COLLEGE OF AGRICULTURE AND LIFE SCIENCES
CENTER FOR ADVANCED INNOVATION IN AGRICULTURE
VIRGINIA TECH

CAIA Big Event

The Inn at Virginia Tech and Skelton Conference Center

March 16, 2023

COLLEGE OF AGRICULTURE AND LIFE SCIENCES
CENTER FOR ADVANCED INNOVATION IN AGRICULTURE
VIRGINIA TECH

CAIA Big Event- Agenda

March 16, 2023

7:30 – 8:15am	***Guest Speakers Breakfast with graduate student representatives*** (Preston's Restaurant at the Inn)

Morning sessions: for CAIA affiliate faculty and speakers | *Solitude Conference Room (upstairs)*

Morning session I (8:30-10:00 am): **Presentations**

8:30 - 8:45 am	***Welcome and CAIA update*** (Dr. Kang Xia, Interim Director for CAIA)
8:45 - 8:55 am	***CALS' priorities, future, & strategic plan*** (Dr. Alan Grant, Dean, CALS)
8:55 - 9:00 am	***Introduction of the speakers and logistics of the morning*** (Dr. Robin White)
	Keynote speakers – Working with CAIA to Advance Innovation in Agriculture
9:00 - 9:15 am	***Dr. Mike Gutter*** (Director of VCE, Associate Dean of CALS, Virginia Tech) *Representative VCE Programs*
9:15 - 9:30 am	***Dr. Matt Wolfe*** (Vice President of Technology, Virginia Tech Applied Research Corporation)
9:30 - 9:45 am	***Dr. John Vicini*** (Technology Safety and Acceptance Lead, Bayer Crop Science)
9:45 - 10:00 am	***Ms. Melissa King*** (Virginia Employment Commission Manager, Fredericksburg Virginia Career Works)
10:00 - 10:30 am	***Poster viewing***

Morning session II (10:30-11:45 am): **Targeted breakout sessions**

11:45 – 12:45 pm	***Morning session CAIA faculty networking and lunch***

Afternoon session: for all participants - *Latham Ballroom*

Afternoon session (1:00 - 5:00 pm): Poster session

****All posters should be set up before 10 am***

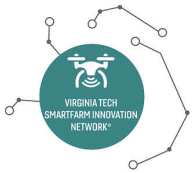
1:00 - 1:30 pm	***Announcement*** – (Dr. Kang Xia) ***CAIA summary update and acknowledgement of contributions*** (Dr. Kang Xia) ***CAIA's future and direction*** (Dr. Saied Mostaghimi) ***Remembrance of Dr. Susan Duncan*** (Dr. Robin White)

Poster display, presentation, and judging (1:30-3:30 pm)

****Poster presenters: Please stand by your posters during your designed session***

1:30 - 2:30 pm	***Poster session I***
2:30 - 3:30 pm	***Poster session II***
3:40 - 4:00 pm	***Announcement of poster awards***
4:00 - 5:00 pm	***Social hour***

CAIA Research Platforms

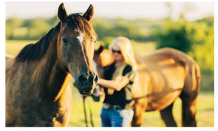


The Virginia Tech SmartFarm Innovation Network® is a community-based agricultural research and communications network throughout Virginia.

- **Sustainable Precision Animal Agriculture**
- **Controlled Environment Agriculture Innovation Center (CEA-IC)**
- **SmartTechnologies for Crop and the Green Industries**

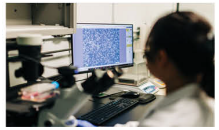
The Agricultural Research and Extension Centers (ARECs) provide testbeds and technical support to the Center for Advanced Innovation in Agriculture (CAIA) and the Virginia Tech SmartFarm Innovation Network®, where experts collaborate to foster informed decisions using agricultural technologies and analytics for research opportunities.

VIRGINIA AGRICULTURAL EXPERIMENT STATION
VIRGINIA TECH



Cyberbiosecurity focuses on identifying and reducing the risk of security vulnerabilities at the interface of life sciences, information sciences, and biosecurity.

Biosecurity focuses on identifying the risks and addressing protective measures needed to protect humans and animals against disease or invasive or harmful biological agents.



Data analytics are essential for understanding the complexity of data that technology is delivering and translating into actionable decisions.

COLLEGE OF AGRICULTURE AND LIFE SCIENCES
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Center for Advanced Innovation in Agriculture (CAIA)

The Center for Advanced Innovation in Agriculture (CAIA) is designed to drive innovation and advance agriculture and food systems in the era of automation and digital agriculture. CAIA develops partnerships, creates synergies, and evaluates technological efficiencies for economic growth within the Commonwealth and beyond.

Short-Term Milestones
(within the first 5 -years)

DEVELOP
- Leadership and administrative structure
- Competitive seed funding RFA
- Ongoing affiliate faculty seminars, workshops, team building

ESTABLISH
- Platform Teams
- Interdisciplinary graduate education program
- Annual seminar and training series
- External Advisory Council

CREATE
- Partnerships between CAIA, CCI-affiliated universities, industry
- External Communications network
- Workforce training

EXPAND
- Pursue large Center and Research Grants
- Increase overall funding and technology capacity
- Partnerships and Impacts

Our Mission to leverage science and technology to create transformative solutions to support agriculture and food systems, the environment, and communities in the Commonwealth and beyond

Our Vision to foster informed decisions using agricultural technologies and analytics for growth and research opportunities

CAIA Graduate Student Affiliate (GSA) Group

The GSA provides a common space for graduate students to learn, brainstorm, and grow as students and professionals in their own research areas.

