., morphology, geometry and color, and physiological states, such as water potential or nutrient deficiency) and phenotypes of genetic resources grown under precise environmental control. The CEPF has a single walk-in growth room with a capacity for 256 plants and can provide controlled-environment conditions ranging from subtropical to desert. The system is fully automated to monitor plant growth, fertilization, watering, etc. A second walk-in growth room was recently funded by Ag Alumni Seed and will be installed in 2021, doubling the facility's capacity. The plants are moved via a conveyor system to imaging systems—an RGB camera and a hyperspectral camera for assessing above-ground plant traits.

In 2019, a gift from Ag Alumni Seed allowed for an X-ray µCT scanner to be added to the facility for imaging plant roots. This operation is the first of its kind in the U.S. to monitor both shoot and root traits on a wide range of plant species. The CEPF design and protocols allow plants from other greenhouse and growth chambers to be loaded onto the conveyor for imaging and analysis. However, producing quality data from such experiments demands plants be grown under uniform and consistent conditions. Thus, adequate plant growth and maintenance facilities in the Lilly Greenhouse will be integral to the future success of the CEPF. The greenhouse is the gateway to the widespread use of the CEPF. With a well-functioning

greenhouse, the CEPF complex would be the centerpiece for numerous projects. Several AGRY faculty use the CEPF facility regularly. The CEPF is operated as a cost recovery center, where fees are based on the number of pots used and how long they are in the system (on the belt). A virtual tour of the facility is available here: https://ag.purdue.edu/cepf/virtual-tour/.

General concerns about our spaces: Power supplies and temperature control are poor in our laboratory spaces. Lighting is poor, and hoods often malfunction. Some labs must use window units for air-conditioning. We lack high-quality water, which means most labs purchase or rent equipment to treat the water to ensure a stable source and reduce impurities. Plumbing problems are prevalent in many labs; drain issues which will cause minor flooding. Cold rooms and walk-in freezer space are lacking, and managing the cold-room area is complex (Figure 10.6). General-use autoclaves are old and often down for repairs. Office space is renovated (painted) when requested or when we bring in a new hire.

In the greenhouse, existing and proposed projects require better environmental control, pest management, and digital data acquisition. The older spaces lack modern energy-efficient lighting and adequate heating and cooling, and they sometimes have insufficient electrical supplies and poorly functioning controllers. Water quality and consistency are variable. Pest management is confounded by structures permeable to the outside environment, dirt or gravel floors, and uneven concrete, making it difficult to keep insects, pathogens, and weeds at bay. While we have made several necessary changes to the greenhouse functions, the greenhouse complex and plant growth facilities need to be replaced with modern technology, usable year-round. Currently, the Lilly Greenhouse is a fundamental part of the research programs for many of our plant breeding and genetics faculty. Traditionally, their time in the greenhouse reduces their project production intervals, thus allowing for faster plant releases and quicker publications. They need smaller assignable spaces for greater flexibility. Our goal is to make the Lilly Greenhouse Complex the Purdue University centerpiece for Plant Sciences and Plant Breeding work. It should showcase how to conduct modern plant sciences research work and be a powerful recruitment tool for students, faculty, and donor support.

Overall, an assessment of the quality of space in our buildings was conducted in 2019 by an independent architecture firm and the university's space management team (Appendix D). All of Lilly Hall, LSPS, and the LSR greenhouse complex are rated as "poor." This led to the idea of **constructing a new building that will host Agronomy, Botany and Plant Pathology, and Entomology.** The building will house the three departments, but space will be divided by function. For example, cropping systems faculty will be near weed science faculty near pest management faculty. Plant breeding faculty will be housed near disease researchers who are near plant physiologists. This will create the most unique and robust scientific research structure in the world. While the building will be multistoried, the first floor will be designed to contain collections: insects, fungi, soil monoliths, plants, etc., so that the displays are fully viewable to the public. The exhibitions will be held behind a glass wall to be easily viewed and work as part of efforts like spring fest. Along with the collections, the first floor will also contain the department head offices, business offices, conference rooms (3, 40 person rooms), and a café / gathering space. The other consideration is including a drop-off space/customer service area for the crop diagnostic lab. We envision something similar to the Boilermaker Butcher Block. Shared space for grinders, dryers, and sample preparation is also needed and should be adjacent to the first floor's loading dock.

11. Agronomy Department Organization and Faculty Duties

Faculty

The Agronomy Department faculty comprises 29 full-time tenure-track professors, one professor in a university Voluntary Early Partial Retirement VEPR, and two clinical track faculty. The distribution is two assistant professors (Quinn and Wang), six associate professors (Armstrong, Casteel, Cammarano, Mohammadi, Rainey, and Zhang), two clinical associate professors (Erickson and Gerber), and 22 full professors (Anderson, Bowling, Brouder, Camberato, Ejeta, Grant, Jiang, Johnson, Johnston, Kladivko, Lee, Ma, Nakatsu, Nielsen (on VEPR), Rocheford, Schulze, Schweitzer, Steinhardt, Tuinstra, Turco, Volenec, and Vyn).

The department is home to one Distinguished Professor and four Named Professors. Dr. Gebisa Ejeta is a Distinguished Professor and a recipient of the World Food Prize. Dr. Torbert Rocheford holds the Patterson Chair of Plant Breeding, and Dr. Tony Vyn holds the Henry A. Wallace Chair in Crop Sciences. Dr. Sylvie Brouder and Dr. Mitch Tuinstra occupy Wickersham Chairs of Excellence.

Agronomy faculty work across in several vital campus roles. Dr. Linda Lee directs the Ecological Sciences & Engineering Interdisciplinary Graduate Program. Dr. Laura Bowling (50% appointment) directs the Natural Resources and Environmental Sciences undergraduate program. Dr. Ejeta is the Director of the Purdue Center for Global Food Security, and Dr. Tuinstra is the Scientific Director for the Institute for Plant Sciences and now leads the Purdue Plants Sciences 2 effort. Dr. Anderson leads distance education for the College of Agriculture. Dr. Cliff Johnston holds partial appointment (25% FTE) in Earth and Planetary Sciences in the School of Science whileDr. Lee has a partial appointment (25% FTE) in the Environmental Sciences and Engineering program in Engineering.

Agronomy supports four joint appointments at 25% FTE for faculty with majors appointments in other departments: Dr. Dan Szymanski, Botany and Plant Pathology, Dr. Melba Crawford (Chair of Excellence), Civil Engineering, Dr. Suresh Rao, Civil Engineering (Distinguished Professor), and Dr. Quinlai Zhuang, Earth and Planetary Sciences (The Miller Chair). In addition, Agronomy works with six USDA adjunct faculty, including Drs. Steven Scofield and Karen Hudson, who both work in the plant space, and Drs. Chi-Hua Huang, Chad Penn, Mark Williams, and Javier Gonzalez, all of whom work in soil and water quality areas. The plant-based USDA work occurs in Lilly Hall laboratory space. The soil and water work takes place at the nearby National Soil Erosion Laboratory, a federal building.

Agronomy's faculty has changed since the last review in 2016 (Table 11.1). During the five years, the department has recruited and hired four tenure track faculty members (Ackerson, Cammarano, Quinn, and Wang) and added two clinical faculty members (Gerber and Erickson). Agronomy has one new assistant professor, Wilhelm, starting in February 2022. **For 2021-22 we have been authorized for two faculty searches: 1) Agroecology and 2) Geospatial / Agricultural data scientist.**

Our assistant professors are Wang, who was hired in 2020, and Quinn, hired in 2021. Our most recent associate professor is Mohammadi, promoted in 2021, followed by Armstrong and Zhang (both promoted to associate professor in 2020), Cammarano (who was hired as an associate professor in 2020), Rainey, who was promoted in 2018, and Casteel, totaling six Agronomy associate professors.

We have also hired one professional staff member since 2016, Dr. Beth Hall, as the Indiana State Climatologist. She directs the Indiana State Climate Office and now runs the Midwest Regional Climate Center.

Since 2016, two faculty members, Graveel and Weil, have retired, and six faculty members, Ackerson, Cammarano, Joern, Mashtare, Owens, and Niyogi, have left Purdue for other positions. Dr. Cammarano has indicated he will be leaving Purdue in January 2022. Dr. Jason Ackerson, who was hired after the last review, left Purdue to work with a non-profit organization the Soil Health Institute. Partial faculty appointments Filley and Doerge have also left Purdue. Niyogi had been the Indiana State Climatologist while also researching climate modeling. Of the seven faculty who retired or left Purdue since the 2016 review, 70% worked in the soil area. Across across all of the Agronomy faculty a rough estimate indicates 17 could retire in the next five to ten years. Retirements will could leaving the soil research and teraching susceptible to the loss of our core functional areas, including soil chemistry, soil classification, and soil and land use. Research on climate and teaching in the undergraduate crops areas could also be impacted by retirements.

The department has 12 local emeritus professors, including Drs. Ellsworth Christmas, John Graveel, Chris Johannesen, Bill McFee, Charles Roth, George Van Scoyoc, James Vorst, and Cliff Weil. We have emeritus adjunct professors as well: Diana Stott, Jim Wilcox, and Christine Williams. A complete listing of our retired and emeritus faculty is available at https://ag.purdue.edu/agry/Pages/emeritus.aspx. The department provides a small office for the use of the emeritus faculty.

Staff

The Department of Agronomy directly supports a dedicated staff who work in several specific areas (Table 11.2). Our staff work in two general program areas: graduate and undergraduate education, including recruitment and advising, and research program support. Jane Wiercioch supports undergraduate advising and career development. Wiercioch works with Dawn Bull, our scheduling deputy, and the undergraduate students committee, which Dr. Lee Schweitzer chairs. Melinda Smith supports undergraduate recruitment, social media (Twitter, Facebook, Instagram), and general departmental and department head's office operations. Holly McIntire supports graduate education and International Students and Scholars (ISS) activities. McIntire works with the graduate committee and the graduate chair, Dr. Richard Grant. Connie Foster works as the department's receptionist and handles mail and incoming calls. She is often the department's primary point of contact with visitors and the public. Brandon Chafin provides website help and works with travel planning and reimbursements. Extension operations are managed by Lexie Wilson, who is also the Diagnostic Training Center (DTC) coordinator. She schedules events and works on Extension publications. Wilson works with all Extension staff but interacts most directly with Corey Gerber in the DTC. As a result, she works with many individuals and companies that engage with the DTC (https://ag.purdue.edu/agry/DTC). Only Wiercioch, Bull, and Foster were on staff during our last review.

Currently, the department supports three teaching-related positions. Dr. Sara Allen is the teaching laboratory coordinator and Continuing Lecturer for Agronomy 321 Genetics Laboratory. At our last review, this position was held by Dr. Gregore Koliantz, who retired in 2020. Dr. Allen is responsible for both the lab class and for moving the resources for the class to an on-line format. Dr. Allen uses some of our best teaching space that was updated with funds from an outside gift (see Figure 5.3). Ms. Sherry Fulk-Bringman is a laboratory and outreach coordinator who works with Agronomy 255 Soil Science. She

oversees the hands-on learning lab associated with the class and works with several student groups. Dr. Shams Rahmani was recently hired to coordinate the soil teaching labs (AGRY 255, 349, 365) and work with the with the online development of AGRY 255. Fulk-Bringman was on staff at the last review, and she has expressed interest in decreasing her appointment. Dr. Rahmani will continue to assist with transitions in AGRY 255 and manage the soils-related teaching labs. Since our last review, Dr. Charles Mansfield, an Extension Agronomist associated with Agronomy (70%), Vincennes University (30%), and Southwest Purdue Agriculture Center (SWPAC), has retired. The position has not been filled.

The management of both our business services and IT operations has undergone a significant change since our last review. At the last review, both business and IT operations reported to the department; now, they are managed centrally in the College. The College has developed business centers, and our business staff (Raub, Long, and Linn) report to the business center but still work in the department. Two of our past business office positions (purchasing and employment) have been eliminated by centralization and moved to the College-level business centers. In addition, we are moving to a similar model for our technology services. Our Academic IT Specialist, Plumier, will report to the College of Agriculture Information Technology (AGIT) at some point in time. The department also pays out some ~50K dollars a year for campus-level IT core support, including phones, computer connections, internet access, and a limited amount of digital storage.

A highly skilled staff manages the Lilly Hall facilities operations, which includes the building and greenhouses. Overall building management is by Jason Dietrich, whose position was upgraded to Facilities Manager from his past designation as building deputy. Dietrich is our safety officer and deals with building updates for the individual departments, including AGRY, BPP, BIOL, and the building's common spaces. Dean Plaut provided resources to (re-)create a greenhouse manager position for the Lilly Complex (50:50 split between AGRY and BPP). Mike Woodard was recruited and hired in 2018. The greenhouse manager reports directly to BPP and AGRY; he coordinates all greenhouse growing processes for numerous plants and research projects. He manages and operates the 55,000+ sq. ft. greenhouse complex, associated head house, and growth chamber facility that serves two colleges and at least five departments. Recent upgrades include LED lighting in some ranges, heating and cooling control improvements, improved management of internal resources, and better interactions with faculty and staff. Both Dietrich and Woodard work with technician Ron Steiner, whose primary mission is to support plant growth operations (greenhouse and growth chambers). We also support the Agronomy Center for Research and Education (ACRE) staff, detailed in section 14 of this document.

The department is home to the Indiana Industrial Hemp Extension Specialist, Marguerite Bolt; the state Soil Health lead Joe Rorick; and, as mentioned, the Indiana State Climate Office director, Dr. Beth Hall. These positions are supported by a combination of grants and general funds.

Regarding staff in support of research, the Department of Agronomy also has multiple staff who conduct specific research work where grants, contracts, and endowment funds pay their salary and benefits (Table 11.3). The support mechanism has significantly changed since our last review, when some laboratory and research staff were supported by College of Agriculture and departmental funds. While there are occasional and temporary exceptions, funding for all research staff comes from external sources. The general rule is that the College will not provide long-term support for research staff.

Postdoc Support

Since 2016 the department has hosted 17 postdocs and 41 visiting scientists (Table 11.4). These individuals are supported by outside funding and typically work with individual scientists and their research groups. The one exception is a new program called the Accelerated Underrepresented Minority Postdoctoral Program. Dr. Shalamar Armstrong developed the program to address the shortage of underrepresented minority postdoctoral scientists and faculty within the agricultural research community. The program aims to generate a resource of high-quality underrepresented minority agricultural scientists qualified to fill assistant professor positions worldwide. Initial support was provided by extramural funding from Drs. Shalamar Armstrong and Davide Cammarano's research efforts, as well as internal backing from the College of Agriculture, Office of Agricultural Research and Graduate Education (ARGE). The initial steps for the Accelerated Program have resulted in the recruitment of two postdoctoral scholars.

Graduate Student Support

Since 2016 the department has supported 80 graduate students (46 MS and 34 Ph.D.) and is currently home to 15 M.S. and 22 Ph.D. students. Details on the graduate program are provided in Graduate Education portion of this report. Nearly all our graduate students are supported with outside funding from grants and contracts or internal assistantships (College, University, or three specific graduate programs: Ecological Sciences and Engineering, Purdue University Interdisciplinary Life Science Program, and the Center for Plant Biology (CPB). We provide partial support for graduate students via teaching assistantships (TA), typically at quarter-time, but we do not characteristically support research assistantships with departmental funds.

Faculty Leadership Efforts Outside of Agronomy

Agronomy faculty serve in many essential university roles that significantly extend the impact of programs.

Purdue Soybean Center (https://ag.purdue.edu/agry/soybean/Pages/PurdueSoybeanCenter.aspx)

Dr. Katy M. Rainey uses her expertise with soybeans to lead the Purdue Soybean Research Center. The Center has consulted with faculty and staff members and representatives of the soybean industry in developing a strategic plan for research and Extension that engages Purdue faculty and staff in critical issues of the soybean "value chain."

Natural Resource Environmental Sciences (NRES) (https://ag.purdue.edu/nres)

Dr. Laura Bowling uses her background in hydrology and water resources modeling to lead the NRES undergraduate program. NRES is an interdisciplinary program and a unique and exciting major for students who want to contribute to environmental change in the world.

Purdue Center for Global Food Security (PCGFS) (https://www.purdue.edu/discoverypark/food/)

Dr. Gebisa Ejeta leads the PCGFS mission to address a range of global food security challenges and contribute to research and policy-making and human and institutional capacity-building.

Ecological Sciences and Engineering (ESE) (https://www.purdue.edu/gradschool/ese/)

Dr. Linda Lee leads ESE, an interdisciplinary graduate program at Purdue University. ESE students work to create an understanding of the processes that link human activity and ecological systems to improve natural resource management.

Plant Science 2.0 (https://ag.purdue.edu/plantsciences/plant-sciences-2-0/)

Dr. Mitch Tuinstra is the Science Director for the Plant Sciences 2.0 program. Plant Sciences 2.0 is part of Purdue's Next Moves program and will expand Purdue Agriculture's expertise in phenotyping and the use of other technologies to build capacity in our food supply.

Distance Education

Dr. Joe Anderson is the Director of distance education for the College of Agriculture. This program works to remove barriers in the creation of online resources for teaching and research.

Table11.1. Faculty rosters for 2016 and 2021. Individuals listed in blue have retired or left Purdue.