Learn more about our student organization on GobblerConnect!

- Collaboration with other graduate students and faculty across disciplines
- Experiential learning grants
- Travel support to attend/present at conferences
- Opportunities to share your research with CAIA affiliate members and external audiences

CAIA Affiliate Member Expectations

→ Develop new partnerships with other CAIA affiliate faculty
→ Contribution to building CAIA national and international reputation
→ Lead and contribute to large proposals
→ Participate in recruiting/mentoring highly competitive graduate students
→ Include CAIA affiliation on your authorship description and your CV, etc.
→ Actively promote and acknowledge CAIA contributions and impact, etc.

Browse over 150 CAIA affiliates using the search feature to find collaborators, who meet your research needs, by topic (e.g. pests, sensors, data), department, or CAIA platform.

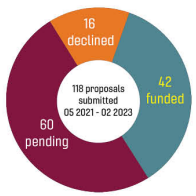
Center Events + Achievements January 2021 - March 2023

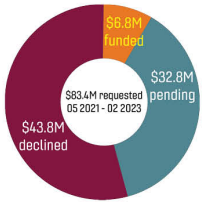
CAIA Sponsored Events + Meetings:

→ 2 Annual CAIA Big Events and Fall Kickoffs
→ 5 Big Idea Sessions
→ 12 Lightning Talk Sessions
→ 2 Projects with Partners Sessions
→ 3 Industry Days
→ 6 Ag-Cyber Field Days (CAIA/CCI-SW Sponsored)
→ 2 CAIA Sponsored Ag-Expos
→ 5 Conference Sponsorships with CAIA Ambassadors
→ 2 Workshops
→ 1 Grad Recruitment Forum
→ 5 Industry/Partnership Meetings/Events (Microsoft + AgEagle + Senai Team from Brazil + Open Generation 5G Consortium)

Numerous partnerships have been formed that have led to proposal submissions, funded projects, publications, and future collaborations.

Proposals Submitted/Funded Projects by CAIA Affiliates





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CAIA Big Event - Morning Session

Keynote Speakers

Dr. Mike Gutter is Associate Dean and Director for Virginia Cooperative Extension. Prior to this he served as Associate Dean for Extension at the University of Florida. His PhD is in Family Resource Management from The Ohio State University. He began his career as an Extension Specialist over two decades ago at the University of Wisconsin in and then moved to the University of Florida in 2007 as a state specialist. His own Extension work was rooted in economic disparities and emphasized creating supportive mechanisms for those who are facing financial burden or challenging economic situations.

Dr. Matt Wolfe is VT-ARC's Vice President of Technology and leads the corporation's technology development strategy and ensures its technical, business development, partnership, and commercialization activities align with the corporation's business strategy. In this role, he is responsible for identifying, incubating, and transforming new opportunities by leveraging creative partnerships to achieve global impact.

Before joining VT-ARC, Matt spent six years as a United States civil servant leading technology development, acquisition, and procurement activities. Prior to joining the federal government, Matt provided technical expertise in support of medical diagnostics, counter-WMD, and special operations forces technical programs at DARPA.

Dr. John Vicini is a Senior Research Fellow and the Technology Safety and Acceptance Lead in Bayer Crop Sciences. He was born in Washington, DC and earned a Ph.D. in Animal Sciences from the University of Illinois. Dr. Vicini joined Monsanto Company in 1987 and throughout his scientific career he has worked primarily in Regulatory with teams that developed products for improving productivity of farms or to enhance animal and human nutrition.

Melissa King is currently the Virginia Employment Commission (VEC) Manager in the Fredericksburg OneStop Center. She is originally from Louisiana and attended Baylor University. Melissa worked for an NGO in Thailand teaching English and Business at Lampang College of Commerce and Technology. She worked in private industry in Dallas, Texas and with the University of Minnesota Extension Service in Rochester, Minnesota. After coming to Virginia, she worked as an Employment Navigator for Homeless Services and for the as a contractor for the Department of Social Services before coming to the VEC.

Return to Agenda

Virginia Cooperative Extension Programs

A Collaborative Opportunity for CAIA Affiliated Faculty to Address Community Needs

Dr. Dan Goerlich, Associate Director, Economy, Community, and Food, Virginia Cooperative Extension - dalego@vt.edu
Dr. Cathy Sutphin, Associate Director, Youth, Families, and Health, Virginia Cooperative Extension - cmsutph@vt.edu
Jeremy Johnson, Associate Director and State 4-H Leader, Virginia Cooperative Extension - jejohns1@vt.edu

Abstract

Building local relationships and collaborative partnerships since 1914, Virginia Cooperative Extension helps people put scientific knowledge to work through learning experiences that improve economic, environmental, and social well-being. We take concrete action that advances the well-being of all Virginians. Whether we're building a more resilient food system, supporting local economies, or mentoring youth, we bridge access to knowledge, and shape a brighter future for our communities. Extension faculty and staff come from a variety of backgrounds. This helps us better understand the distinct needs of all Virginians. It is through this lens that we can accurately and effectively assess, prioritize, and respond to local and state needs. Virginia Cooperative Extension has professional faculty and staff located in 107 city and county unit offices, 11 Agricultural Research and Extension Centers, six 4-H educational centers, and two university campuses. This network is enhanced by a connection to the resources of the land-grant universities across the nation, a large and dedicated volunteer base, and is located in every county and major city in the state where we deliver programming that helps citizens make positive life change. VCE educational programs are delivered in-person and virtually through field days, workshops, seminars, newsletters, videos, demonstration areas, and other methods in schools, in homes, and in the field every day.

Sample Programs

Health

Balanced Living with Diabetes • Diabetes Prevention Program • EXCITE Vaccination Education Program • Family Nutrition Program • Food Safety Programming for Businesses • Home Food Preservation • Master Food Volunteer Program • Physical Activity Programming (FitEX and LIFT) • Prevention and Control of Cancer through Community Education • Serv-Safe

Food

Beginning Farmer and Rancher Coalition • Family Nutrition Program • Food Innovations Program • Good Agricultural Practices (GAP) Certification • Home Food Preservation • Master Food Volunteers • Mobile Meat Processing • Pesticide Safety Education • Retail and Consumer Food Safety • Seafood Processing • Serv-Safe • Small Farm Outreach Program • Urban Agriculture Certificate Program

VCE Program Teams

4-H Positive Youth Development
Agribusiness Management and Economics
Agronomy and Horticulture
Animal Production
Community, Leadership, and Civic Engagement
Community, Local, and Regional Food Systems
Emerging Pests and Pest Management
Ensuring Safe High Quality Food from Field to Table
Family and Community Economics
Farm to School
Healthy People, Healthy Communities
Human Development
Natural Resources, Environmental, and Agricultural Literacy Education
Natural Resources Management

Family

Balancing Life: Supporting Families • Behavioral Health/Substance Abuse Prevention • Caregiving over the Lifespan • Kid's Market Place • Master Financial Education Volunteers • Mental Well-Being • Personal Finance and Money Management • Reality Store • Small Business Support • Tax Schools

Community

Certified County Supervisor Program • Coming Together for Racial Understanding • Community Planning • Emergency Preparedness • Energy Masters • Facilitation • Innovative Leadership • Master Gardeners • Master Naturalists • Recidivism • Strategic and Project Planning • Strengthening Your Facilitation Skills • VALOR • Virginia Geospatial Extension Program • Volunteer Development

Youth

4-H Healthy Habits • 4-H Healthy Living Summit • 4-H Intermediate Congress • 4-H STEM Challenge • 4-H Teen Summit • Ambassador Programs • Health Rocks! • National 4-H Congress • College Access Collaborative • Reality Store • State 4-H Congress • State 4-H Day at the Capitol • Tech Change Makers • Teen Diversity Task Force • Youth For the Quality Care of Animals 4-H Camping • DECA • HOSA • FFA

Economy

Consumer and Commercial Horticulture • Farm and Forestland Legacy Planning • Insect Identification and Integrated Pest Management • Livestock Quality Assurance and Value-Added Marketing • Nematode, Plant Disease, and Soils Diagnostics and Testing • Traditional and Niche Cropping Systems • Virginia Agricultural Leaders Obtaining Results (VALOR) • Virginia Forest Landowner Education Program (VFLEP) • Virginia Sustainable Harvesting and Resource Professional (SHARP) Logger Program • Water Quality • Women in Agriculture

Return to Agenda

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CAIA Big Event

Inaugural Graduate Student Poster Competition

Poster Awards

Congratulations to our CAIA Graduate Student Poster Competition Award Winners!

1st Place - $500 Award

Amelia Loeb

Poster Title: *Predicting Malt Quality with Drone Imagery in Barley (Hordeum vulgare L.)*

2nd Place - $300 Award

Jitendor Rathore

Poster Title: *Small unmanned aerial system-based spectral imaging for evaluating peanut maturity in field conditions*

3rd Place - $200 Award

Shreya Mitra and Mehul Bhanushali

Poster Title: *Farmers' User Experience Related to Digital Advancements in Agriculture*

Runner Up - $100 Award

Ryan Wright

Poster Title: *Evaluation of Robot Capabilities for Rumen Exploration*

Runner Up - $100 Award

Claire Murphy

Poster Title: *Traceability in Hydroponic Lettuce: A Model Activity for Empowering Agricultural Educators and Supporting Middle School Girls*

Return to Agenda

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Poster Presentations: Session 1

1:30- 2:30 p.m.

1. **Path Planning for Nematodes Sampling**

[1]***Weihang Wang***, [1]*Hasan Seyyedhasani*

[1]School of Plant and Environmental Sciences

Intro: Nematodes sampling has always been a time-consuming and tedious job. The machine I'm developing now shortens the sampling collection process and is able to collect more data for analysis. Then where to take samples became another problem. This poster presents a new way to pick sample locations.

Goals: Consider both relativity scores and travel distance, and generate a new method to pick the best representative locations while keeping the traveling distance to the minimum.

Method: Divide the whole field into sub-areas and pick the best representative sub-area for each level. Then run through each cell to give different weighted scores. Pick the five highest-scored locations then based on representative and distance factors to generate the best combination of locations.

Next steps: Comparing this method with the traditional method in the real field to see the result differences.