Faculty Listing in 2016	Academic Rank in 2016	Academic Rank and Status in 2021
Joe Anderson	Professor & Head	Professor & Director of Distance Education
Shalamar Armstrong	Assistant Professor	Promoted to Associate Professor (2020)
Laura Bowling	Professor	Professor & Head of NRES (%50)
Sylvie Brouder	Professor	Professor, Wickersham Chair
James Camberato	Professor	Professor
Shaun Casteel	Associate Professor	Associate Professor
Melba Crawford (25%)	Professor & Chair of Excellence	Professor & Chair of Excellence - Engineering
Rebecca Doerge (25%)	**Professor (Stats)**	**Left Purdue (Dean, Carnegie Mellon Univ)**
Gebisa Ejeta	Distinguished Professor & Director of PCGFS	Distinguished Professor & Director of PCGFS
Richard Grant	Professor	Professor
John Graveel	**Professor**	**Retired (2019)**
Yiwei Jiang	Professor	Professor
Brad Joern	**Professor**	**Left Purdue (Private Industry)**
Keith Johnson	Professor	Professor
Cliff Johnston	Professor	Professor
Eileen Kladivko	Professor	Professor
Linda Lee	Professor	Professor & Director of ESE (25%)
Jianxin Ma	Professor	Professor
Michael Mashtare	**Assistant Professor**	**Left Purdue (Assist. Prof, Penn State - 2020)**
Mohsen Mohammadi	Assistant Professor	Promoted to Associate Professor (2021)
Cindy Nakatsu	Professor	Professor
Robert Nielsen	Professor	Professor (VEPR)
Dev Niyogi	**Professor**	**Left Purdue (Dist. Chair, UT Austin - 2020)**
Philip Owens	**Associate Professor**	**Left Purdue (Research Leader, USDA - 2016)**
Katy Martin Rainey	Assistant Professor	Promoted to Associate Professor (2018); Director of Soybean Research Center
Suresh Rao (25%)	Distinguished Professor (CIVL)	Distinguished Professor (CIVL)
Torbert Rocheford	Professor & Patterson Chair	Professor & Patterson Chair
Darrell Schulze	Professor	Professor
Lee Schweitzer	Professor	Professor
Gary Steinhardt	Professor	Professor
Dan Szymanski (25%)	Professor (BPP)	Professor (BPP)
Mitch Tuinstra	Professor & Wickersham Chair	Professor, Wickersham Chair & Science Director Plant Sciences 2.0
Ronald Turco	Professor	Professor & Head
Jeff Volenec	Professor	Professor
Tony Vyn	Professor	Henry A. Wallace Chair in Crop Sciences
Cliff Weil	**Professor**	**Retired (2020)**
Cankui Zhang	Assistant Professor	Promoted to Associate Professor (2020)
Quinlai Zhuaug (25%)	Miller Professor of EAPS	Miller Professor of EAPS

New Faculty Since 2016	Academic Rank when hired	Academic Rank and Status in 2021
Jason Ackerson	**Assistant Professor**	**Left Purdue (Nonprofit, SHI, 2021)**
Davide Cammarano	**Associate Professor (2020)**	**Associate Professor (Departing Jan 2022)**
Tim Filley (25%)	**Professor, EAPS**	**Left Purdue (Univ of Oklahoma, 2021)**
Daniel Quinn	Assistant Professor (2021)	Assistant Professor
Diane Wang	Assistant Professor (2020)	Assistant Professor
Corey Gerber	Clinical Associate Professor	Clinical Associate Professor
Bruce Erickson	Clinical Associate Professor	Clinical Associate Professor

Table 11.2. Staff supported by the Department or the College

Staff Member	Position Type	Area of Work
Departmental Functions		
Jane E Wiercioch	Academic Advisor, Senior	Undergrad Support/Counseling
Dawn R Bull	Administrative Assistant	Undergrad Support/Scheduling
Melinda M Smith	Administrative Assistant, Lead	Undergrad recruitment/DH-Operations
Holly C McIntire	Prog. Administration Specialist	Graduate Programs/ISS
Lexie M Wilson	Program/Project Assistant	Extension Programs/DTC
Tyler L Brown	Research Technician, Associate	Diagnostic Training Center (DTC)
Connie D Foster	Administrative Assistant	General Operations/Receptionist
Brandon C Chafin	Administrative Assistant	Web/Travel/Seminar Programs
Teaching Functions		
Sherry Fulk-Bringman	Instruction Specialist, Senior	AGRY 255 Soils/Outreach
Dr. Sara L Allen	Lecturer, Senior	AGRY 321 Genetics
Dr. Shams Rahmani	Soils Teaching Lab Manager	AGRY 255, 349, 365
Core Facilities Support		
Jason M Deitrich	Facilities Administrator, Lead	Facilities Manager, Lilly Hall
Mike Woodward	Greenhouse Manager (1/2 BPP)	Greenhouse Manager, Lilly Hall
Ronald F Steiner	Research Technician, Senior	Greenhouse/Facilities
Thomas M Pluimer	Software Engineer, Lead	IT - Software support
Agronomy Center for Research and Education		
Rachel Stevens	Agronomy Research Center	ACRE - Farm Manager
Evan D Bossung	Farm Technician, Senior	ACRE
Bryan J Gretencord	Farm Technician, Senior	ACRE
Aaron J Kult	Farm Technician, Senior	ACRE
Supported by the College and/or Grant funds		
Marguerite Bolt	Extension Administrator, Senior	Hemp Extension Programs
Joseph D Rorick	Extension Administrator, Senior	Conservation Cropping Systems Agronomist
Dr. Beth L Hall	Research Scholar, Lead - Engineering	Director, Indiana State Climate Office

Table 11.3. Staff supported using funding from outside of the department (grants & contracts)

Lead PI	Staff Member	Position Type	Work Area
Crops, Plant Breeding and Production			
S. Casteel	Alex Angel	Agronomy Technician	Production - Soybeans
G. Ejeta	Adedayo O Adeyanju	Research Scholar	Plant Breeding - Sorghum
	Dr. Patrick J Rich	Research Associate	Plant Genetics - Sorghum
	William D Foster	Research Assistant	Plant Breeding - Sorghum
J. Ma	Xutong Wang	Research Associate	Plant Genetics - Soybean
M. Mohammadi	Tracy Richards	Farm Operations Administrator	Plant Breeding - Wheat
K. Rainey	Eric Seal	Research Technician	Plant Breeding - Soybeans
T. Rocheford	Dr. Darwin Ortiz	Research Associate	Plant Breeding - Corn
	Marsha E Kern	Research Geneticist	Plant Breeding - Corn
M. Tuinstra	Andrew G Linvill	Research Geneticist	Plant Breeding - Corn/Sorghum
	Clifford E Glover	Farm Technician, Senior	Plant Breeding- Corn/Sorghum
Soils, Weather & Hydrology			
S. Armstrong	Michael Ruffatti	Research Associate	Cover Crops / Soil Health
L. Bowling	Katy E Mazer	Research Operations Administrator	Hydrology / Cropping systems
S. Brouder	Nicole S De Armond	Laboratory Operations Specialist, Senior	Water Quality Field Station / Cover Crops / Soil Health
B. Hall	Jonathan Weaver	Research Analyst	Climatology Research Analyst
E. Kladivko	Anna L Morrow	Program Administration Specialist	Midwest Cover Crops Council Program Manager
L. Lee	Dr. Youn Jeong Choi	Chemist	Soil Chemistry
R. Turco	Becca L Thomson	Research Technician, Associate	Soils Microbiology
	Marianne Bischoff Gray	Research Associate, Senior	Soils Microbiology

Table 11.4 Postdocs* and visiting scholars in the Department of Agronomy from 2016 to 2021.

Year	Lead PI	Visiting Scholar	Project Area
2016	C. Zhang	WANG, SHUJUAN	Plant Physiology
	G. Ejeta	CHIKSSA, HABTE NIDA*	Sorghum breeding
	J. Ma	WANG, XUTONG*	Soybean genetics
2017	Chi Hua Huang	LUO, SONG-PING	Soil Erosion
	C. Zhang	DOU, YANXIA	Physiology
	K. Rainey	HUANG, MENG*	Soybean genetics
	Devdutta Niyogi	JAMSHIDI, SAJAD	Climate
2018	Y. Jiang	XU, MENGXIN	Plant Physiology
	C. Zhang	WANG, QING	Plant Physiology
	C. Zhang	HE, LIN	Plant Physiology
	Y. Jiang	TANG, JIA	Plant Physiology
	Y. Jiang	GAO, YUNFEI	Plant Physiology
	M. Mohammadi	BATOOL, SYEDA Q	Wheat Breeding
	Chi Hua Huang	LI, FU-CHENG	Soil Erosion
	Chi Hua Huang	LU, YAFENG	Soil Erosion
	C. Zhang	LI, GANG	Plant Physiology
	Devdutta Niyogi	QUN, TIAN	Climate
	C. Zhang	HUANG, XIAOXIA	Plant Physiology
	C. Zhang	SAEED, QUDSIA	Plant Physiology
	T. Filley	BRECHEISEN, ZACHARY S	Soils
	M. Crawford	KARAMI, ROBATI AZAM*	Remote Sensing
	J. Ma	DUAN, JINGBO*	Soybean genetics
	C. Weil	AOUINI, LAMIA*	Wheat
	L. Lee	MODIRI-GHAREHVERAN*	Contaminants in Soil
	Yang Yang	HERRERO, HUERTAMONICA	Phenotyping
	T. Vyn	OLMEDO, PICO LIA B*	Corn production
2019	M. Mohammadi	ZHANG, HONGRUI	Wheat Breeding
	Chi Hua Huang	ZHOU, NA	Soil Erosion
	M. Mohammadi	AJLOUNI, MOHAMMAD	Wheat Breeding
	Devdutta Niyogi	KUMAR, ANKUR	Climate
	R. Nielsen	BULNES, LOPEZ MARCELA	Corn Production
	C. Zhang	LI, PINGHUA	Plant Physiology
	Chi Hua Huang	YONG, WANG	Soil Erosion
	Chi Hua Huang	ZHAO, FANGKAI	Soil Erosion
	C. Zhang	LI, PINGHUA	Plant Physiology
	Chi Hua Huang	ZHANG, HANDAN	Soil Erosion
	M. Tuinstra	OHNISHI, TAKAYUKI	Sorghum breeding
	C. Zhang	FAN, JINPING	Plant Physiology
	J. Ma	JI, XINGLONG	Soybean genetics
	L. Prokopy (HORT)	CORDONERO, JEANINE	Watershed dynamics
	T. Vyn	TORRALLARDONA,	Corn Production
	L. Lee	BEHBEHANI, LAMIS	Soils and Contaminants
	C. Zhang	SUN, LIJUN	Plant Physiology

	M. Mohammadi	CONDORI, APFATA JORGE*	Wheat breeding
	M. Mohammadi	LIU XIAOQIN	Wheat breeding
2020	Chi Hua Huang	GAO, HAIDONG	Soil Erosion
	C. Zhang	GUO, ZHENRU	Plant Physiology
	Chi Hua Huang	WANG, BING	Soil Erosion
	T. Filley	YEASMIN, SABINA	Soils
	M. Mohammadi	NEPAL, NIRMAN	Wheat breeding
	S. Armstrong	WELIKHE, PAULINE*	Soil Conservation
2021	M. Tuinstra	DIATTA, ELISABETH	Sorghum breeding
	D. Cammarano	PIVARAL, KATHERINE	Landscape modeling
	D. Wang	KARLA, MISERENINO	Plant modeling
	S. Armstrong	PREZA, FONTES GIOVANI*	Soil sensors
	S. Armstrong	JOHNSON, FRANK EARL*	Soil sensors

Faculty Duties

Committees

Faculty serve on formal Departmental, College, and University level committees and take an active role in graduate education by serving on thesis committees. Listed below (Table 11.6 a,b,c) are the most significant faculty committees at all three levels. Also indicated is the number of faculty on the committee. Faculty members on College and University level committees are determined by a nomination process from eligible faculty and a vote of all the faculty.

Table 11.6a. Department Level Committees

Committee	Committee Size & Make up	Role
Teaching & Advising	10 – staff and faculty	Undergrad programs
ACRE Advisory	15 – staff and faculty	Input on ACRE operations
Extension	All Extension staff	Input on Extension planning
Department Head Advisory	6 – faculty	Input to the department head
Graduate Committee	9 – faculty	Graduate programs
Research Committee	11 – faculty	Input on research directions
Student & Staff Diversity	5 – staff and faculty	Input on DEI opportunities
Curriculum Review	9 – staff and faculty	Input on curriculum directions
Awards	5 – faculty	Leadership on awards submissions
Seminar	5 – faculty	Leadership on speaker selection

Table11.6b. College Level Committees

Committee	Agronomy Member	Term
Agenda & Policy	1	3-year term
Area Promotions	1	3-year term (full profs only)
Curriculum & Student Relations	1	3-year term

Table 11.6c. University Level Committees

Committee	Agronomy Member	Term
University Senate	1	3-year term

Faculty Mentoring Program

The department has a mentoring program for new faculty hired at the assistant or associate levels. The program aims to mitigate possible barriers in the promotion process by providing new faculty with access to accurate information.. The process is simple: 1) all new faculty work with the department head to select their mentoring committee. The goal is to have the committee in place within their first six months; 2) the new professor works with the committee, which offers input to the faculty member on their progress and helps with setting priorities (they are expected to meet twice a year); and 3) the committee is expected to help the new faculty member by reviewing their promotion package before it is released to the general faculty. One member of the mentoring committee acts as the faculty member's advocate at the promotion meeting. The mentoring committee does more than just promotion document review, however. The mentoring committee works with faculty members to consider local and national awards opportunities and to maneuver through their startup at Purdue as they develop classes. The department's formal review of assistant professors starts after their second year on staff, and two years after their promotion for associate professors. The faculty member can request a change in the mentoring committee, and members from outside the department are encouraged.

Teaching Loads and Responsibilities

The teaching load for most of the faculty ranges between 2 and 6 credit hours per year, with the average at three credit hours. The range tends toward the smaller side for research-active faculty and the higher side for faculty with fewer research activities. Over the past years (2015 to 2018), across all the individuals who teach, we typically generated between 5,722 and 6,288 academic credit hours (class credit hours X enrollment) per year (Appendix 1). More current data, 2020-2021 from digital measures, indicates our academic credit hours for the department range from 0 to 1795 per faculty member, with an average of 194 student credit hours per faculty member across all tenure track faculty. However, seven faculty members account for 90% of the 5624 student credit hours we generated from 2020 to 2021. If we remove those seven faculty members from the calculation, the average falls to 22 student credit hours per faculty member for the remaining 21 people. Across the same period, 371 additional academic credit hours were generated by our clinical faculty.

Historically, our larger classes were handled by a dedicated teaching faculty. Since the last review, teaching responsibilities have shifted dramatically. For example, the retirement of Graveel and the departure of Mashtare resulted in changes in the teaching format for General Soils, AGRY 255, where the class is now shared by three faculty, a teaching coordinator, and a new laboratory coordinator. The potential for other retirements will impact our current teaching loads. We are currently shifting responsibilities and may rely on more clinical faculty members to teach these larger classes.

Departmental Equipment and Shared Resource Facilities

The department helps maintain a limited amount of research equipment. The department primarily maintains our autoclaves, cold storage (walk-in refrigerators and freezers), and equipment and spaces related to teaching. Recent efforts to obtain university grant support for teaching equipment have been highly successful, and the department has contributed general funds to provide match as part of the application. Most specialized equipment is housed in individual researchers' lab space and is maintained as part of that individuals' research program. Most new equipment comes as part of equipment grants or

components of an individual's startup package. The department has paid some service contracts, but faculty are primarily responsible for most of these expenses. Some faculty have established recharge centers for equipment in their labs. A recharge center is created when individuals outside the department repeatedly request and utilize the equipment and allow a fixed fee to be charged for using a specified device. The money can be used to repair the device and replace expendables. In addition, the department uses general funds and some salary savings to improve equipment when needed or to provide matching funds for new equipment. Overall, the department lacks a unified equipment plan reflecting our distributed equipment, the hodge-podge of service arrangements, and the lack of shared research spaces.

12. The Agronomy Faculty & Professionals Positions

The hiring of faculty and staff is critical to the durability of the department. Outlined below are our history and our hiring goals. The faculty lines for a vacated position reverts to the college. When a CoA assistant professor position is vacated (pre-tenure), we likely get the FTE back. FTEs created by retirement are not returned automatically. A discussion of how the newly described FTE will fit into the departmental plan is required. The following section lays out our situation in terms of recent arrivals and departures. It also suggests where people may be leaving the program. It concludes with a listing of recently discussed faculty lines the department views as critical to achieving our new efforts in Sustainability, Data-Driven Agriculture, Climate Change Adaptation, and Education.

- **Part 1** Identifies faculty and staff who have left Agronomy in the last five years.
- **Part 2** Identifies new hires for both faculty and staff in the previous five years. It also identifies individuals hired who have left the program.
- **Part 3** Gives a ten-year retrospective on faculty who have left.
- **Part 4** Indicates potential retirements in the next 5 to 10 years.
- **Part 5** Outlines suggested positions for the next 10 years, including a brief description of these positions. Our goal is to hire faculty that help us reach the plan suggested in section 1.