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2. **An Examination of Soil Moisture Estimation Using Drone-Based Ground Penetrating Radar**

[1]Milad Vahidi, *[1]Sanaz Shafian, [1]Umme Fatema Piu, [1]Unius Arinaitwe, and [1]Wade Thomason*

[1]School of Plant and Environmental Science

The use of Unmanned Arial Vehicles (UAVs) in precision agriculture is growing due to the simplicity of mission planning and compatibility with optical and radar sensors. The combination of UAV and Ground Penetrating Radar (GPR) has recently been used in various applications such as land mine detection, glaciology, search and rescue, environmental monitoring, and cultural heritage. Still, it has rarely been used in agriculture and smart farming. Furthermore, the ability of the GPR sensor to penetrate lower levels of the soil surface motivated us to investigate the potential of drone mounted GPR in soil moisture monitoring. In this study, a GPR sensor with a central frequency of 500 MHz was mounted on an M300 Matrices DJI drone to collect data from a corn field for soil moisture estimation. The amplitude of signals obtained from soil depth has been shown to be a good predictor of the measured soil moisture.

Return to Agenda

3. **Virginia Seafood Agricultural Research and Extension Center**

[1]*Michael H. Schwarz,* [1]***Keri Rouse****,* [1]*Jonathan van Senten,* [1]*Reza Ovissipour,* [1]*Katheryn Parraga-Estrada, and* [1]*Wendy Stout.*

[1]Virginia Seafood AREC

At the Virginia Seafood Agricultural Research and Extension Center, research and Extension specialists work with industry and research partners to identify and respond to emerging needs and provide technical guidance to stakeholders at every level of the seafood supply chain. Core programs focus on seafood safety and quality of wild-caught, cultured animals and products, business and marketing support for the commercial and aquaculture industries, engineering, thermal processing, intensive recirculating aquaculture, and education/outreach for industry and consumers. In 2022, the Hampton-based Center moved into a new 22,000-square-foot, state-of-the-art facility with design considerations to enhance coastal resilience. New major program area expansions are currently underway, including Sustainable Food Production Systems (aquaponics, microbiome, RAS, alternative proteins including plants and insects); cellular agriculture; Economics and Marketing (policy and regulatory impacts, farm production economics, economic impact analysis, financial benchmarking, and automation/robotics); coastal resilience; in addition to offshore renewable energy and co-location of synergistic activities.

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4. **Affordable Flexible Robotics for Accessible Mobility on the Farm**

[1]***Kim Niewolny****,* [1]*Roberto Franco,* [2]*Divya Srinivasan,* [2]*Satyajit Upasani,* [3]*Alexander Leonessa,* [3]*Alan Asbeck*

[1]Agricultural, Leadership, and Community Education, [2]Industrial Systems Engineering, [3]Mechanical Engineering

The AgrAbility Virginia team has partnered with the Departments of Mechanical Engineering and Industrial and Systems Engineering at Virginia Tech on a three-year $999,277 National Science Foundation (NSF) grant titled, “Affordable Flexible Robotic Technology to Enhance Work Performance of Farmers with Mobility Restrictions.” AgrAbility Virginia worked alongside engineers, medical professionals, and TORC Robotics to co-develop flexible robotic systems that are wearable by farmers with mobility limitations in order to assist them in performing activities of daily living with dignity and success. The purpose of this poster is to share how the team developed a flexible low-cost exosuit that would assist farmers with their mobility limitations without being intrusive or obstructive. This project builds on existing technology developed by researchers at Virginia Tech as well as TORC’s expertise on building automated equipment.

Return to Agenda

5. **Alson H Smith Jr. Agricultural Research and Extension Center: Supporting Commercial Fruit growers and industry**

[1]Kevin Rice

[1]Alson H. Smith Jr. Agricultural Research and Extension Center

The Alson H. Smith Jr. AREC is located in Winchester, Virginia and serves the commercial fruit and value-added horticultural food crops industries through research, educational programs, development of sustainable production systems and technologies, and increased public knowledge of horticultural opportunities and benefits. The AHS AREC has six faculty research programs including grape pathology, tree fruit pathology, horticulture, entomology, enology and viticulture. The station includes 124 acres of apple, peach, grape, and cherry research plots, and three greenhouse bays. Our 80-person capacity video conference room provides educational outreach programs including fruit schools, bee courses, and extension meetings. We organize annual field days and an open house that highlight faculty research and extension activities and provide growers and industry stakeholders with current guidelines for sustainable fruit production and management.

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6. **Research Programs at Alson H Smith Jr. AREC**

[1]Kevin Rice

[1]Alson H. Smith Jr. Agricultural Research and Extension Center

Research programs at the Alson H Smith Jr. AREC focus on sustainable production and management in commercial fruit commodities including apple, peach, grape, and cherry. We have six faculty research programs including entomology, enology, viticulture, horticulture, tree fruit pathology and grape pathology. Our research combines both basic and applied science to ultimately produce sustainable recommendations for fruit production and management. Recent research includes novel molecular diagnostics for pathogens, biopesticide and behavioral management of invasive insects, developing biofungicides for disease management, evaluating plant growth regulators to reduce losses associated with climate change.

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7. **An introduction to Virginia Tech's Southern Piedmont Research and Extension Center**

[1]Atoosa Nikoukar, *[1]Arash Rashed, [1]Margaret Kenny*

[1]Southern Piedmont Agricultural Research and Extension Center

The Southern Piedmont AREC expands over 1,180 acres, including 130 acres of crop research plots, 12 experimental ponds, 120 acres of grazing pasture, and 40 acres of replicated silvopasture research plots. Our team includes 6 resident faculty, 14 full-time staff, 6 graduate students, and employs additional undergraduate trainees and hourly help at various times of the year. The

Return to Agenda

research and Extension programs at the Southern Piedmont AREC are primarily focused on crops grown in the Piedmont region of Virginia, including forages, tobacco, vegetables, small fruits, and row crops. The Agronomy, Applied Forage Systems, Crop Production and Breeding, Entomology, and Plant Pathology Programs at the Southern Piedmont AREC work closely with other research and Extension programs in Virginia Tech and other institutions to improve animal and crop production in the region. As CAIA affiliates, our faculty utilize the latest technologies for monitoring and detecting challenges to our agroecosystem productivity and production sustainability, delivering rapid, timely responses and providing our producers with the knowledge to address future challenges. Spore trapping networks, hyperspectral drone and satellite imaging, high-throughput data analysis, and IoT-enabled environment sensing for soil and other settings are examples of technologies employed by our research and Extension programs for monitoring and early detection of biotic and abiotic stress factors.