1) Vacated positions 2016 to 2021:

Faculty

1. Corn Extension Specialist – **Bob Nielsen** (Voluntary Partial Retirement Plan)
2. Cropping Systems Modeling – **Davide Cammarano (2022)**
3. Biogeochemistry – **Tim Filley (2021)**
4. Applied soils research – **Jason Ackerson (2021)**
5. Maize Genetics & Genomics – **Cliff Weil (2020)**
6. International Climate Research/State Climate Office – **Dev Niyogi (2020)**
7. Soils Teaching – **Michael Mashtare (2020)**
8. Soil Science Teaching – **John Graveel**
9. Soil Geomorphology – **Phillip Owens**
10. Statistics – **Rebecca Doerge**, split appointment
11. Nutrient Management Planning – **Brad Joern**

Staff/Professional

12. Agronomy Extension Specialist – **Chuck Mansfield (2020)**
13. Continuing Lecturer for AGRY 321 Genetics Lab – **Gregore Koliantz (2020)**
14. Agronomy Center for Research Education, Superintendent – **James Beaty (2020)**

2) Filled positions 2016 to 2021:

Faculty

1. Roland Wilhelm, Soil Microbiome (2022)
2. Daniel Quinn, Corn Extension Specialist (2021)
3. Diane Wang, Plant-environment modeling (2020)
4. Davide Cammarano, Crop Systems Modeling (2020) *(Departs for Denmark in 2022)*
5. Bruce Erickson, Digital agriculture (clinical, 2018)
6. Jason Ackerson, applied soils research (2017) (*Departed for SHI in 2021)*

7. Tim Filley, partial appoint. biogeochemistry (2017) *(Departed for Ok. State in 2021)*
8. Corey Gerber, Crop management (clinical, 2016)

Staff/Professional

1. Soils Teaching labs manager – Dr. Shams Rahamani
2. Agronomy Center for Research Education, manager – Rachel Stevens
3. Continuing Lecturer for AGRY 321 Genetics Lab – Dr. Sara Allen
4. Director of the Indiana Climate Office – Dr. Beth Hall
5. Greenhouse Manager (shared with BPP – Mike Woodard
6. Soil Health/Cover Crops Specialist (Master of Science) – Joe Rorick
7. Industrial Hemp Extension Specialist (Master of Science) – Margurite Bolt

3) **All former faculty over the last 12 years**

1. Craig Beyrouty, Plant Root Ecology/Soil Chemistry (resigned, 2009)
2. James Vorst, Crop Management (retired, 2009)
3. Brad Lee, Soils & Land Use (resigned, 2009)
4. Zachary Reicher, Turfgrass Science (resigned, 2010)
5. Kevin Gurney, Partial Appointment Biogeochemistry (resigned, 2010)
6. Tom Housley, Plant Physiology (retired, 2011)
7. Scott Jackson, Soybean Genomics (resigned, 2011)
8. Paul Schwab, Environmental Soil Chemistry (resigned, 2012)
9. Lori Snyder, Crop Management (Assistant Prof. resigned, 2012)
10. *Aaron Patton, Turfgrass (Transferred to Horticulture & Landscape Architecture, 2014)*
11. *Cale Bigelow, Turfgrass (Transferred to Horticulture & Landscape Architecture, 2014)*
12. *Dan Szymanski, plant physiology (Transferred to Botany Plant Pathology, 2014)*
13. Herb Ohm, Small Grains Plant Breeding & Genetics (retired, 2014)
14. George Van Scoyoc, Soils Teaching (retired, 2015)
15. Phillip Owens, Soil Geomorphology (resigned, 2016)
16. Rebecca Doerge, split appointment w/ Statistics (resigned, 2016)
17. Brad Joern, Nutrient Management Planning (retired, 2017)
18. John Graveel, Environmental Soil Science/Soils Teaching (retired, 2017)
19. Michael Mashtare, soils teaching (resigned, 2020)
20. Cliff Weil, Maize Genetics & Genomics (retired, 2020)
21. Dev Niyogi, International Climate Research (retired, 2020)
22. Jason Ackerson, applied soils research (resigned, 2021)
23. Bob Nielsen, Corn Extension (Voluntary Partial Retirement Plan)
24. Davide Cammarano, Cropping Systems Modeling (resigned, 2022)

4) Potential retirements next five to ten years:

1. Gary Steinhardt (Soils and Land use)
2. Lee Schweitzer (Plant Physiology / Undergrad Teaching)
3. Gebisa Ejeta (Sorghum Breeding / Food Security)
4. Eileen Kladivko (Soil Physics)
5. Cliff Johnston (Soil Chemistry)
6. Darrell Schulze (Soil Chemistry / Mineralogy)
7. Keith Johnston (Forage Production)
8. Cindy Nakatsu (Microbiology)
9. Jim Camberato (Crop Systems / Soil Fertility)

10. Tony Vyn (Cropping Systems)
11. Rich Grant (Climate / Micrometrology)
12. Ron Turco (Soil Microbiology)
13. Jeff Volenec (Plant Physiology)
14. Bruce Erickson (Distant Ed / Cropping Systems)
15. Torbert Rocheford (Corn Breeding)
16. Joe Anderson (Genetics)
17. Melba Crawford (Remote Sensing / Engineering)
18. Sherry Fulk Brinkman (Soils Teaching, professional)

Possible positions:
The faculty has identified the following positions as critical to department needs over the next ten years. These positions were arrived at via discussions and survey work. They meet long-term goals that focus on either core areas (1, 4, 5, 7, 9, 10, 11) or new areas (2, 3, 6, 8). Two positions (2 and 3) were recently approved, and search committees are being formed. This list does not preclude the possibility for other positions, but it serves as a holding point for ideas.

Positions in support of our future program:

1) Vadose Zone/soil physics – soil and subsurface transport processes [Sustainability -- Data-driven agriculture]
2) Agroecology/regenerative AG leadership in the development of this area [Sustainability] — ***APPROVED***
3) Informatics/agricultural data sciences/GIS [Data-driven agriculture] — ***APPROVED***
4) Ecophysiologist [Sustainability]
5) Pedology and field soil sciences [Climate change adaptation -- Sustainability]
6) Human dimensions of agricultural production [Climate change adaptation -- Sustainability]
7) Global plant breeding [International Agriculture -- Sustainability]
8) Soils and soil health education [Sustainability -- Education]
9) Crops and crop production education [Sustainability -- Education]
10) Soil chemistry [Data-driven agriculture -- Sustainability]
11) Cropping systems [Sustainability -- Data-driven agriculture]

<u>2030 DRAFT POSITIONS - SHORT VERSIONS</u> for Discussion Only

Assistant Professor **_____** [plan areas]

Responsibilities: *This is a full-time (9 month) tenure track position with an initial appointment of 75% research and 25% teaching. The successful candidate will direct graduate students, teach and develop a vigorous, externally funded research program in _____, emphasizing cutting-edge techniques to define the role of the _____.*

Assistant Professor Vadose Zone/soil physics – soil and subsurface transport processes [Sustainability -- Data-driven agriculture]

Soil health plays a vital role in supporting a vibrant, profitable, and sustainable ecosystem. Soil physical properties are essential to creating healthy soil, as they control infiltration, water holding capacity, erosion, compaction, and more. The soil's physical health supports other essential soil functions, such as nutrient cycling and biodiversity. The successful candidate will develop a high-impact,

nationally/internationally recognized, and externally funded research program that integrates theoretical and applied approaches to explore the complex physical, chemical, and biological processes associated with coupled hydrologic and biogeochemical cycles that underpin all soil processes. The environmental physicist will be a crucial member of our soil health cluster and bring a fundamental approach to a soil health study. Potential areas of research include understanding the physical controls on soil and ecosystem processes associated with climate change, water quality, and quantity in agriculture; and impacts of soil physical properties, hydrologic processes on soil water dynamics of nutrient cycling and microbial processes. The individual will work with our recently established modeling group and serve as a bridge between faculty engaged in lab, field, and watershed scale experimental studies, and will be involved with soil and water management relevant to soil health investigations.

Agroecology/regenerative AG [Sustainability] — ***APPROVED***
We seek an agroecologist with strong quantitative skills to provide campus-wide leadership in addressing system-level knowledge gaps: regenerative/sustainable agriculture, agriculture's role in climate change mitigation and adaptation, and interactions between genetic traits, management, and the environment that pertain to agricultural resilience and sustainability. The successful candidate will have foundational skills in manipulating large, spatio-temporal datasets and measuring and monitoring techniques and technologies for ecosystem service quantification. Science suggests that we cannot stay below most climate thresholds without removing significant amounts of carbon from the atmosphere. Using the tools of Agroecology (e.g., agroforestry, reductions in N_2O emission, a social process to increase adaptation, diversified rotations, refugia for pollinators, improved H_2O management, etc.) and regenerating US agricultural working lands can help us meet our climate and carbon reduction goals. These approaches also provide a host of additional benefits, such as increased resiliency, enhanced biodiversity, improved water quality, and strengthened rural economies. Program products are expected to support Extension efforts to develop and disseminate educational materials on agronomic aspects of natural capital markets (e.g., carbon markets) and, in collaboration with other disciplines, support decision-making on ecosystem service valuation at the field to landscape scales.

Informatics/agricultural data sciences/GIS [Data-driven agriculture] — ***APPROVED***
Provides leadership in developing an interdisciplinary and transdisciplinary research program that intersects geospatial sciences, mathematical and statistical sciences, and cyberinfrastructure and computational sciences. The research program would facilitate synergies between plot and field research data, remote sensing, geospatial technologies, machine learning, and modeling principles to produce discovery and innovation on a state, regional, national, and international scale. The program will include large-scale agricultural systems modeling that leverages data generated from current agronomic research. Research can include one or more of the following: climate change forecasting, large scale crop physiology and phenotype modeling, and market development for carbon and nutrient trading.

Crop Production/Ecophysiologist [Sustainability]
Provides leadership in developing strategies to produce higher yields and better tolerance to abiotic/biotic stresses in wet or dry climates associated with a changing global environment. The research will complement the existing efforts with field and laboratory-based research that enhances efforts in conditioning plants for stress tolerance, industrial crop production, or general climate resilience. The work will take advantage of novel Purdue field, greenhouse, and laboratory facilities, including advanced phenotyping systems, rainout shelters, and crop production capacity associated with advances in digital agriculture. Research can include one or more of the following: data science and analytical approaches that underpin trait discovery; providing novel methods of high throughput phenotyping, identification of traits such as heat and drought tolerance, water-use efficiency, seed, grain yield, and quality.

Human dimensions of agricultural production [Sustainability -- Climate change adaptation]
Provides leadership in developing strategies to understand the needs and values of humans, human society, and culture as they relate to agriculture production and its impact on the environment. We welcome diverse candidates who complement one or more departmental strengths, including sustainability, crop production, water quality, soil health, geospatial science, cover crops, and greenhouse gas production. We encourage individuals interested in contributing to the conservation, stewardship, and management of land and agricultural resources in a way that produces a healthy environment, profitability, and sustainable human benefits. We are interested in degrees in sociology, geography, natural resources, social science, or a related field.

Global Plant Breeding [International Agriculture -- Sustainability]
The successful applicant will build on an internationally recognized sorghum breeding and genomics program. Over the past 50 years, Purdue University has contributed significantly to the development of modern sorghum, emphasizing stress and Striga resistance. Numerous projects have generated external support to improve sorghum for biotic (disease and parasitic weed) and abiotic resistance (drought and cold tolerance). The background is a pattern of continuous work to improve nutritional quality and growth characteristics that are critical to maintaining productivity. Purdue remains a significant repository for genetic resources that have backstopped programs across the world. As a result, our program has an immense potential value and ongoing impact in developing countries and the developed world. The successful candidate is expected to lead the Purdue University sorghum program eventually. Other expectations for the position include: 1) developing an extramurally-funded program focused on sustainable sorghum production as part of meeting the world needs for the crop; 2) developing and releasing superior cultivars of sorghum for use in stressed (e.g., drought, cold, or parasitic weeds) environments; 3) collaborating with the existing breeding and genomics team at Purdue University and industry to improve agronomic and end-use quality of sorghum; 4) working with international collaborators to achieve program goals; and 5) developing a high-quality graduate/postdoc program in plant breeding and genetics. Teaching responsibilities will include instruction of an undergraduate and graduate-level course in plant genetics and breeding in subjects determined by the department head. The successful candidate is expected to establish and maintain close working relationships with industry, commodity groups, state and federal agencies, and other organizations as appropriate.

Pedology and field soil sciences [Data-driven agriculture -- Sustainability -- Climate change adaptation]
Pedology is the branch of soil science that integrates and quantifies the formation, morphology, and classification of soils as natural landscape bodies. Basic pedological research is directed at understanding how the earth's surface environments have developed and how this development influences the use of the resource. A solid understanding of soil development underpins the development of the best possible land-use scenarios. The successful candidate will conduct critical basic research that complements departmental and college efforts in carbon sequestration, soil mapping, and hazard identification. The incumbent will work to articulate the very nature of soil as it is found in the environment. We anticipate that the successful candidate will couple laboratory and field experiments with cutting-edge spectroscopic, microscopic, and analytical methods. The incumbent will also teach graduate pedology and another course based on the department's needs. The successful candidate will also seek extramural funding to support the program.

Soil chemistry [Data-driven agriculture -- Sustainability]

The successful candidate will conduct critical basic research that complements departmental and college efforts in areas such as carbon sequestration in soils, water quality, and enhancing the understanding of how soil retains plant nutrients (N, P, K). This work could include efforts to understand how soils contribute to non-point source contaminant issues, working with industries to mitigate pollution to protect natural resources and human health. We anticipate that the successful candidate will couple laboratory and field experiments with cutting-edge spectroscopic, microscopic, analytical, and numeric approaches. The incumbent will also teach graduate soil chemistry and another course based on the department's needs. The successful candidate will also seek extramural funding to support the program.

Cropping systems [Data-driven agriculture -- Sustainability -- Climate change adaptation]
The successful candidate will work with corn and soybeans systems or other high-value systems. The soils and production capacity of Indiana offer researchers the opportunity to study and create unique cropping systems that can maximize water and nutrient relations, crop rotation, and soil function. Creating precision management systems that optimize yields and grain quality is a significant responsibility. The candidate is also to lead in the discovery of best management practices related to digital agriculture. The work will include planning, designing, and conducting field experiments (including data collection and statistical analyses). The ability to work with the broader Purdue University community on novel project ideas, including sensor technologies and tools, is required, as is securing extramural funding and publishing research and extension findings.

Soils and soil health education [Sustainability -- Education]
The successful candidate will develop a nationally recognized, externally funded program that integrates teaching and research to create knowledge in the next generation of leaders. The program should create a better understanding of soil nutrient management and nutrient cycling in agricultural systems. Areas of interest include plant and soil nutrient management, nitrogen and phosphorus cycling, carbon sequestration, greenhouse gas emissions, or other areas related to system nutrient management, crop productivity, and environmental quality. The selected candidate will collaborate to develop educational resources applicable to both on- and off-campus audiences. The ability to use the tools of online education and willingness to work with students is critical. Working as part of a team that includes departmental and college researchers to provide interdisciplinary support of sustainability in the agroecosystems is critical. This effort will include working closely with Extension personnel in support of outreach educational programs.

Crops and crop production education [Sustainability -- Education]
The successful candidate will develop a nationally recognized, externally funded program that integrates teaching and research to create knowledge in the next generation of leaders. The program should better understand crop plant management and nutrient and water use efficiency in agricultural systems. Areas of interest include crop management, nitrogen and phosphorus use efficiency, or other areas related to system nutrient management, crop productivity, and environmental quality. The incumbent will collaborate to develop educational resources applicable to both on- and off-campus audiences. The ability to use the tools of online education and willingness to work with students is critical. Working as part of a team that includes departmental and college researchers to provide interdisciplinary support of plant system sustainability is critical. This effort will include working closely with Extension personnel in support of outreach educational programs.

13. Curriculum Report

Operational Tenets

The curriculum and courses "belong" to the faculty and not Individual faculty members.
The curriculum should be dynamic, receiving systematic evaluation and evidence-based revision based on the needs of society and students.
Educated students master their discipline while simultaneously placing that knowledge in context by understanding the world around them.
Foundational knowledge transcends time and space and enables life-long learning.

Context: Education in an Ever-changing, Food-insecure World

Issues facing society and our graduates

1. Climate change
2. Resource scarcity, including water quantity and quality
3. Ecosystem services
4. Economic resilience
5. Broad social issues including DEI, human health, and food justice
6. Shifting demographics
7. Global and local sustainability

Desirable skills (not tools) that employers and society value

1. Systems thinking including understanding Genotype x Environment x Management interactions
2. Quantitative analysis that converts data (big and small) into actionable knowledge
3. Predictive skills including multi-level (farm, watershed, regional, national, and global) modeling
4. Life-long learning including certifications that extend professional growth and opportunities
5. Understanding scale (temporal and spatial) and inference space for decision making
6. Critical/analytical thinking and multifaceted problem solving
7. Creativity and independent thinking, while still participating fully in team efforts
8. Integrity and transparency, including evidence-based decision making
9. Managing and embracing change
10. Others…….both hard and soft skills

Purdue University Core Curriculum

The core curriculum's central motivation is to better prepare all Purdue students for future employment success and responsible citizenship. Recent studies indicate employers are seeking employees with a broad set of skills beyond their discipline-specific abilities. A well-rounded, broad-based core curriculum will ensure this need is fulfilled. Two additional factors support the implementation of a core curriculum: new accreditation requirements and recent legislative initiatives. The Higher Learning Commission of the North Central Association of Colleges and Schools recently updated accreditation mandates that require institutions to maintain a minimum requirement for general education. Additionally, Indiana Senate Act 182 (2012) requires state educational institutions to create a statewide transfer general education core to be implemented by May 15, 2013. Purdue's core curriculum fulfills both of these requirements.

The learning outcomes of the core curriculum at Purdue University are divided into two categories: foundational and embedded. All Purdue undergraduate students must meet the foundational learning outcomes regardless of discipline or major. Embedded learning outcomes are included in the core requirements of particular degrees or plans of study and are addressed within courses or activities identified within a specific discipline.

Foundational Elements of the Core Curriculum include one three-credit course in each of the following outcomes:

1. Written communications
2. Informational literacy
3. Oral communications
4. Science, technology, and society
5. Mathematics/quantitative reasoning
6. Human cultures: humanities
7. Human cultures: behavioral and social sciences

In addition to these outcomes, students will take at least six credits (two courses) in science.

Courses currently approved by the faculty to meet these foundational outcomes can be found at: https://www.purdue.edu/provost/students/s-initiatives/curriculum/courses.html

Discipline-determined embedded outcomes that are determined at the college or department level include:

1. Communications
2. Ways of thinking
3. Interpersonal skills and intercultural knowledge

The College of Agriculture Core Curriculum

The College of Agriculture core requirements go beyond and encapsulate the Purdue University Core requirements outlined above. By meeting College of Agriculture requirements, University Core requirements are automatically exceeded. The credit hour distribution of the College of Agriculture Core across knowledge domains is summarized in Table 13.1.

Table 13.1. Semester credit hour requirements of College of Agriculture Core Curriculum by knowledge domain within the academic category.

Academic Category	Semester credit hours
Freshman orientation	**1**
Mathematics and Sciences	
Biology	8
Chemistry	6
Calculus	3
Statistics	3
Additional Mathematics or Science	3-5
Minimum Total	**23**
Science, Technology and Society	1-3

Written and Oral Communication	
First-year composition	3-4
Fundamentals of speech	3
Additional oral and/or written communications	3
Minimum Total	**9**
Social Sciences and Humanities	
Economics	3
University Core Humanities	3
Other Humanities and/or Social Sciences	6
Humanities or Social Sciences 30000+Level	3
Minimum Total	**15**
Departmental Requirements and Electives	68
Total credits for BS degree	120

Plans of study must include a minimum of nine credits, or equivalent, of International Understanding electives, three credits of Multicultural Awareness electives, and an approved capstone course or experience.

Majors and Minors in the Department of Agronomy

The Department of Agronomy currently offers seven majors/concentrations. Enrollments vary widely by major, with long-standing departmental strengths of plant breeding/genetics and soil/crop management accounting for nearly 60% of the current undergraduates (Table 13.2). The science-based Crop Science and Soil/Water majors target science-oriented undergraduates and possibly considering graduate studies. Many students enter the program as undeclared students who take general studies courses as freshmen and select a major by their sophomore year. Several highly specialized majors have had low enrollments, including International Agronomy and Applied Meteorology and Climatology. Enrollments in the once very popular Agronomic Business and Marketing major are declining. Overall, enrollment has declined 12% between 2017 and 2020. The department can meet the educational needs of over 200 undergraduate students; increasing enrollment is a strategic goal.

Table 13.2. Department of Agronomy majors/concentrations and their enrollments (% of total enrollment also included in 2020) for the last 4 years.

Enrollment by Major/Concentration	Fall 2017	Fall 2018	Fall 2019	Fall 2020	Description
Agronomy:				93 (61%)	
/Agronomic Bus. & Marketing	44	31	17	14 (9%)	Agronomic Business and Marketing prepare students to meet the high demand for professionals in technical sales and marketing or professional field agronomy with strength in business.
/Crop and Soil Management	42	51	65	44 (29%)	Crop and Soil Management is for students interested in applying basic agronomic information to practical situations or

					problems. This is an ideal option for students who plan to become a professional crops/soils manager as an agronomist, farm manager, soil conservationist, or a related profession.
/International Agronomy	3	0	4	6 (4%)	International Agronomy is designed for students interested in the agronomic aspects of international agricultural development. The program prepares students for opportunities in world agriculture through careers with social action agencies, government, and/or private industry.
/Undeclared Agronomy Conc.	26	38	20	29 (19%)	
Applied Meteorology & Climatology	3	4	5	2 (1%)	Applied meteorologists apply weather and climate information to problems facing agriculture and commerce. Graduates work on many environmental problems such as air quality, renewable energy sources, climate change and the impacts of climate change.
Crop Science	4	1	5	5 (3%)	Crop Science provides an education in the basic sciences, with applications in crop plant management and crop improvement. Opportunities are numerous and encompass a broad range in science, business, and education.
Plant Genetics Breeding & Biotechnology	40	43	40	46 (30%)	Plant Genetics, Breeding, and Biotechnology students are interested in agricultural biotechnology, genetic engineering, and research in genetic mechanisms that control crop growth and development.
Soil & Water	5	5	6	7 (5%)	The Soil and Water Sciences option provides a strong science education, while preparing students to apply this knowledge in many technical phases of soil, water resources and environmental management.
Grand Total	171	174	162	153 (100%)	

<u>Minors offered by the Department of Agronomy to students outside of the department.</u>

Currently, a total of 94 students are receiving minors offered by the Department of Agronomy.

Crop Science Minor: 18 Credits Required

<u>Required Courses (6 credits):</u>

AGRY 25500 - Soil Science and either AGRY 10500 - Crop Production **or** AGRY 37500 - Crop Production Systems

Selective Courses (12 credits)

AGRY 10500 - Crop Production
AGRY 32000 – Genetics
AGRY 32100 - Genetics Laboratory
AGRY 33500 - Weather and Climate
AGRY 36500 - Soil Fertility
AGRY 37500 - Crop Production Systems
AGRY 48000 - Plant Genetics
ENTM 20600 - General Entomology
AGRY 50500 - Forage Management
AGRY 51500 - Plant Mineral Nutrition
AGRY 52000 - Principles and Methods of Plant Breeding
AGRY 52500 - Crop Physiol. & Ecology or HORT 30100 - Plant Physiol.
BTNY 30100 - Introductory Plant Pathology
BTNY 30400 - Introductory Weed Science
BTNY 35000 - Biotechnology in Agriculture
ENTM 20700 - General Entomology Laboratory

Soil Science Minor: 18 Credits Required

Required Courses (6 credits)

AGRY 25500 - Soil Science and AGRY 36500 - Soil Fertility

Selective Courses (12 credits)

AGRY 29000 - Introduction To Environmental Science
AGRY 33500 - Weather and Climate
AGRY 33700 - Environmental Hydrology
AGRY 33800 - Environmental Hydrology Laboratory
AGRY 34900 - Soil Ecology
AGRY 35500 - Soil Morphology and Geography
AGRY 38500 - Environmental Soil Chemistry
AGRY 45000 - Soil Conservation and Water Manage.
AGRY 46500 - Soil Physical Properties
AGRY 54400 - Environmental Organic Chemistry
AGRY 54500 - Remote Sensing of Land Resources
AGRY 55500 - Soil and Plant Analysis
AGRY 56000 - Soil Physics
AGRY 56500 - Soils and Landscapes
AGRY 58000 - Soil Microbiology
AGRY 58200 - Environmental Fate 0f Pesticides
AGRY 58500 - Soils and Land Use
AGRY 54000 - Soil Chemistry

Minors of potential interest to AGRY majors

International-related minors:
International Studies in Agriculture
Global Food Agricultural Systems
Global Liberal Arts Studies
Global Studies

Business-related minors:
Farm Management
Economics
Food and Agribusiness Management

Environment-focused minors:
Natural Resource & Environmental Science
Sustainable Environments
Sustainable Food and Farming Systems
Environmental and Ecological Engineer.
Earth, Atmospheric & Planetary Sciences

Plant Genet/Breed/Biotech-related minors:
Biotechnology
Bioinformatics
Insect Biology
Plant Biology
Plant Pathology

Courses Supporting the Curricula and Majors in the Department of Agronomy

The department's courses supporting majors and minors are grouped by concentrations (knowledge domains) that align with faculty expertise (Table 13.3). Within a concentration, courses are further parsed

out by level (I-entry level; II=advanced level) and include aspirational courses that faculty in this concentration considered necessary for student education but currently are not offered. Courses outside of the Department of Agronomy that contain content relevant to the concentration are also listed as these could serve as an alternative to or complement existing departmental courses. For example, several departments provide courses in the Plant Genetics concentration area. Most coursework in the Earth Systems Sciences Concentration that supports majors the Applied Meteorology and Soil/Water majors are in the Earth, Atmospheric and Planetary Sciences Department (EAPS) and/or Schools of Engineering. Low enrollment courses (<10 students annually) are highlighted in yellow (Table 13.3) and listed below for convenience. Reasons for low enrollment vary but include relatively new courses (e.g., AGRY 123, 598), labs with enrollment limits (AGRY 338, 518), or have specialized, advanced content (graduate courses).

Table 13.3. Courses within the Department of Agronomy (AGRY prefix) and other departments at Purdue University that support the curricula. Within a concentration, courses are further broken out by level (I-entry level; II=advanced level) and aspirational courses that faculty in this concentration considered necessary for student education but currently are unavailable on campus. Courses outside of the Department of Agronomy that contain content relevant to the concentration are also listed as these could serve as an alternative to or complement existing departmental courses. Low enrollment courses (<10 students annually) are highlighted in yellow and summarized in Table 8.4.

International Concentration		Plant Breeding and Genetics Concentration		
International AGRY II		**Plant Breeding II**		**Plant Genetics II**
AGRY 598/Ejeta Global Food Sec.		AGRY 550 Fld Breed. Tech.		AGRY 511 Pop. Genet.
AGEC 571 Emerging Global Issues		AGRY 605 Adv. Plt Breed.		AGRY 600 Genomics
		BTNY 525 Int. Plant Path.		AGRY 611 Quant. Genet.
		BTNY 613 Adv. Plant Path		AGRY 530 Adv. Plt Genet.
		ANSC 595 Genomics Appl Breeding		HORT 531 Appl Plant Genomics
		BTNY 525 Intermediate Plant Pathology		BTNY 552 Molecular Approaches to Plant Biology
		BTNY 613 Advanced Plant Pathology		BTNY 590G Plant Developmental Genetics
				BIOL 595 Introduction to Bioinformatics
				BIOL 595 Genetics Omics Host Microbe
				BIOL 595 Genomics in Ecology and Evolution
International AGRY I		**Plant Breeding I**		**Plant Genetics I**
AGRY 285 Crop Adapt. Distr.		AGRY 520 Principles Plant Breeding		AGRY 123 Genetics & Society
AGRY 350 Global Awareness				AGRY 320 Genetics
AGEC 250 Econ. Geogr. of World Food & Resources				AGRY 321 Genetics Lab
FNR 302 Global Sustainability Issues				AGRY 480 Plant Genetics
AGEC 340 International Economic Development				BIOL 241 Genetics & Mol. Biol.
AGEC 450 International Agricultural Trade				FNR 305 Conservation Genetics
				BIOL 312 Great Issues: Genomics & Society
				BTNY 350 Biotechnology in Agriculture
				BIOL 395 Genes + Proteins = Big Data
				BIOL 415 Introduction to Molecular Biology
				BIOL 478 Introduction to Bioinformatics
				BIOL 481 Eukaryotic Genetics
Aspirational Courses		**Aspirational Courses**		**Aspirational Courses**
None at this time		Breeding for Nutritional Traits		None at this time
		Phenomics		
		Breeding for Biotic & Abiotic Stress Tol.		
		Tissue Culture Appl. to Plant Breeding		

Eco-physiology Conc.	Crop Management Conc.	Earth System Sciences Concentration	
Eco-physiology II	**Crop Management II**	**Hydology II**	**Biometeorology II**
AGRY 624 Plt Ecophysiol.	AGRY 598 Crop. Sys. Res.	AGRY 641 Adv. Hydrology	AGRY 535 Bound. Layer Met.
AGRY 518 Physiol. Lab	AGRY 505 Forage Mgmt	ABE 522 Ecohydrology	AGRY 536 Env. Biophys.
AGRY 525 Crop Physiol & Ecol	AGRY 598 Precision Crop Mgmt	ABE 529 Nonpoint Source Poll.	AGRY 635 Micromet.
BIOL 595 Ecology	BTNY 504 Adv. Weed Science	AGRY/CE 641 Stat. Hydrology	EAPS 510 Climate Analy
BIOL 591 Field Ecology		CE 542 Hydrology	EAPS 521 Atm. Chemistry
BCHM 625 Metab. Plant Physiol.		CE 544 Subsurface Hydrology	EAPS 522 Chem of Earth's Upper Atm
AGRY 514 Env. Stress Turfgrass		CE 549 Comput. Watershed Hydrol.	EAPS 530 Ext. Weather and Clim.
AGRY 515 Plt Mineral Nutr.		CE 682 Groundwater Seepage	EAPS 532/3 Atm Physics I, II
		EAPS 584 Hydrogeology	EAPS 534 Trop. Meteor.
		EAPS 680 Contam. Hydrogeology	EAPS 538 Cumulus Dynamics
			EAPS 539 Mesoscale Meteor.
			EAPS 620 Aerosols, Clouds, & Climate
			EAPS 638 Atm Radiation
Eco-physiology I	**Crop Management I**	**Hydrology I**	**Biometeorology I**
SFS 301 Agroecology	AGRY 105 Crop Production	AGRY 337 Env. Hydr.	AGRY 335 Weather & Clim.
HORT 301 Plant Physiology	AGRY 375 Crop Prod. Sys.	AGRY 338 Env. Hydr. Lab	EAPS 117 Intro Atm Science
BTNY 302 Plant Ecology	BTNY 301 Intro Plant Pathology	AGRY 120 Water & Food Security	EAPS 221 Surv Atm Science
FNR 434 Tree Physiology	BTNY 304 Intro Weed Science	CE 341 Hydaulics, Hyd. & Drainage	EAPS 225 Science of the Atm
	ENTM 206 Gen. Entomology	ABE 325 Soil & Water Resour Engin.	EAPS 227 Intro Atm Obs. & Meas.
	ENTM 207 Gen. Entomology Lab.	ABE 325 Soil & Water Resour Engin.	EAPS 230 Lab in Atm Sci
		CE 442 Into to Hydrology (new)	EAPS 325 Aviation Meterol.
		EAPS 200 Water World (new)	EAPS 327 Clim, Sci & Society
		AGRY 190 Intro Env. Sci. (aka 290)	EAPS 421 Atm Thermodyn
			EAPS 422 Atm Dynamics I
			EAPS 432 Atm Dynamics II
			EAPS 434 Weath Anal & Forecasting
			EAPS 431/2/3 Synop Lab I, II, III
Aspirational Courses	**Aspirational Courses**	**Aspirational Courses**	**Aspirational Courses**
Advance Agro-ecology (500/600)	Intro Crop Diagnostic Princp Techn.	None at this time	None at this time
	Intro to Precis. Agric.		

Soil Science Concentration		Systems and Data Concentration		Cross-cutting Skills
Soils II		**Systems and Data II**		**Professional Development II**
HORT 513 Nutrition of Hort. Crops		HORT 530 Intro to Computing for Biologists		AGRY 596 Prof. Presentations
AGRY 540 Soil Chem.		ABE 531 Instrumentation and Data Acquis.		AGRY 597 Comm w/ Public
AGRY 544 Env. Org. Chem.		ASM 540 GIS Application		AGRY 696 Grad. Seminar
AGRY 560 Soil Physics		AGRY 545/CE 597 Remote Sens. Of Land Resources		
AGRY 565 Soils & Landscapes				
AGRY 580 Soil Microbiol.				
CE 587 Soil Dynamics				
AGRY 649 Mol Microb Ecol				
AGRY 650 Clay Minerology				
EAPS 518 Soil Biogeochemistry				
AGRY 598 N Course (1 cr. Jim C.)				
CE 681 Eng. Properties of Soils				
Soils I		**Systems and Data I**		**Professional Development I**
AGRY 155 Soil Morphology		ENTM 242 Data Science		AGRY 398 Soph. Seminar
AGRY 255 Soil Science		AGRY 598 Plants, Data, and Comp. Thinking		AGRY 498 Senior Seminar
ABE 325 Soil & Water Resource Eng.		FNR 355 Quant. Methods for Resource Mgmt		AGRY 390 Co-op
AGRY 349 Soil Ecology		FNR 357 Fund. Remote Sensing		AGRY 400 Study Abroad
AGRY 355 Soil Morphology		AGRY 598 Plant to Landscape Modeling		
AGRY 365 Soil Fertility				
AGRY 385 Env. Soil Chem				
AGRY 450 Soil Cons. Mgmt				
Aspriational Courses		**Aspirational Courses**		
Contaminant Hydrology		AGRY 398 Intro to Digital Agronomy		
Advanced Soil Fertility				
Soil, Plant, & Water Analysis Lab				

Table 13.4. An average of 10 or fewer students have enrolled annually in these departmental courses from 2013 to 2020

Undergrad courses	Dual-level courses	Graduate Courses
AGRY 123 Genetics & Society	AGRY 511 Population Genetics	AGRY 600 Genomics
AGRY 155 Soil Morphology	AGRY 514 Environ. Stress Turfgrass	AGRY 605 Advanced Plant Breeding
AGRY 355 Soil Morphology	AGRY 515 Plant Mineral Nutrition	AGRY 611 Quantitative Genetics
AGRY 338 Environ. Hydrology Lab	AGRY 518 Plant Physiology Lab.	AGRY 624 Plant Ecophysiology
AGRY 390 Co-op	AGRY 536 Environ. Biophysics	AGRY 635 Micrometeorology
AGRY 400 Study Abroad	AGRY 535 Boundary-Layer Meteorol.	
AGRY 480 Plant Genetics	AGRY 540 Soil Chemistry	AGRY 649 Molecular Microbial Ecology
	AGRY 550 Field Breeding Techniques	AGRY 650 Clay Mineralogy
	AGRY 580 Soil Microbiology	
	AGRY 597 Communicating w/ Public (graduate seminar)	
	AGRY 598 Global Food Security.	
	AGRY 598 Cropping Systems Research	