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8. **Genomic prediction of image-derived high-throughput phenotyping traits in rice.**

[1]Shikhar Poudel, *[2]Gota Morota*

[1]Translational Plant Sciences Center, [2]School of Animal Sciences,

To get enough food for the rising global population, farmers are working together with researchers and scientists. Scientists continuously work to find the best rice genotype to tolerate drought, weeds, insects, pests, and more. Rice is a staple food around the world. Researching suitable genotypes is made more accessible by genomic prediction. Genomic prediction is a method in genetics to predict traits using genomic information. Genomic prediction is imperative in plant breeding because it helps predict the genotype's breeding value. Genomic selection (GS), which is a form of marker-assisted selection (MAS), is getting popular in finding out the genome-based estimated breeding value (GEBV). The GS is based on the statistical model; in this research, we used a parametric, penalized approach to the GS selection model, GBLUP. The genomic prediction is for the rice diversity panel containing 413 accession IDs. We had both genotype and phenotype data, and the phenotype data were collected using a high-throughput phenomics platform (Lemnatec Scanalyzer 3D) in Australia. From the images, plant pixels were quantified and summed to find the plant shoot area, which was used to measure plant shoot growth. We had nine days of imaging, and firstly, we used a cross-validation method using the GBLUP model to predict the plant shoot area from day 7 to day 15, and the prediction accuracy was higher than 70%. Secondly, we used day seven and day nine imaging, using GBLUP to predict other days' plant shoot area, and we got prediction accuracies higher than 94%. It shows that single-time point analysis using threefold cross-validation gave less prediction accuracy than longitudinal time point analysis. Optimizing the model to get a higher prediction accuracy is recommended in the future. Hence, predicting plant shoot areas can support farmers in decision-making and increase rice production for global food security.

Return to Agenda

9. **Towards Pesticide Smart Agriculture using System Thinking and Precision Farming**

[1]Olamide Olowoyo*, [1]Eric Kaufman, and [1]Austin Council*

[1]Agricultural, Leadership, and Community Education

Pesticides play a major role in agricultural production, they are extensively used in modern agriculture (Sharma et al., 2019). Farmers have continuously used pesticides to control pests and diseases, and have tremendously increased the production of food (Tudi et al., 2021). The use of pesticides remains an effective and economical way to improve the quality and quantity of food production. Globally, about 3 million tonnes of pesticide are utilized annually, where China contributes the most, followed by USA and Argentina (Pariona, 2017; Sharma et al., 2019; Statista, 2023). Despite the contribution of pesticides to agricultural production, the indiscriminate usage poses serious consequences to human health and the environment (Sharma et al., 2019). Evidence in the last few decades have shown that they could also be detrimental to human health from food contamination due to pesticide residue, posing threat to health of the farmers who spray the pesticides as well as the environment (Sosan & Akingbohungbe, 2009). Proffering solutions to the problem of indiscriminate pesticide usage and pesticide residue in food requires finding the root causes of the problem. The iceberg model of system thinking is an effective tool that would help in determining the root cause of the problem. The iceberg model comprises four main system thinking languages: events, patterns, systemic structures and mental models (Monat & Gannon, 2015). Applying the model will help to look beyond the events, to the mental models responsible for these trends. Likewise, the use of precision farming techniques will provide farmers the ability to use crop inputs effectively, especially pesticides (Zanin et al., 2022). Effective usage of pesticide through precision farming will improve yield and increase farmers income, and minimizes health and environmental hazards (Raj at el., 2022). Thus, pesticide smart agriculture requires collective efforts of farmers, government agencies, researchers, extensionists and private organizations.

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10. **Optimizing AI-Based Technologies for Precision Agriculture: The Role of Semi-Supervised Learning in Overcoming Data Labeling Obstacles**

[1]Dhiraj Srivastava *and [1]Vijay Singh*

[1]Eastern Shore Agricultural Research and Extension Center

Palmer amaranth (Amaranthus palmeri) is a troublesome weed that can cause significant yield reduction in major crops, including soybean. Integrated weed management practices, such as, spot spraying and selective placement have proven effective in controlling the weeds while reducing herbicide usage. In recent years, eco-friendly artificial intelligence (AI)-based weeding robots and spot sprayers have been gaining popularity in the agriculture industry. However, the lack of quality image data is the biggest obstacle faced by agricultural researchers to create reliable AI technology robust enough to map weeds under different weather conditions and locations. Labeling large image dataset for training supervised machine learning models is not cost-effective. Semi-supervised learning offers a solution by requiring only partially labeled datasets and utilizing unlabeled examples for learning. This research focuses on presenting a new architecture based on self-

Return to Agenda

supervised contrastive learning to detect Palmer amaranth in soybean. The study was conducted in 2022 in Painter, VA, using unmanned aerial systems (UAS) that captured RGB imageries of soybean and Palmer amaranth at different growth stages. Object detection approaches based on YOLOv5 and YOLOv6 were also utilized. Image data for object detection models were annotated using LabelImg. Self-supervised learning labeled Palmer amaranth and soybean with 98.5% accuracy. The YOLOv6 model was found to be suitable for real-time deployment, with a Precision and Recall of Palmer amaranth greater than 82% at mean average precision 0.5 and an average inference speed of 8.28 milliseconds. Future research will focus on using self-supervised learning to predict the crop yield variation due to different densities of weeds. These findings have the potential to advance weed management in the context of climate change, reduce herbicide usage, and associated environmental impacts, and enhance the economic viability of farming operations.