Future Curricular Opportunities

1. Review of course offerings
   a. Analysis of course offerings is ongoing.
   b. Low enrollment courses, especially at the 100 to 499 level that target undergrads, will receive careful evaluation in terms of content, target audience, instructor effectiveness, overlap, etc. Some of these will be dropped and resources re-deployed on course opportunities that will better serve our students.
   c. Aspirational courses will be evaluated for their relevance, potential audience, overlap with existing offerings, impact, level, alignment with majors and minors, innovation, etc., and where appropriate, created initially as an AGRY 598 (temporary course). These new courses will be evaluated annually for their effectiveness at meeting student needs and provided permanent course status if deemed appropriate.
2. Review and change as necessary majors with low participation.
   a. Retain majors that serve student educational needs as indicated by enrollment.
   b. Change or eliminate majors with little or no interest.
      i. Because of low student interest, we will consider dropping the International Agronomy major and use the suite of minors (see above) to complement our majors, certify student competency in international studies, and provide this knowledge to interested students. This change also eliminates the misperception that agronomic principles used in international settings is somehow fundamentally different from principles used in "domestic agronomy".

ii. Applied Meteorology/Climatology will be changed to a minor because of historic low enrollments (see Table 13.2) and limited faculty numbers in the department to support the major. We will consider renaming the new minor to include "Climate Science" (or similar) to emphasize this topic and to capture the interest in climate change among students and society.

iii. We will consider combining Crop Science and Soil & Water majors into a single graduate-preparation track major called Crop and Soil Science (or similar title). Both majors currently have persistent low enrollments and similar purpose (high scientific rigor; potential graduate school attendees)

c. We will evaluate the "Agronomy Major/Concentration" scheme and propose to simply use Agronomic Bus & Marketing and Crop & Soil Mgmt. as majors. This assumes the International Agronomy major is dropped, and the "Undeclared" freshman can be well-served as a separate group.

d. Using the 2020 enrollment figures, this restructuring would result in the following student distribution across our majors:

i.	Crop and Soil Management	29% of students
ii.	Crop and Soil Science	8%
iii.	Agronomic Business and Marketing	9%
iv.	Plant Genetics, Breeding and Biotech.	30%
v.	Undeclared	19%

3. Evaluate current minor offerings and alter as necessary

a. Review and update our current minors in Crop Science and Soil Science.

b. Add a new minor in Agronomic Analytics (or similar title) that focuses on data workflows and curation, metadata and data interoperability, data analysis, including machine learning, modeling, and interpretation. Two new faculty, Drs. Wang and Cammarano have expressed interest in developing/supporting this new minor as they launch their teaching/research programs. This will be placed in the curriculum in a manner that complements the existing minor Data-Driven Agriculture.

c. Add a new minor in Agro-meteorology and Climate Change. This will replace the major in Applied Meteorology and Climatology. It will also shift the focus to include climate change science that should interest many majors within the College of Agriculture.

d. We will consider adding a new minor called Agro-ecology to attract new students who otherwise might not consider agronomy as an academic home and who have an interest in regenerative agriculture, sustainability, environment, climate change, ecosystem services, etc. If successful, this minor may evolve to be a major as interest and faculty support increase.

e. Evaluate minors external to the department and make better use of these external certifications to support the education of our students. For example, if declining enrollments in the Agronomic Business and Marketing major continue, we will evaluate the use of minors in business, management, and/or economics to provide the knowledge and certification historically provided by this major.

14. Agronomy Center for Research and Education

The ACRE Mission

Agronomy **C**enter for **R**esearch and **E**ducation (**ACRE**) is a state-of-the-art agricultural research facility that supports innovative research in plant science, genetics, breeding, soil science, weather and climate, environmental sciences, agricultural production, agriculture technologies, and precision agriculture. It is open to Purdue faculty in the Department of Agronomy and related departments in the College of Agriculture and College of Engineering, as well as industry collaborators.

ACRE Vision

Our vision is to be a progressive field-based research facility promoting a collaborative research environment. We aim to pursue Purdue's education, research, and Extension missions and to create innovative solutions for today's and tomorrow's critical agricultural production and environmental protection questions.

We focus on this vision by:

- Fostering the development of Purdue's best assets, its people
- Positioning ourselves as a leader in agricultural technology development and testing
- Staying nimble to accommodate a broad range of research, teaching, and Extension needs
- Aiming for excellence in our interactions with researchers, industry, and farmer clientele
- Staying true to our name—to be a center facilitating the best the state has to offer in research and educational opportunities

Impact

The ACRE is home to ~80 researchers from 10 university departments (Table 14.1). This cross-disciplinary work is one of the most valuable and unique aspects of this research facility. Currently, cooperating Purdue University departments include Agronomy, Entomology, Botany and Plant Pathology, Agricultural and Biological Engineering, Biological Science, Computer Science, Civil Engineering, Aviation, Aeronautical Engineering, and Mechanical Engineering, which span four colleges. Collaborators from across the globe, other universities, and industry join these faculty in a wide array of multi-disciplinary work at ACRE.

The studies range from fundamental to applied research, including plant breeding and genetics, crop production, nutrients, and soil tillage management, the impact of agricultural practices on air, water, and soil quality, plant physiology, weed control, disease and insect resistance and control, and innovative research in field robotics and automation, sensor controls, and ag technologies.

Research emanating from ACRE reaches thousands of farmers and industry stakeholders across the state of Indiana. Additionally, hundreds of students utilize ACRE as research technicians, graduate research assistants, summer students, or through interactive classroom laboratories utilizing the ACRE space.

Table 14. 1 Faculty and Staff using ACRE as part of their research program during 2017-2021:

Shalamar Armstrong; Cropping Systems	Christian Krupke; Crop Insects
Mike Baldwin; EAPS Weather Sensors	Linda Lee; Environmental Chemistry
Larry Bledsoe; Entomology	Damon Lisch; Genetics
Laura Bowling; Watershed Hydrology	Jianxin Ma; Soybean Genomics
Adam Brock; USDA Soybean Production	Katy Mazer; Water Management
Sylvie Brouder; Plant Nutrition/Water Quality	Michael Mickelbart; Genomics
Guohong Cai; USDA Soybean Pathologist	Mohsen Mohammadi; Small Grains
Jim Camberato; Soil Fertility	Bob Nielsen; Corn Production Systems
Shaun Casteel; Soybean Production	Beth Hall; Weather and Climate
Keith Cherkauer; Sensor Networking	John Obermeyer; Integrated Pest Mgt.
Melba Crawford; Remote Sensing	Gouri Prabhakar; Environmental and Air Quality
Brian Dilkes; Corn Genomics	Daniel Quinn; Corn Production Systems
Jeffrey Dukes; Ecosystems	Katy Rainey; Soybean Breeding and Phenomics
Shawn Ehlers; Grain Systems Management	Ankita Raturi; Cover crops, Digital Ag
Gebisa Ejeta; Sorghum Genetics	Patrick Rich; Sorghum Genetics and Breeding
John Evans; Machine Systems and Automation	Tracy Richards; Wheat Breeding
Bill Foster; Sorghum Genetics and Breeding	Torbert Rocheford; Corn Genomics, Genetics
Jane Frankenberger; Watershed Hydrology	Cliff Sadof; Insect physiology
James Garrison; Remote Sensing & GPS	Darrell Schulze; Soil mapping and Mineralogy
Corey Gerber; Crop Diagnostic Training	Steve Scofield (USDA); Wheat Genetics
Kevin Gibson; Crop-weed Competition	Gary Steinhardt; Soils
Steve Goodwin (USDA); Wheat Fungal Diseases	Richard Stroshine; Grain Quality
Rich Grant; Climate and Environment	John Sullivan; Unmanned Aircraft
Karen Hudson; USDA Soybean Genetics	Mitch Tuinstra; Crop Genomics and Phonemics
Klein Ileleji; Post Harvest Grain	Ron Turco; Soil and Water Microbiology
Jian Jin; Sensors and Phenomics	Darcy Telenko; Field Crop Diseases
Guri Johal; Plant Genomics	Tony Vyn; Cropping Systems
Bill Johnson; Weed Management	Yang; Phenomics
Keith Johnson; Forages and Cover Crops	Bryan Young; Weed Control Management
Cliff Johnston; Environmental Soil Chemistry	
Eileen Kladivko; Soil Physical Properties	

Operational Data

ACRE is comprised of a 1,600-acre farm-research facility located five miles northwest of Purdue University Main Campus (Figure 14.1). It is located on U.S. Highway 52 West, West Lafayette, Indiana. The facility is under some pressure from home development in nearby locations.

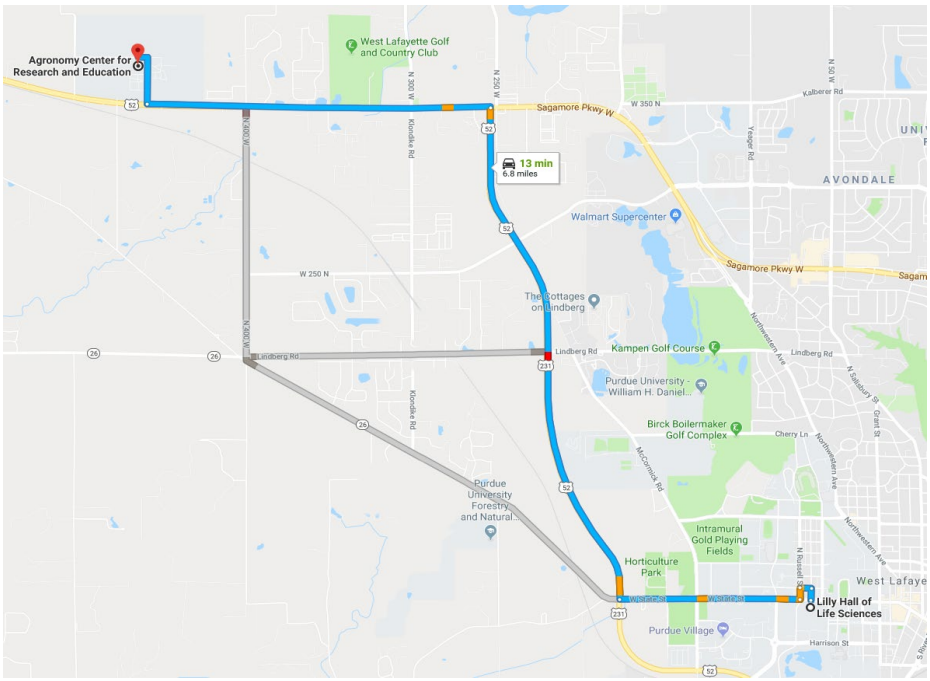


Figure 14.1. The ACRE facility is located near West Lafayette, Indiana, and is approximately 5 miles from campus and the Department of Agronomy offices in Lilly Hall. The addition of State Road 231 in 2013 has improved travel safety and diminished travel time to under 13 minutes from campus to the ACRE (from Google Maps).

History

ACRE began in 1949 with a 374-acre land purchase and has been expanded to our current 1,600 acres using eight major land procurements, typically occurring when an adjacent property becomes available for sale. The most recent addition of 200 acres occurred in 2020 and is being used for bulk production, as the land needs to be tiled and drained before being utilized for research. This field is earmarked for research in digital agriculture, machine automation, and ag robotics and will be kept as one field for complete field-scale trials.

Three superintendents have managed ACRE: Ozzie Luetkemeier, 1949-1986, Jim Beaty, 1986-2020, and Rachel Stevens, 2021-present. Beyond the superintendent, ACRE employs three full-time technicians, with additional seasonal and student labor as needed. As the farm manager, Stevens also works with an advisory committee composed of staff and faculty.

Management

ACRE is divided into approximately 115 plot locations (Figure 14.2). The plots are arranged to accommodate soil diversity, drainage, and other characteristics associated with agronomic production. Most fields range from 9 to 40 acres, with several extensive tracts around 200 acres. We rotate the plot areas in and out of research and bulk production and rotate between corn and other crops yearly to ensure soil productivity. Because fields are rested every other year, our results are more reliable; they are not skewed by compaction and previous research treatments. In any given year, about 75% of the farm is in rotational acres and 25% is in research plot acres. Grain produced on the rotational acres is contracted and sold on the open market. The money generated from the rotational acres funds all farm acres. Land requests are made by the researchers each spring via the land request form (see Appendix K). ACRE does not have a land management fee or charge for management services because we subsidize the research acres with rotation fields.

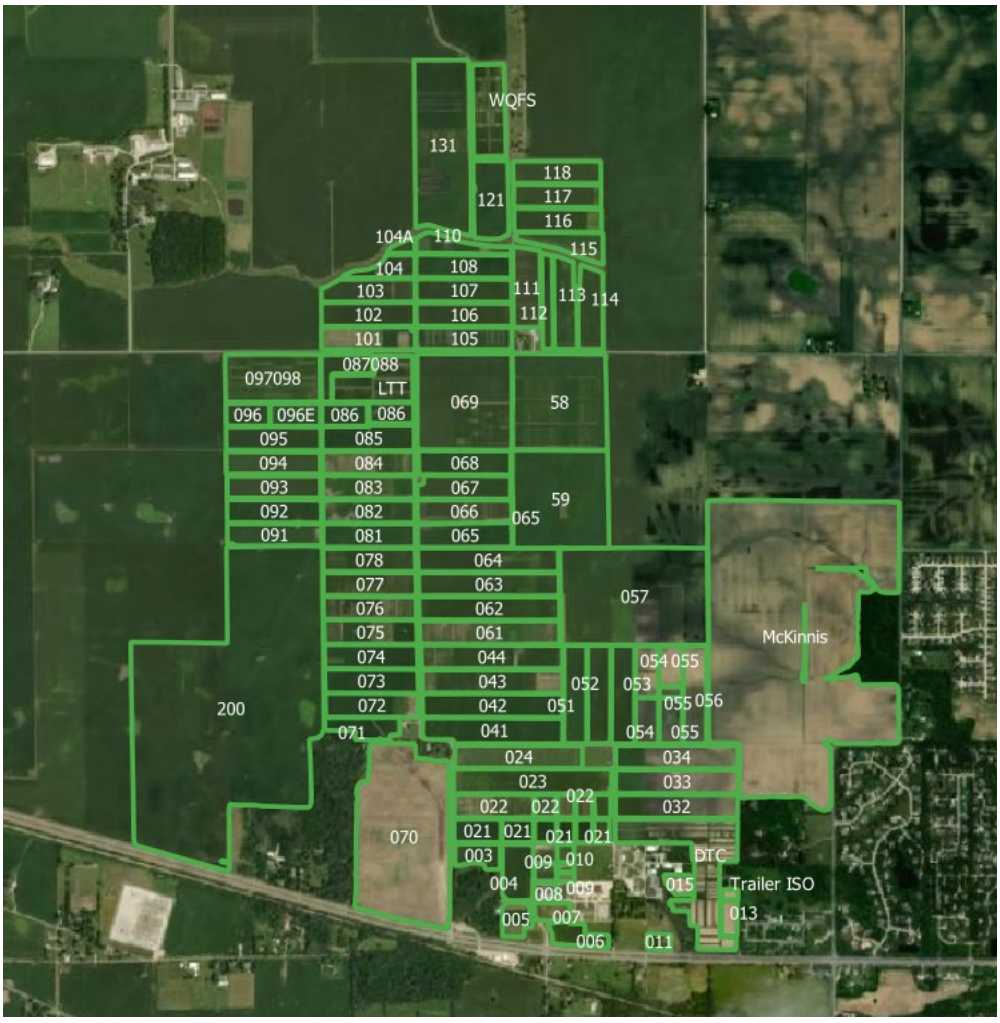


Figure 14.2: The approximate 115 fields available for research and rotational acres at ACRE. LTT is the long-term tillage area, while the WQFS is the Water Quality Field Station. The McKinnis area, purchased in 2020, is being prepared for research.

Soils on the farm are classified as somewhat poorly drained to poorly drained. Predominate soil series consists of Chalmers silty clay loam, poorly drained, and Raub-Brenton complex made of silt loams, which are somewhat poorly drained. Parent materials are typical of the region but can be challenging to manage, with wet soil conditions frequently causing delays in fieldwork.

The general crop rotation on the farm is between corn and soybeans while accommodating research acres of wheat and sorghum. Again, the rotational acres significantly benefit research by allowing for a buffer year between research to ease the impacts of previous compaction and treatments. All fields on the farm are utilized for research in some capacity. The majority of the 9 to 13-acre fields are used for research every other year. Larger fields are being used for field-size trials or analysis of various management practices for the farm.

Soil sampling on the farm has generally been sporadic and not georeferenced. Historical soil sample records date back to the mid-1970s. Fertility has not been a significant priority for the farm, with some sites intentionally left under-fertilized for period fertility studies. Soil fertility is a significant point of improvement to be prioritized in future years.

Extensive tillage has been completed across the farm since its inception and continued even as no-till became more prevalent in the state. Historically, plot management has required tillage to enable researchers' small plot planters to function correctly. Conversely, tillage before rotating into bulk rotational acres has also been necessary due to the impact of plot equipment on field conditions. Tillage equipment used in past years includes a chisel, disc ripper, field cultivator, and vertical tillage tool. Our tillage strategy needs to be evaluated in future years, and various tillage practices are demonstrated. Potential options include fall disc ripping followed by a spring field cultivator, fall disc ripping followed in spring with a soil finisher, fall strip-till, spring soil finisher, and no-till. Implementation of cover crops as an alternative to some tillage practices should also be considered.

Predominant tiling of the farm occurred in the '50s and '60s. Clay tile was laid at 66-foot intervals. A few newer tiling projects have occurred, mainly to fix older tile mains or correct issues as they arise.

Challenges

- Lack of available storage space, as well as a number of buildings in inferior condition or in a poor location.
- ACRE grain storage and handling facility (to allow for the timely harvest of research plots) is out-of-date, inadequate in size, in need of constant repair, uses obsolete electrical equipment, has an inefficient drier, and creates a traffic safety hazard for trucks.
- Lack of modern field equipment (see Table 14.1).
- 200 acres acquired in 2015 and 200 acres acquired in 2020 require drainage tile installation.
- Tile installation is also needed on fields 57, 112, 113, and 114—a whole farm assessment is needed.
- Drainage tile in most fields needs replacement, as tiles are old or filled with soil.
- Limited access to water for irrigation/limited irrigation (challenging to run drought stress studies).
- Inadequate soil, seed, and plant biomass sample storage.
- Inadequate education space for adult and student education programs near DTC plot areas.
- Rodent problems.

- Poor farm security (lack of modern approaches).
- Small equipment/tool checkout/storage area is lacking.
- Lack of signage/wayfinding signs, producing safety concerns.
- Lack of public transportation to/from ACRE to the campus limits, which makes it more difficult for undergraduate and graduate students to work at ACRE.
- Electricity to various parts of the farm is lacking.
- Need for a crew of trained summer employees to help on projects.
- Undersized and limited sewage system (no new buildings with bathroom facilities until upgrades to our sewage management are made).
- Lack of georeferenced soil sampling data and historical farm fertility data and management.
- Tight staffing—downsizing of staff from Farm Manager, Assistant Manager, and 3 technicians to Farm Manager and 3 technicians

Funding

ACRE fiscal resources and productivity

Nearly all ACRE operations (excluding staff salaries) are funded through grain sales from the rotational acres. Historically, for the ACRE operation, the college provides salaries and fringe benefits via a unique state program called, Crossroads funding, while nearly all operations dollars are generated from the cash sale of corn and soybeans. Income and profitability depend on the percent of the land in rotational acres each year and marketing strategy and success. Research acres generally range from 275 to 400 acres a year. As the farm has grown, so has the number of research acres, with these acres usually taking up about 18-25% of crop ground.

Consequently, 75% of the cropped ground is responsible for carrying the cost of the entire farm. This is a reasonable way to subsidize the cost of research acres and avoid land fees for researchers; however, this does reflect in our cash flows. A contingency plan or additional source of funds needs to be in place for low-profit years where rotational acres cannot cover the break-even cost for both the rotational and research acres.

Crop production provides most of the operation's income, but we do receive funds from the college, university, Ag Alumni Seed, and others for large buildings and special projects. Data in Table 14.2 shows farm production over the last five years. Five-year corn and soybean averages are 188 bu/ac (+/- 22) and 58 bu/ac (+/- 4), respectively. ACRE averages may be artificially low as the calculation includes can include harvest from land in border areas, crop destruction programs, plant breeding, and other low-yielding areas. For a simple comparison, we have taken data from the National Agricultural Statistics Service (https://quickstats.nass.usda.gov), which shows that average reported yields for corn in Tippecanoe County have ranged from a low of 180 (2017, 2019) to a high of 207 bu/ac (2020), with an average of 190 bu/ac over the same five-year period. Beans followed the same trend in terms of production across years. Beans ranged from a low of 50.1 (2017) to a high of 65.4 bu/ac (2020), with an average of 58 bu/ac. Again, ACRE has many acres of nurseries and crop destruction programs that reduce our apparent overall yields.

Table 14.2. Historical production areas and yields for ACRE from 2016-2020.

Crop	2016	2017	2018	2019	2020
Corn					
Area (ac)	467	531	528	617	822
Yield (bu/ac)	185	174	199	170	213
bushels	86,395	92,394	105,072	104,890	175,086
Soybeans					
Area (ac)	457	601	549	530	520
Yield (bu/ac)	60	61	53	51	66
bushels	27,420	36,661	29,097	27,030	34,320
Wheat					
Area (ac)	20	20	76	18	18
Yield (bu/ac)	54	47		35	
bushels	1,080	940		630	
Sorghum					
Area (ac)	46	35	37	27	27
Yield (bu/ac)	28	23	24		
bushels	1,288	805	888		

In terms of funding, ACRE would greatly benefit from creating two funds: an endowment to invest in the long-term vision and viability of ACRE, and a land maintenance fund for land repairs and improvements to tile and drainage. Data in Table 14.3 clearly demonstrate that ACRE is at its fiscal capacity as a farming operation. Land payments and equipment repair and replacements have consumed all existing cash reserves. Over the five-year period, the cost of seed, fertilizers, pesticides, and fuel ranged from $152,0195 to $281,380, typically consuming 25 to 35% of operational funds. Land payments consumed an additional 23 to 30% of available funds, typically $150,000. Of note is the decline (38%) in farm income in 2017-2019, even though harvested acres and total yields (bushels) for corn and soybean increased over this same period.

The current fleet of ACRE farm equipment is old and not providing optimal operational strength in terms of productivity or data (see Table 14.4). To supplement our aging fleet of tractors, we rely on leased tractors throughout the year—one John Deere tractor in the 300-horsepower range for planting, and one larger horsepower tractor from Case for fall tillage. These leases are very reasonably priced, ranging from $30-50/hour. At these rates, our leased tractors are more economical to run than owning the machines.

Replacement of our 12-row planter with a system with improved metering, hydraulic downforce, and liquid fertilizer capabilities and improved monitoring is essential, mainly as larger-scale field trials are implemented.

Improvements to our 6-row planter for better monitoring and recording of planting data and more precise seed placement and accurate population would greatly benefit the many research acres planted with this machine.

Table 14.3. Income and expenses for ACRE from 2017-2021.

Crop	2017	2018	2019	2020	2021
	Income				
Corn					
Income ($)	304,462	317,720	218,426	401,156	548,423
Soybeans					
Income ($)	247,650	301,817	188,123	427,062	389,232
Wheat					
Income ($)	4,597	4,802	0	1,154	2,000
Sorghum					
Income ($)	4,597	3,873	11,311	0	3,000
Income from Sales[1]	560,707	628,212	417,860	829,372	942,655
Total Income	624,973	761,051	426,760	836,147	952,030
Carry Forward	-4,435	-32,017	4,074	-89,450	104,781
Gross Income	**620,538**	**729,034**	**422,686**	**746,697**	**1,056,811**
	Expenses				
Real Estate	-152,856	-150,000	-150,000	-150,000	-150,000
Capital Equipment	-59,200	-27,300	-231,006	-34,000	- 248,489
Repairs/Maintenance	-35,888	-70,983	-78,640	-77,718	-58,272
Utilities	-43,628	-52,371	-47,931	-34,588	-47,242
Other Works	-11,070	- 9,259		-19,206	-14,315
Temp staff/Undergrads	-89,693	-34,548	-5,551	-8,050	-10,731
Fertilizer/Pesticides	-137,512	-141,625	-80,387	-146,766	- 121,334
Seed	-53,103	-42,573	-37,988	-66,951	-127,041
Fuel	-34,204	-37,480	-33,644	-39,754	-33,005
All other[2]	-49,896	- 81,112	-67,991	-67,883	-46,832
Total Direct Expenses	-667,052	-647,253	-512,136	-641,916	-857,261
Renovations[3]	0	-77,707	0	0	-1,000
Total Expenses	-667,052	-724,961	-512,136	-641,916	-858,261
Fringe return	+14,496				
Remaining Balance	**-32,017**	**4,074**[4]	**-89,450**	**104,781**	**198,550**

[1]Sales income are derived from the sale of the previous year's crop.

[2]Includes: Rentals, some professional services, taxes, telecom, insurance, etc.

[3]Includes: Renovations to restrooms and breakroom, Welch House Roof and painting, and tile installation.

Table 14.4 Farm equipment managed by ACRE.

Tractors	Model Year	Other Equipment	Model Year
JD 4555	1991	7200 JD planter	1995
JD 4440	1982	Hagie Sprayer STS 12	2020
JD 4240	1979	JD Backhoe	1996
JD 6400	1998	Fork-Lift	2017
JD 6400		JD S660 combine	2014
John Deere 8245R	2018	JD 12 Row Planter	2009
		Kinze 3500 15 Row	2017
		JD-2510L Sidedress	
		Case 875 disc ripper	2019
Truck number & capacity	**Model Year**		
#261 ½ Ton	2008		
#572 ½ Ton	2006		
#581 ¾ Ton	2009		
#632 1-Ton	2009		
#9480 Ken Water Tanker	1989		
#115 Grain Truck	1980		
Dump Truck			
Tempte Grain Semi and Trailers (Two)	2003/2016		

A recent purchase of the Hagie STS12 spray rig dramatically improves our efficiency and accuracy for spray applications and gets us up-to-date with spray technologies. Different systems, such as a pulse width modulation system (PWM), drops for in-season N applications, or mountable crop sensors for variable nitrogen rate applications, could be implemented in the future.

Our tillage equipment includes a new Case disc ripper that was a dramatic upgrade from our previous implement. Many research acres are disc ripped in the fall, followed by cultivation in the spring. Our field cultivator and rolling harrow are adequate. In the past year, we leased a vertical tillage tool. Further research into tillage practices and management moving forward is needed before future tillage equipment purchases are needed.

A new side-dress applicator, a 2510L, was purchased to increase side-dress timing efficiency and accuracy. This toolbar reduced the time spent side-dressing and was more accurate for applications in studies with multiple nitrogen rates. A possible upgrade would include the implementation of a PWM system for on-the-go adjustments to a broad range of rates.

Buildings

Existing infrastructure was assessed as part of the ACRE Master Plan and can be found in Appendix K. Buildings were inventoried, and following a set of criteria, marked as appropriate, in need of repair, or in need of removal. The assessment determined that a minimum of 12 buildings need to be repaired or removed. Of note are the grain center complex and some of the older storage buildings. Eleven new buildings have been proposed for development at ACRE, including a soil processing addition to ICSC, a new grain complex, soil archival storage, cold storage for seeds, equipment and storage bays, student and adult education building, and a rainout shelter. The rainout shelter development is currently underway at ACRE.

The additional infrastructure needed includes expanded parking around Beck and ICSC, a water tower for increased capacity and ability to expand irrigation for research, upgraded sewage and wastewater systems, and improved roads through the farm. Most significantly, a whole farm investment in improved pattern tile is critical. Currently, research is limited by poor drainage across the farm, in terms of damage to research plots from water inundation, challenging research circumstances with highly variable soil conditions, and loss of workable field days.

Education

Extension programing is currently the primary educational use of ACRE. Workshops through DTC and field days to disseminate research conducted at ACRE are held annually. Several classes visit ACRE each year as part of their laboratory or course work.

Additional emphasis on education at ACRE is important, given it is a key part of our mission and our name. Investing in resources to interact with more students every year for various courses in crop management, precision agriculture, and soil science is essential, including improved classroom space at ACRE. Exposure to a working farm and a variety of research groups is a substantial educational benefit to students. An internship program is being developed to foster student interest in farm management, field research, and ag technology application. The Beck Center at ACRE is utilized year-round for hosting field days, workshops, faculty retreats, and industry meetings and often is not available for educational events. Additional infrastructure for educational space would be of great benefit to further these goals.

Future Directions

DATA @ ACRE

As the players in the world of digital agriculture increase, so does the need for reliable testing, verification, and accessible testbeds for digital ag startups. ACRE will position itself as the premier test bed for agriculture technologies in the coming years through its Digital Agronomy Testbed Alliance (DATA) @ ACRE program. This testbed will be a collaborative working environment providing full-scale access to various field sizes and management practices, a variety of farm equipment, and a real-world testbed for developing and deploying agriculture technologies. The access to space and the robust pool of researchers is a tremendous asset to ACRE and those in the ag technology space.

DATA @ ACRE flyer (see Appendix K) shares more about the initiative and direction of digital agriculture at ACRE.

Maximize Research Space

One of our priorities moving forward is to maximize our research on the farm through a few key areas.

Collect as many data layers as possible across all fields to develop robust datasets for stand-alone research projects in precision agriculture, site-specific crop management, and crop modeling.

Implement field-scale research projects on rotational acres, essentially emulating management practices typical for farmers to answer Indiana farmers' management questions.

We are partnering with new faculty across the college and university to engage a larger clientele to broaden the scope of research.

ACRE75

ACRE will celebrate its 75th birthday in 2024. Building to this event, the ACRE Farm Manager and Technicians, as well as the ACRE advisory board, will develop a strategic plan for where we would like to see ACRE in the next 75 years. This includes engagement with a broad range of research faculty and administration as well as developing industry partnerships and building critical infrastructure.

15. Purdue University and The College of Agriculture

Purdue University

Purdue University, founded in 1869, is Indiana's Land Grant University. Approximately 45,869 students (34,920 undergrads and 10,949 graduate students) are enrolled at the West Lafayette campus (Fall 2020). Incoming enrollment for fall 2021 exceeds the fall 2020 incoming class by nearly 1,200 students and is the largest incoming class in our history. Purdue has 11 academic colleges: Agriculture, Education, Engineering, Exploratory Studies, Health and Human Sciences, Krannert School of Management, Liberal Arts, Pharmacy, Purdue Polytechnic Institute, Science, and Veterinary Medicine. We also have the Honors College and the Graduate School. The governing body of the university is a ten-person Board of Trustees appointed by the Governor.

Purdue offers both undergraduate and graduate programs in over 200 major areas of study. The university catalog is found here: https://catalog.purdue.edu/. The Purdue University campus in West Lafayette employs 1,919 tenure track faculty, 926 clinical professors, 342 adjunct faculty, and 458 continuing lecturers supporting these programs. The staff on the West Lafayette campus of Purdue is nearly 11,530 people (2020 data). System-wide,(Indiana University-Purdue University Indianapolis (IUPUI), Purdue-Fort Wayne (PFW), Purdue University Northwest PUN) Purdue employs some 2,563 tenured and tenure-track faculty. The West Lafayette campus sits on 2,602 acres (10.53 km^2) with an additional 15,325 acres (62.02 km^2) across the state for research and education.

Mitchell E. "Mitch" Daniels was appointed Purdue University's twelfth president in January 2013. Mitch Daniels is an academic administrator, author, businessman, lawyer, and politician. From 2005 to 2013, Daniels served as the 49th Governor of Indiana. In November 2017, Dr. Jay Akridge became the Provost and Executive Vice President for Academic Affairs and Diversity after serving as the Dean of Agriculture and faculty member in Agriculture Economics. In June 2019, Dr. Theresa Mayer was appointed as Purdue's Vice President for Research and Partnerships.

The Purdue University budget exceeds $2.5 billion, and the Purdue Research Foundation (PRF) manages an endowment of approximately $2.6 billion. Purdue's research awards reached a record $513 million in 2019 and $506 million in 2020. Purdue ranks fifth among public institutions in the United States, based on a survey released in 2016 by The Wall Street Journal and Times Higher Education. U.S. News & World Report also recognized Purdue as the fifth most innovative school in the country (2021).

College of Agriculture

The College of Agriculture (CoA) is comprised of 11 academic departments: Agricultural and Biological Engineering, Agricultural Economics, Agronomy, Animal Sciences, Biochemistry, Botany and Plant Pathology, Entomology, Food Science, Forestry and Natural Resources, Horticulture and Landscape Architecture, and Agricultural Sciences Education and Communication. The college has two support departments, Agricultural Communications and Agricultural Information and Technology.

The leadership in the CoA is provided by Dr. Karen Plaut (Glenn W. Sample Dean of Agriculture), Dr. Christine Wilson (Associate Dean and Director of Academic Programs (OAP)), Dr. Bernie Engel (Senior Associate Dean of Agricultural Research and Graduate Education (ARGE)), Dr. Jason Henderson (Senior Associate Dean and Director of Purdue Extension), Dr. Gerald Shively (Associate Dean and Director of

International Programs in Agriculture (IPIA)), and Dr. Pamala Morris (Associate Dean of the Office of Multicultural Programs (OMP)). The fiscal management of the college is led by Matt Clawson, Director of Financial Affairs (DFA).

In 2020, the college had 1,505 employees, including 290 tenure-track faculty, 29 clinical professors, 252 Extension educators, 116 postdocs, and 818 staff members. In fall semester 2021, the college had 2,731 undergraduate and 681 graduate students. The five-year fall semester student average is 2,779 undergraduate students and 691 graduate students. In 2019, both undergraduate and graduate enrollments reached fall semester highs of 2,841 and 740, respectively.