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11. **Alternative analytics strategies to complement meta-regression analyses in animal nutrition: an example exploring milk yield and composition.**

[1]***Sathya Sujani***, [1]*Barbara Roqueto dos Reis, and* [1]*Robin White*

[1]School of Animal Sciences

This manuscript evaluated 2 alternative analytical approaches namely, recursive feature elimination (RFE) and additive Bayesian networking (ABN) in parallel to the traditional mixed-model-meta-analysis. Recursive feature elimination is an approach (based on random forest machine-learning method) to select features with high relative importance and fits a model while dropping features with low relative importance. Additive Bayesian networking is a method to determine an optimal directed acyclic graph and a multivariate approach using machine-learning and well adapted to study messy, highly correlated data. To evaluate how these alternative data analytics approaches might complement traditional meta-analyses, our objective was to explore the strengths and limitations of linear-mixed effect regression, RFE, and ABN in identifying relationships among diet, rumen, animal, and milk performance variables. One hundred and ninety five (194) studies representing 705 individual treatments were used to construct the database leveraged in this study. Most relationships identified among the analysis methods were consistent with existing knowledge on dietary and ruminal variables contributing to milk production and composition. The ABN and the mixed-modeling approach aligned well in most analyses and highlighted the need for considering interactions in animal nutrition modeling. Although the ABN was a more intuitive way of depicting the complex associations among variables, the mixed-model was better suited to specific quantitative inquiry. The RFE frequently failed to identify the same important variables as the ABN and the mixed-model approach, likely due to the lack of interactions considered within that framework. Based on this analysis, future meta-analyses may benefit from inclusion of ABN as a component of exploratory data analysis or as a complementary analysis to traditional mixed models.

Return to Agenda

12. **AI-based Rational Design of Antimicrobial Peptides for Controlling the Infection of Both Human and Plant Bacterial Pathogens**

[1]***Qi Li***, [1]*Kunru Wang,* [1]*Ayoyinka Okedigba,* [1]*Daniel Capelluto, and* [1]*Bingyu Zhao*

[1]School of Plant and Environmental Sciences

Since penicillin was discovered as the first antibiotic in 1928, more than 100 antibiotic compounds have been identified. However, only a few new antibiotics have been found since 1987. Developing new antibiotics is the key to controlling the life-threatening super “bugs” in the future. Antimicrobial peptides have been explored as new antibiotics because of their apparent advantages over conventional antibiotics, including slower resistance and broad-spectrum antibiofilm activity. The antimicrobial peptides also have great potential to be biopesticides for controlling plant diseases. In this project, we characterized a small antimicrobial peptide, Hyde1, isolated from Acidovorax citrulli, as a novel antibiotic and biopesticide. We demonstrated that Hyde1 could be secreted through the bacterial type 6 secretion system (T6SS) to inhibit the growth of diverse bacterial species. We further demonstrated that the N-terminal of 33 amino acids (N33) of Hyde1 is essential and sufficient for its antimicrobial activity. Synthesized peptides (N33) can inhibit the growth of both gram-positive and negative bacteria that infect crop plants. However, N33 has a low solubility in most common buffers. To improve the solubility of N33, we modeled the 3-D structure of N33 using the AlphaFold algorithm and rationally designed N33 variants that may enhance their solubility and antimicrobial activities. In addition, we developed a novel expression strategy that allows us to co-express hyde1 along with an antitoxin protein in E. coli. Lastly, we collected 3,569 peptides/proteins with known antimicrobial activities and are currently modeling their 3-D structures. Analyzing the 3-D structures may allow us to identify shared features in diverse antimicrobial peptides. The structure database of these diverse antimicrobial peptides will be a valuable resource for developing novel antibiotics and biopesticides.

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13. **Traceability in Hydroponic Lettuce: A Model Activity for Empowering Agricultural Educators and Supporting Middle School Girls**

[1]***Claire Murphy***, [1]*Alexis M. Hamilton and* [1]*Laura K. Strawn*

[1]Food Science and Technology

Cyberbiosecurity is a new field working to improve food safety by securing the protection of data collected, used, and shared during food production. Given the need for the development of cyberbiosecurity professionals with an understanding of challenges specific to agricultural systems, focusing on creating and designing STEM experiences that meet the needs of female students, before they finish 8th grade, creates an opportunity to establish such a pipeline. One of the emerging perspectives through which to observe these concerns for farm production is traceability, which encompasses food safety practices from the farm through distribution. Therefore, the goal of this project was to develop classroom activities and educator resources to engage middle school girls in agricultural science through hands-on activities, female representation, and cyberbiosecurity examples. This four to six week long activity is optimized for 7th- and 8th-grade students, but

Return to Agenda

adaptable to 5th- and 6th-grade students. The activity is also fully adjustable based on hydroponic system and budget. Furthermore, this educational resource emphasizes observation, critical thinking, and individual responsibility while containing positive representation of women in science.