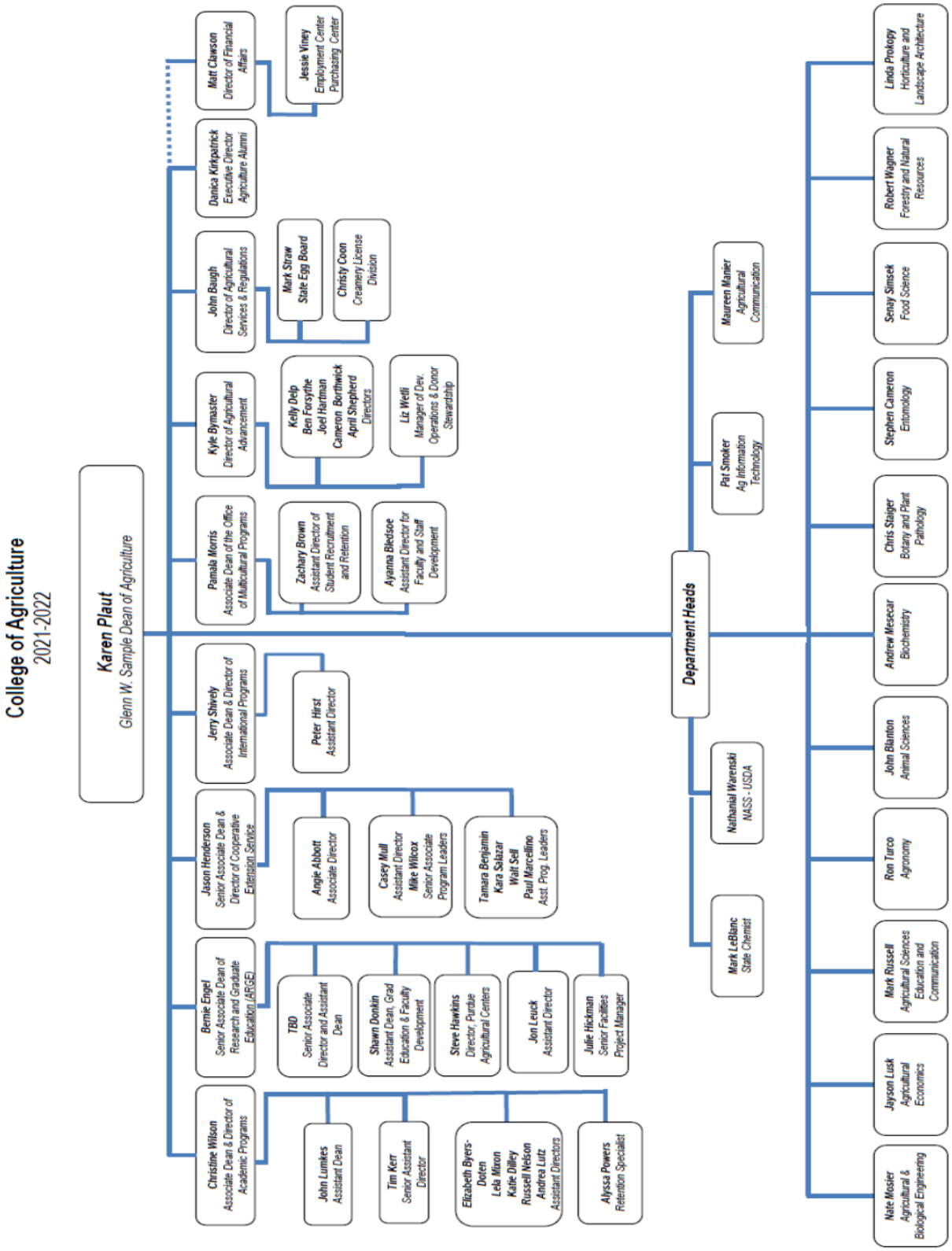
The CoA website can be found at: https://ag.purdue.edu, while the CoA Strategic Plan is found here: https://ag.purdue.edu/strategic_plan.

The College of Agriculture is ranked 15th in the Top Public Universities in America (2021) and 16th on Best Colleges for Agricultural Sciences in America (https://www.niche.com/colleges/purdue-university/rankings/). The CoA ranks 15th on the QS Top Universities for Agriculture and Forestry (https://www.topuniversities.com/universities/purdue-university), indicating we are one of the world's leading colleges in agricultural, food, life, and natural resource sciences.

The CoA fulfills its role as a land-grant institution as its primary mission. We incorporate the land-grant philosophy into our teaching, research, and outreach efforts. These efforts start with the Agricultural Research and Graduate Education (ARGE) office at the college level. ARGE works to bring together scientists, students, and many others to impact people's lives in Indiana, the nation, and the world. The **Office of Academic Programs (OAP)** prepares students for leadership in agricultural, life, and natural resource sciences. **Purdue Extension** reaches all 92 Indiana counties to strengthen Indiana's livelihoods and future through hands-on research and education. **International Programs in Agriculture (IPIA)** collaborates with educational institutions, agencies, and organizations worldwide. The **College of Agriculture's Office of Multicultural Programs (OMP)** strengthens an inclusive community where diverse and unique contributions, capacities, and skills are valued. Fiscal management of all aspects of our mission is done via our business and account managers, who report to Matt Clawson. The hiring and purchasing processes are managed via college-level employment and procurement/purchasing centers (https://ag.purdue.edu/businessoffice).

The department heads in the CoA report to the Dean and Associate Deans of the college. The following organizational chart provides additional information on the administrative structure of the College and University (Figure 15.1).

Figure 15.1 . Organizational chart for the College of Agriculture 2021 to 2022.



16. HISTORY of the AGRONOMY Department

As far back as 1829, the Indiana Legislature encouraged organized activities to improve farm yields and crop quality. State government also encouraged agricultural experimentation and recommended creating a school of agriculture, but financial support to achieve these objectives was not forthcoming. After funds became available from the Land Grant Act of 1862, and with an additional donation of $150,000 from John Purdue in 1869, Purdue University was established in West Lafayette. Classes began in 1874. In 1875, to support agricultural research, the state provided $8,000 to purchase farm ground, a house, stock, and implements for fieldwork. In 1879, the Indiana Legislature appropriated an additional $4,000 for machinery and improvements for agriculture research. In 1879, corn, oat, and wheat experiments were undertaken on Purdue's first research farm, located south of the current Stewart Center building. The research farm moved in 1880 to a 160-acre location west of Marstellar Street and south of State Street. The farm moved several more times until landing in its final location, five miles northwest of campus, in 1949. In 1883, the School of Agriculture and Horticulture was established. By 1887, the School of Agriculture was listed as one of five program options in the Purdue catalog. Also, in 1887, the U.S. Congress passed the Hatch Act, which helped establish the Purdue Agriculture Experiment Station. The first and second publications from the Experiment Station concerned Hessian fly in wheat and fertilizer studies in corn.

Departments in the School of Agriculture and Horticulture were derived from courses of study listed in the class catalogs. Purdue's first agricultural department was established in 1903. The first independent agronomy-based curriculum was developed around 1896, and the term "Agronomy" was first used in the 1905-1906 catalog. In the 1907-1908 catalog, all courses in soils and crops were grouped under Agronomy. In 1908, Agronomy was established as an "option" in the catalog, with Alfred Wiancko listed as "in charge" of Agronomy's six staff. In 1910, the agronomy, agricultural engineering, and agricultural economics departments were established, with the term "Agronomy Department" used for the first time, and 15 courses were offered.

In 1916 Professor Martin L. Fisher was named head of agronomy instruction. He held that position until 1926 when he became Dean of Men and Wiancko became head of the Agronomy Department and the director of the Agricultural Experiment Station; he held both positions until his retirement in 1943. Dr. George D. Scarseth became head of Agronomy in 1943 but resigned in 1944 to accept an appointment as Director of Research at the American Farm Research Association. In 1944, Norman J. Volk was appointed head and associate director of the Agricultural Experiment Station until 1948, when he turned his full attention to the Experiment Station.

Dr. John B. Peterson, Professor of Agronomy at Iowa State University, was appointed in 1948 as the fifth head of Agronomy and served for 23 years until 1971. During Dr. Peterson's leadership, the department more than doubled its faculty and gained national recognition. In 1971, Dr. Marvin W. Phillips, a Purdue agronomy faculty member since 1961, was appointed head and served until June 30, 1991. Dr. William W. McFee, a member of the department since 1965, was appointed head in 1991 and served until 2001. Dr. Craig A. Beyrouty, Professor of Agronomy at the University of Arkansas, was appointed head in 2001, becoming the eighth head of the Agronomy Department, serving until 2009. Dr. Beyrouty left Purdue to become Dean of Agriculture at Colorado State University and later Dean at the University of Maryland.

Dr. Herbert W. Ohm, Distinguished Professor of Agronomy, was appointed interim department head until October 1, 2010, when Dr. Joseph M. Anderson, USDA/ARS and an adjunct professor of agronomy since 1993, was appointed department head. Dr. Anderson returned to a faculty role and now heads the College's Digital Education program. In July 2017, Dr. Ronald Turco was appointed the 11th department head of Agronomy. Dr. Turco has been a faculty member since 1985.

17. Development Activities

Within the College of Agriculture, we have development officers who work with the Department Head to raise awareness and funds. Development operates in two ways: Kelly Delp works with our alumni, alumni families, and others on Individual Alumni Giving; Ben Forsythe works with industrial partners on Corporate Giving and donations, including equipment. Ms. Delp has been instrumental in developing several scholarships and fellowship opportunities. Mr. Forsythe has worked with us as we plan for expansions and changes at ACRE. The development officials meet with the department head monthly.

Included in this section is a summary of the last five years of development history. Our future development plans are aimed at improving facilities and equipment at ACRE.

3,638
Total number of alumni

2,087
Total number of donors

DONATION BY FY

2017	$525K
2018	$1.2M
2019	$479K
2020	$276K
2021	$1M

Fundraising Goals for the next 5 Years

Individual Alumni Giving

- ACRE Support
- Graduate support endowments
- Undergraduate scholarships
- Faculty chairs

Corporate Giving

- Grain bins, rainout shelter, and other infrastructure for ACRE
- Equipment fof ACRE
- Support for Plant Science 2.0

Agronomy Endowments: The Agronomy Department has multiple endowment accounts that typically honor a past faculty, staff, or student member.

Established	Endowment Name
1954	F.E. Robbins Scholarship Endowment
1962	Keller E. Beeson Scholarships Endowment
1970	Agronomy Student Ed Activities /Ag Alum Trust Endowment
1977	George D. Scarseth Scholarship Endowment
1983	Keim Family Scholarship Endowment
1987	M. O. Pence Memorial Scholarship Endowment
1992	F.L. Patterson Visiting Lecturer Endowment
1992	Kenneth and Mary Cohee Crop and Soil Science Award Endowment
1994	Helmut and Gerda Kohnke Junior and Senior Award in Soil Conservation Endowment
1995	Bruce F. Hardy Memorial Scholarship Endowment
1999	Marshall Allman Memorial Endowment
2000	Emerson J. Kuhn Scholarship in the College of Agriculture Endowment
2002	Arvin R. 'Rudy' Hilst Memorial Scholarship Endowment
2002	The Bradford Family Endowment for Student Activities
2002	The John D. Axtell Memorial Fund in Plant Breeding and Genetics Endowment
2003	Kenneth B. and Mary J. Cohee Scholarship in Agronomy Endowment
2004	Charles and Rosalee Schmidt Scholarship Endowment
2004	Dr. Fred L. Patterson Chair in Agronomy Endowment
2004	Dr. Stanley A. Barber Memorial Scholarship in Soil Fertility and Plant Nutrition
2005	Dr. Joe L. White Memorial Graduate Scholarship in Agronomy Endowment
2006	J.B. Peterson Agronomy Support Endowment
2006	Marvin W. Phillips Memorial Endowment
2006	Maurice B. and E. Catherine Woodward Memorial Scholarship in Agronomy Endowment
2007	Ozzie Luetkemeier Endowment in Agronomy
2008	Dr. Wyman E. Nyquist Endowment Fund for Agronomy
2010	Donn P. Cummings Scholarship in Plant Breeding and Genetics Endowment
2010	James J. Vorst Cropping Systems and Soil Science Scholarship Endowment
2012	Dow AgroSciences Graduate Endowment
2012	Dr. A. Bruce and Katherina M. Maunder Scholarship Endowment for Agronomy
2012	Ralph M. and Winifred E. Woodward Scholarship in Agronomy Endowment
2013	Ralph and Winifred Woodward Graduate Fellowship in Agronomy Endowment
2013	Woodward Family Endowment Fund
2014	Dr. J.B. Peterson Agronomy Support Fund Scholarship Endowment
2014	M.O. Pence Memorial Undergraduate Scholarship Endowment
2014	Anonymous Scholarship Endowment
2015	Pamela Rogers-Butcher Women in Agronomy Endowment
2015	Sherry Fulk-Bringman Scholarship in Agronomy Endowment
2016	Dr. Charles Rhykerd Scholarship for Agriculture Endowment
2016	Dr. Eldon Hood Family Scholarship in Crop Science Endowment
2016	Dr. Jerry V. Mannering Award in Soil Conservation and Management Endowment
2017	Godfrey Family Scholarship Endowment
2019	Alvin J. Ohlrogge Graduate Fund Endowment
2019	Digital Agriculture Fund Endowment

Corporate Overview

Corporate donations typically reflect program support and an interest in aiding our researchers.

Corporate Research Awards by Year

- 2017 -- $587,315
- 2018 -- $719,633
- 2019 -- $719,161
- 2020 -- $453,767
- 2021 -- $522,768

Total: $3 Million

Sponsor Count

- 47

Largest Projects

- Autonomous Systems Development Tools
- Soybean Extension Research
- Agricultural Cropping Systems

Largest Partner

- Deere & Co
- Corteva
- Bayer

Corporate Gifts by Year

- 2017 -- $327,400
- 2018 -- $375,394
- 2019 -- $365,805
- 2020 -- $270,293
- 2021 -- $321,703

Total: $1.6M

Sponsor Count

- 55

Companies providing over $100,000 of Gifts and Research

- Ag Alumni Seed
- Corteva
- Ag Spectrum Company
- Deere & Company
- Dow
- CHS
- Advanced Agrilytics
- Sumitomo
- Pivotbio
- Mosaic
- Bayer

Top Gift Accounts

- Department of Agronomy
- Tony Vyn
- Cliff Johnston

Largest Partner

- Corteva
- Ag Spectrum
- Deere & Company

18. Agronomy Online Programs

We support both for-credit and online certificate programing.

Currently, we also host Agronomy 320 Genetics as a for-credit class. It is typically offered only in the summer. Dr. Katy M. Rainey developed and now manages the class. As part of our pandemic response, the class has also been offered during a regular semester (Fall 2020).

Enrollment data for AGRY 320 online shows:

1. Summer 2018: 67 students (Dr. Rainey)
1. Summer 2019: 80 students (Dr. Rainey)
2. Summer 2020: 105 students (Dr. Rainey)
3. Fall 2020: 223 students (Dr. Rainey)
4. Spring 2021: 200 students (Dr. Anderson)
5. Summer 2021: 45 students (Dr. Rainey)

We also support two online certificate education programs from the department: the E-Learning Academy and Hemp Essentials. These programs are non-credit generating and are primarily used by people off-campus. The courses are run in a cost-recovery model and are described on the next pages.

E-Learning Academy

Goal: Increase the proficiency of the agricultural workforce to ultimately impact crop productivity, increase input efficiency, reduce environmental impact, and positively impact sales and revenues. Target audience is ag retail and agribusiness.

Courses Offered:

Agronomy Essentials: *Soil Properties, Plant Nutrition, Crop and Variety Selection, Planting Practices, Crop Growth & Development, Diagnostics, Crop Protection/Pest Management, Harvesting & Marketing.* Similar in difficulty to AGRY 105; it can be mastered by those with no previous agronomy knowledge. The course is built around Midwest agriculture, but most concepts apply anywhere.

Agronomy Essentials Europe: Mirrors Agronomy Essentials but focuses on European crops/conditions.

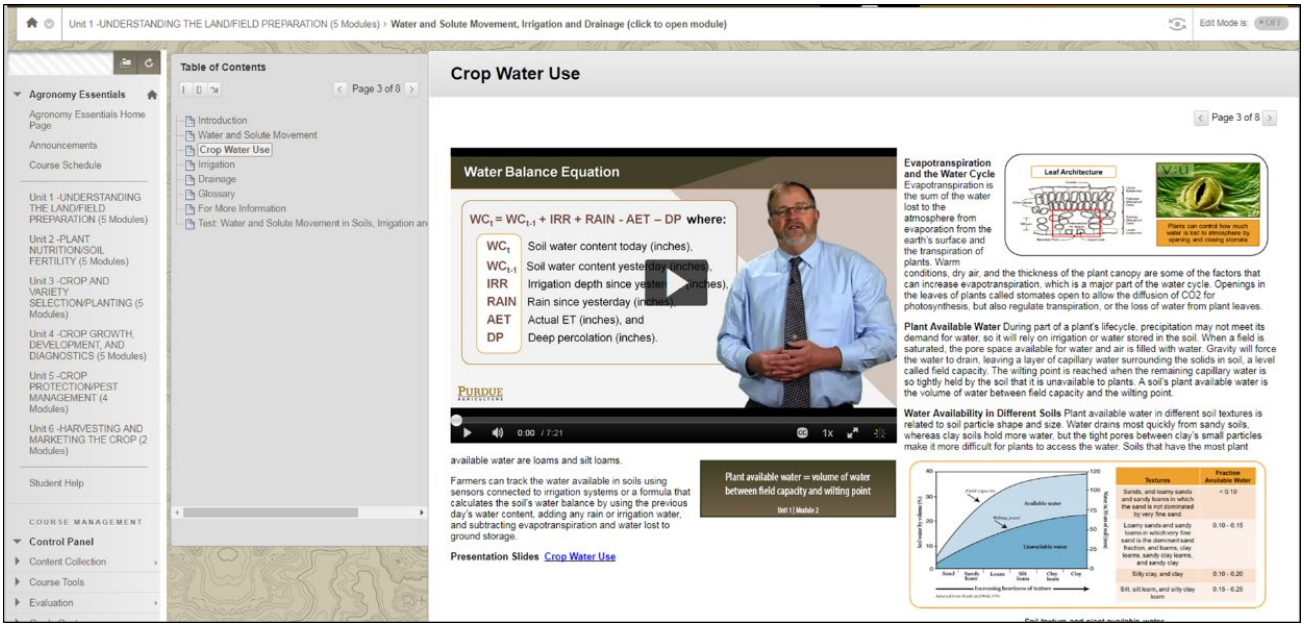
Nutrient Management: *Soil Fertility, Soil Organic Matter and Microbiology, Secondary & Micronutrients, Soil pH and Amendments, Salt Affected Soils, Assessment & Diagnostics, Fertilizers and Additives, Recommendations, Economics, Timing and Placement.*

Precision Agriculture: *Global Positioning Systems/Signal Correction, Sensors, Visualization, Soil and Water/Nutrient/Crop Variability, Geographic Information Systems, Automation, Data Analysis, Telematics, Economics and Adoption.* In 2021 we received a $300,000 USDA-NIFA grant to rebuild this class.

Course delivery: Each course has over 100 professionally edited and annotated videos accompanied by readings and graphics that parallel the videos, links to more information, and a glossary. To aid comprehension students must pass assessments to progress from module to module. Quizzes draw from a robust item bank with multiple items and versions of items for each specific learning objective/outcome. Enrollments, student progress, and online course materials are managed by a ¾ time project manager.

Timing: Offered for 12 weeks three times yearly, January-April, June-September, and September-December. Offerings are timed around busy periods of Midwest crops practitioners. Students must keep up with a schedule that has flexibility built in—they can work ahead but cannot fall behind.

Outcomes: Over 2000 students have enrolled since the academy's inception in 2015, from 48 states and 38 countries. The program won Purdue Awards for Excellence in Distance Learning in 2015, 2017, and 2018. Several corporate clients are repeat customers. The program has generated over $1M in net revenue since its inception. **For More Information**: https://ag.purdue.edu/agry/ADE/



PROGRAM OVERVIEW

Hemp is a versatile plant radically different than more common agricultural crops. The Hemp Essentials program from Purdue University takes a holistic approach, providing an understanding of the hemp industry beyond just production, with the goal of teaching learners how to become a better consultant or grower.

The curriculum covers the plant biology and agronomic aspects of the growth and uses of the hemp plant (Cannabis sativa), including its place in history, the implications of historical and modern legal and social issues and its uses for food, fiber, building products and medical applications. Learners will leave with knowledge of the history and legalities of hemp production, including how to grow and harvest the hemp plant, as well as the many applications that hemp has and the economics of its production.

Through this course students will learn the about:

- Federal and state regulations
- Farm economics (including the different hemp crops)
- Agronomic principles
- Genetics and breeding

COURSE AT A GLANCE

- Modality: Self-paced
- Access: 3 months
- Starts: Open enrollment
- Fee:
  In-state: $500
  Out of state: $550

Prerequisites: None; however, a basic understanding of plants and soil, including an interest in learning about the bio-economy and modern agriculture is recommended.

HEMP ESSENTIALS MODULES

INTRODUCTION OF HEMP, HISTORY, RULES AND REGULATIONS

XXXXXXXXXX

Topics:

- From ancient to modern times, the history of hemp
- Current legal status of hemp production nationally and globally

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PURDUE UNIVERSITY
College of Agriculture

HEMP ESSENTIALS

100% ONLINE PROGRAM

HEMP ESSENTIALS MODULES

ECONOMICS
XXXX

Topics:

- Understanding basic farm production economics
- Production models, supply and demand
- Economic evaluation of the cannabis industry
- The developing hemp industry, what we can expect for the future

MEET THE INSTRUCTOR

Marguerite Bolt
Hemp Extension Specialist
Department of Agronomy

Marguerite Bolt is the hemp Extension specialist at Purdue University in the Department of Agronomy. She received her M.S. in Entomology from Purdue University, and her B.S in Entomology from Michigan State University. Bolt's research has focused on hemp-insect interactions and plant chemistry. She is interested in the secondary compounds that hemp produces and how they affect insect pests, although she has had to shift her focus to agronomic production questions surrounding hemp. Her position is new to Indiana and she is serving as a catalyst to link growers to production facilities and the research community through online resources, field days, and workshops.

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19. Agronomy Dashboards – (Purdue University supplies data)

Index of Dashboards supplied by Purdue University

Table 19.1. University supplied data on faculty, staff, undergrads, graduates, teaching, research awards, extension, international programs development and student placement for 2010 to 2020.

Figure 19.1. University supplied data on faculty and staff distributions, undergraduate and graduate students count and residency, degrees conferred, minority distribution for faculty, staff, undergrads, and graduate students and the distribution of money raised by development for 2010 to 2020.

Figure 19.2. University supplied data on proposals vs awards, expenditures, international awards, placement surveys, research activity vs FTEs, study abroad participation, and extension awards for 2010 to 2020.

Table 19.1. University supplied data on faculty, staff, undergrads, graduates, teaching, research awards, extension, international programs development and student placement for the years 2010 to 2020.

Department Dashboard - Agronomy

Profile

	Classification	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Faculty	Tenure/Tenure Track	35.26	35.20	34.80	32.80	32.58	29.78	32.70	29.95	30.95	29.95
	Clinical	-	-	-	-	-	-	-	1.00	2.00	2.00
	Continuing Lecturers	-	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Research Faculty	-	-	-	-	-	-	-	-	-	-
	Other (Visiting/Postdoc/Etc)	15.00	12.00	10.00	10.00	13.50	16.00	16.00	12.00	14.00	11.00
	% URM	2.86%	2.94%	2.94%	3.03%	3.03%	5.56%	5.88%	6.06%	6.45%	11.11%
	% Women	17.14%	17.65%	20.59%	18.18%	21.21%	19.44%	20.59%	21.21%	19.35%	26.67%
* 2008 - 2017 Faculty #s based on budget. Beginning FY2019, actual faculty numbers are reported from IPEDS October snapshot											
Staff	Administrative/Professional	31.63	29.00	28.80	30.80	33.80	32.80	40.43	33.23	24.05	25.00
	Clerical/Service	28.75	25.25	28.00	25.75	24.25	23.25	20.75	19.75	16.75	19.75
	% URM	0.00%	3.03%	2.63%	5.00%	2.63%	4.00%	2.60%	1.52%	1.59%	3.77%
	% Women	49.32%	42.42%	40.79%	45.00%	46.05%	45.33%	44.16%	42.42%	44.44%	49.06%
** 2008 - 2017 Staff #s based on budget. Beginning FY2019, actual staff numbers are reported from IPEDS October snapshot. ***Job Family Structure/SuccessFactors implemented in Jan. 2019											
Undergrad Students	Resident	88%	83%	86%	83%	83%	84%	84%	85%	89%	83%
	Non-Resident	8%	8%	7%	10%	11%	11%	11%	11%	9%	11%
	International	4%	9%	7%	7%	6%	5%	5%	5%	3%	6%
	# of Students	153	151	161	164	152	156	177	171	174	162
	% US Citzn URM	0.7%	2.2%	1.3%	2.0%	0.7%	1.4%	4.8%	3.1%	5.3%	7.2%
	% URM	0.7%	2.0%	1.2%	1.8%	0.7%	1.3%	4.5%	2.9%	5.2%	6.8%
	% Women	19.0%	22.5%	25.5%	32.3%	34.9%	40.4%	44.6%	42.7%	48.3%	42.6%
Graduate Students	Resident	32%	34%	28%	29%	35%	33%	32%	22%	31%	39%
	Non-Resident	22%	32%	36%	34%	27%	25%	28%	33%	35%	27%
	International	46%	34%	36%	37%	37%	42%	40%	45%	34%	34%
	# of Students	65	73	75	65	62	55	60	60	62	59
	% US Citzn URM	8.6%	8.3%	8.3%	12.2%	12.8%	18.8%	19.4%	18.2%	12.2%	7.7%
	% URM	4.6%	5.5%	5.3%	7.7%	8.1%	10.9%	11.7%	10.0%	8.1%	5.1%
	% Women	40.0%	42.5%	44.0%	38.5%	38.7%	38.2%	43.3%	45.0%	41.9%	40.7%

Metrics

Teaching	Acad. Credit Hours Taught	4,611	5,362	5,495	5,937	5,822	6,018	6,268	5,722		
	Post Second. Cert/Dipl < 1 yr.										-
	Postbaccalaureate Certificate										-
	B.S. Conferred	31	35	38	43	53	42	34	43	53	44
	A.S. Conferred	27	60	-	-	-	-	-	-	-	-
	M.S. Conferred	6	10	10	13	14	17	8	11	7	11
	Ph.D. Conferred	7	2	14	11	7	5	10	5	13	12
Research	Sponsor Exp.	$8.72 M	$7.75 M	$7.73 M	$9.01 M	$9.33 M	$9.42 M	$9.75 M	$8.20 M	$9.20 M	$7.96 M
	Cost Share	$0.29 M	$0.24 M	$0.52 M	$0.38 M	$0.3100 M	$0.33 M	$0.36 M	$0.33 M	$0.11 M	$0.36 M
	Per Faculty FTE	$0.26 M	$0.23 M	$0.24 M	$0.29 M	$0.30 M	$0.33 M	$0.31 M	$0.28 M	$0.30 M	$0.28 M
	Award Count	175.71	190.51	168.23	158.67	132.54	117.33	119.20	127.94	77.06	81.02
	Award Amount	$10.32 M	$9.69 M	$8.28 M	$9.99 M	$11.22 M	$8.49 M	$7.73 M	$12.50 M	$5.13 M	$10.24 M
	Awards / FTE	$0.29 M	$0.28 M	$0.24 M	$0.30 M	$0.34 M	$0.29 M	$0.24 M	$0.42 M	$0.17 M	$0.34 M
	Proposal Count	100.91	100.60	106.19	99.80	114.29	111.50	106.74	93.83	83.28	74.37
	Proposal Amount	$53.96 M	$41.49 M	$25.00 M	$36.12 M	$32.41 M	$25.59 M	$33.92 M	$25.91 M	$29.31 M	$46.94 M
	Proposals / FTE	$1.53 M	$1.18 M	$0.72 M	$1.10 M	$0.99 M	$0.86 M	$1.04 M	$0.87 M	$0.95 M	$1.57 M
Extension	T&TT Faculty FTE			5.77	6.89	7.08	6.14	5.55	5.79	5.74	6.15
	Award Count	16.25	18.85	26.36	26.90	21.91	22.99	16.77	20.35	13.60	7.80
	Award Amount	$0.22 M	$1.25 M	$1.45 M	$1.69 M	$1.78 M	$0.93 M	$1.04 M	$0.70 M	$0.41 M	$0.62 M
	Proposal Count	17.45	17.50	28.56	27.18	25.22	19.92	11.30	18.55	12.85	4.99
	Proposal Amount	$0.42 M	$5.95 M	$1.06 M	$17.57 M	$1.36 M	$0.63 M	$1.44 M	$1.12 M	$0.96 M	$16.44 M
Starting FY2019 - Faculty are no longer budgeted by mission											
IPIA	INT'L Awards	$0.82 M	$3.91 M	$2.59 M	$1.84 M	$2.37 M	$0.91 M	$1.20 M	$6.95 M	$1.61 M	$2.80 M
	Study Abroad Participation										
	Out	13	12	21	11	17	19	23	20	13	8
	In	-	1	-	1	4	3	-	3	3	2
Development	Scholarships	$0.03 M	$0.19 M	$0.69 M	$0.13 M	$0.11 M	$0.10 M	$0.08 M	$0.32 M	$0.16 M	$0.04 M
	Faculty Support	$0.33 M	$0.71 M	$1.73 M	$1.18 M	$2.07 M	$3.42 M	$1.70 M	$7.24 M	$1.32 M	$0.97 M
	Facilities	$0.04 M	-	-	-	$2.24 M	$2.00 M	$0.00 M	$0.92 M	$0.17 M	$0.13 M
	Programs	$0.62 M	$0.26 M	$0.26 M	$0.67 M	$1.08 M	$0.09 M	$0.13 M	$0.04 M	$0.14 M	$0.07 M
	Unrestricted	$0.09 M	$0.07 M	$0.08 M	$0.06 M	$2.54 M	$0.06 M	$0.38 M	$0.04 M	$0.03 M	$0.03 M
	Total	$1.12 M	$1.23 M	$2.76 M	$2.04 M	$8.05 M	$5.67 M	$2.30 M	$8.56 M	$1.83 M	$1.26 M
Placement	Continuing Education	20%	27%	22%	8%	29%	23%	4%	31%	18%	20.00%
	Employed	80%	68%	74%	88%	71%	65%	96%	69%	75%	77.14%
	Not Seeking	0%	0%	0%	4%	0%	4%	0%	0%	0%	0.00%
	Seeking Emp/Ed	0%	5%	4%	0%	0%	8%	0%	0%	7%	0.00%
	# of Respondents	20	22	23	25	35	26	24	32	44	37
	# of No Responses	1	2	3	1	0	0	1	0	0	2

[1] 2008-09 Academic Credit Hours from the SMAS reports are inaccurate due to the switch to Banner, so they have been removed from the dashboards

Figure 19.1. University supplied data on faculty and staff distributions, undergraduate and graduate students count and residency, degrees conferred, minority distribution for faculty, staff, undergrads and graduate students and the distribution of money raised by development for the years 2010 to 2020.

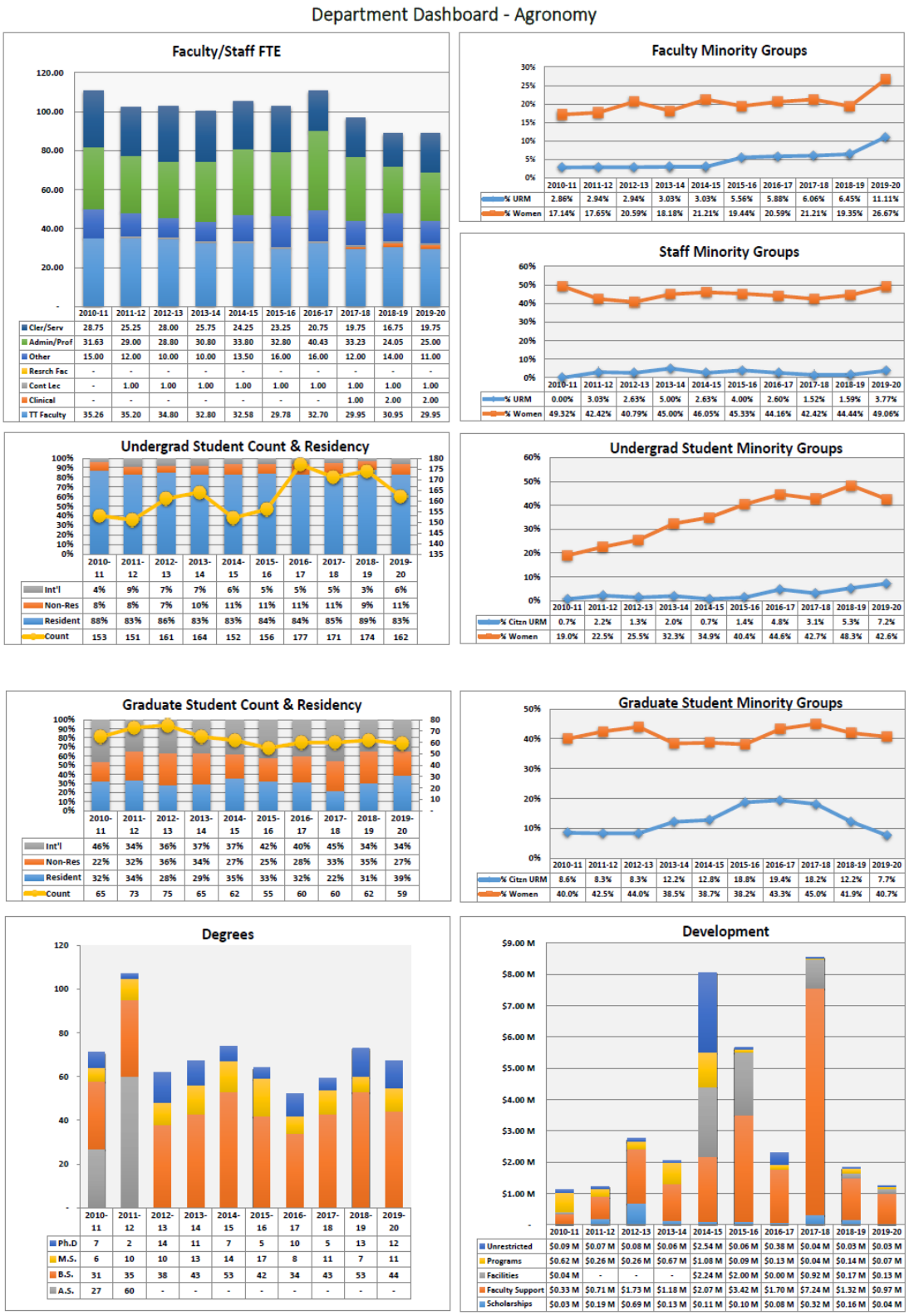

Figure 19.2. University supplied data on proposals vs awards, expenditures, international awards, placement surveys and proposal vs awards count, research activity vs FTE study abroad participation and extension awards and proposals.