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14. **Enhanced Identification of the Spatiotemporal Dynamics of Variable Source Areas.**

[1]***Binyam Asfaw***, [1]*Daniel Fuka,* [3]*Ian Adams,* [2]*Robin White, and* [1]*Zachary M. Easton*

[1]Biological System Engineering, [2]*School of Animal and Sciences,* [3]*Case Western University*

Managing manure deposition in pastured livestock systems is critical to realizing environmental goals. Traditionally this has been accomplished by reducing pastured livestock density, or by rotational grazing. In open grazing systems, continuously moving livestock deposit manure across the landscape, although not evenly, as much as 75% of pasture manure is deposited in streams, water bodies, and critical source areas-CSA (e.g., saturated runoff generating areas). New technology enables advanced management of pasture based livestock manure by monitoring animal defecation patterns and characterizing the pasture conditions, which is then assimilated by a management platform to predict manure nutrient fate. This information is then used by autonomous pasture sanitation robots, which optimize the relocation of manure away from water bodies and CSAs. Leveraging Cyber-Physical Systems (CPSs) to manage livestock manure requires real time information on animal location and defecation patterns, soil moisture conditions, and soil nutrient content. To this end, enhancing the performance of hydrological models beyond standard streamflow prediction to other hydrologic components, such as soil moisture, is given particular emphasis. Using Stroubles Creek as a test watershed, and leveraging increasing availability of remotely sensed surface soil moisture data, advances in spatial downscaling techniques, and relationships between terrain characteristics and soil moisture a new approach is developed to enhance fine scale (e.g. 10 m) pasture management. The model assimilates animal sensor data, remotely sensed soil moisture, and advanced terrain metrics to identify and manage manure deposited in CSA areas. Briefly the proposed approach employs statistical downscaling of remotely sensed global soil moisture data using advanced terrain metrics, integration of animal location and behavior using IoT sensors, and measurements of the soil nutrient status, all of which are used to parameterize a model to provide real time and short term forecasts that inform autonomous robots that manage pasture manure to optimize water quality.

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15. **Glucose Measurements in Sheep Using a Long-Term Continuous Glucose Monitor Designed for Humans**

[1]***Barbara Roqueto dos Reis*** *and* [1]*Robin White*

[1]School of Animal Science

This study aimed to investigate whether continuous glucose monitors (CGM) designed for humans could measure glucose levels in sheep, as compared to traditional blood-sample-based glucose

Return to Agenda

measurements. Four Suffolk x Dorset sheep were fitted with jugular catheters and with a FreeStyle Libre 2 (Abbott) glucose monitor that remained in place for the duration of the collection. The CGM sensors were placed on the animal's neck. To investigate whether the CGM could detect an increase and decrease in glucose concentrations, a hyperglycemic clamp was performed on each animal. During the clamp, a jugular infusion of glucose was administered for an average of 3 hours. Samples were collected ever 5 minutes during the infusion and every 10 minutes for an average of one hour after the infusion (until animals returned to baseline blood glucose). Glucose concentrations from blood samples were measured using a handheld glucometer, and this measurement was considered as ground truth. Relationships were analyzed using a linear mixed-effects model with glucometer glucose observation as the response variables, GCM reading as fixed effects, and animal as random effect. An analysis of variance was performed, and significance level was set at $P < 0.05$.Results indicated that CGM followed a linear relationship with glucometer glucose both during the infusion and ($P=0.0003$) after ($P= 0.006$). The model for detecting increases in glucose concentrates had a concordance correlation coefficient (CCC) of 0.91 and a sigma error of 13.2. The model for detecting glucose concentration when no infusion was occurring had a CCC of 0.94 and a sigma error of 7.9. In both cases, the random intercept for animal was also significant suggesting that individual sensors have unique intercepts which create mean bias in the measurements so absolute values obtained from these sensors should be standardized to ground truth measurements before use in research or clinical contexts.

16. **Quantifying the impacts of agricultural machinery traffic on crop and soil health using very high-resolution satellite imagery**

[1]***Souradeep Deb***, [1]*Abhilash Chandel, and* [2]*David Holshouser*

[1]Biological Systems Engineering; Tidewater Agricultural Research and Extension Center, [2]School of Plant and Environmental Sciences; Tidewater Agricultural Research and Extension Center

Excessive on-farm traffic from operating machinery can be detrimental to crop and soil health, however, such impacts have not yet been quantified as to form a pathway for controlled-traffic-farming practices. A study was conducted on 13 fields (9 planted with soybean and 4 with corn) where very high-resolution spectral satellite imagery (80cm x 80cm) was evaluated during "crop-ON" (June) and "crop-OFF" (December) seasons. Traffic patterns were also identified on respective farms using geotagged shapefiles exported from operating machinery systems. Normalized Difference Vegetation Index (NDVI) magnitudes were significantly higher (crop-ON: 0.28 to 0.70 and crop-OFF: –0.4 to 0.23) on non-traffic lines than traffic lines (crop-ON: 0.21 to 0.57 and crop-OFF: –0.49 to –0.24). Next, binary masks were created for each field and net %traffic area were computed for the grids of 10×10 m to evaluate the aggregated impact on crop and soil health. Spearman's correlation analysis showed NDVI to decrease with the % traffic area (r: -0.48, $p < 2.2e-16$). Study findings evidently support that in-field traffic can negatively impact crop and soil health. Further spatiotemporal analyses on the effect of traffic will be instrumental in developing and adopting control traffic farming operations towards sustainable production.

Return to Agenda

17. **Evaluation of corn leafspot injury and fungicide application impacts using high-resolution aerial multispectral imagery**

[1]***Sheetal Kumari***, [1]*Abhilash Chandel, and* [2]*David Langston*

[1]Biological Systems Engineering; Tidewater Agricultural Research and Extension Center, [2]School of Plant and Environmental Sciences; Tidewater Agricultural Research and Extension Center

Corn leafspots (LS) are one of the most destructive foliar diseases which can lead to yield losses exceeding 50%. Conventionally, LSs are identified manually which is tedious and expensive. We utilized aerial multispectral imagery (MSI) to rapidly quantify the incidence of a recently discovered LS (Diaporthe sojae) in Virginia, as well as the efficacy of fungicide treatments. A randomized experiment was developed with four plots, each having four subplots/treatment. Each treatment was the combination of a fungicide and phenological growth stage of application. MSI were collected at 1 cm/pixel at stage-R5 (dent) from which 24 vegetation indices (VI) were extracted. LS was rated concurrent to imaging, and crop yield & grain moisture (GM) was acquired at harvest. Among fungicides, Revysol, PTF (Prothioconazole, trifloxystrobin, Fluopyram), and PAB (Propiconazole, Azoxystrobin, Benzovindiflupyr) showed higher efficacy when applied at tasseling and reproductive stages (VT/R1) (LSavg rating: 4.33%, 5.5%, 9%) compared to vegetative stages (V10-14, LSavg rating: 6.25%, 20%, 15.5%). While, LS rating for untreated control was 34.37%. It was observed that LS did not impact yield (p=0.07) and GM (p=0.21) under the influence of fungicide treatments. Among extracted VIs, VARI and GLI had relatively the strongest and most significant correlations with LS ratings (r=-0.56 and -0.51). While GCI and GNDVI had the strongest correlations with GM (rGM=0.69) and yield (rY=0.74). Other VIs including SAVI, LAI, TDVI, GRVI also had significant correlations with GM and yield (rGM=0.67-0.68, rY=0.73–0.74). Aerial imagery can be instrumental in spatially quantifying corn disease damages and for precision fungicide applications.

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18. **Wireless Sensor Node System to Monitor Pig Activities for Behavior Classification**

[1]***Yuezhong Xu*** *and* [1]*Yuezhong Xu*

[1]Electrical and Computer Engineering

Wireless sensor nodes (WSNs) are useful for monitoring animals remotely and continuously. The proposed WSN aims to monitor pig activities, and it consists of a 3-axis accelerometer, a 3-axis gyroscope, and a microcontroller with embedded BLE (Bluetooth Low Energy) radio. The WSN was designed and prototyped with a custom PCB and used to collect data from pigs in the field for about 131 hours, and the collected data was processed to classify pig behaviors with machine learning models. The sampling rate of the sensors is 10 samples per second. On average, the proposed WSN dissipates 6.29 mW, and the peak power dissipation is 41.01 mW during transmission of the sensed data. The WSN is estimated to operate for about three weeks with a coin cell battery CR2477.

Return to Agenda

19. **A Signature-based Approach to Quantify Soil Moisture Parameters under Contrasting Irrigation Practices**

[1]***Suman Budhathoki*** *and* [1]*Julie Shortridge*

[1]Biological Systems Engineering

Soil moisture is an important component of the hydrologic cycle, as it controls the exchange of water and energy between the land surface and the atmosphere through evaporation and plant transpiration. As a result, soil moisture plays a key role in crop production. However, interpreting and making use of soil moisture data requires quantifying certain hydrologic parameters, including field capacity and permanent wilting point, that can be challenging to estimate. Hydrological signatures are metrics derived from hydrological time series data such as rainfall, streamflow or soil moisture that can be used to estimate such hydrologic parameters. Till date, this approach has been mostly applied to streamflow data with limited work with soil moisture data, and no research has applied hydrological signatures in agronomic soils where soil moisture conditions change rapidly. The objective of this study is to assess whether hydrologic soil moisture signatures proposed in the literature can distinguish and interpret differences in soil moisture dynamics among contrasting irrigation practices at different soil depths and cropping treatments. We use hourly volumetric water content data for soils under three different irrigation treatments, including precision irrigation, non-irrigation, and full-irrigation treatment plots growing corn and cotton located at Virginia Tech's Tidewater Agricultural Research and Extension Center (AREC). We demonstrate capabilities and limitations of existing methodologies for extracting soil moisture signatures under various irrigation systems in agronomic soils and suggest potential avenues for improvement and future research.

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20. **Predicting Malt Quality with Drone Imagery in Barley (Hordeum vulgare L.)**

[1]***Amelia Loeb***, [1]*Wynse Brooks,* [1]*Felipe Sabadin, and* [1]*Nicholas Santantonio*

[1]School of Plant and Environmental Sciences

The eastern US has over 3,021 craft breweries; however, local malt production is almost non-existent due to disease pressures from a humid climate. To help meet local demand, highly resistant malt barley types have been recently developed at Virginia Tech. Selection for malt quality traits is difficult due to expensive and time-consuming lab analysis. Aerial imaging is inexpensive, rapid to collect, and has been shown to be predictive of field phenotypes. We aim to estimate malting quality traits by using measures of growth and development captured with aerial imaging. Predictions of malt quality at early breeding stages will allow for efficient and cost-effective decision. Additionally, this work examines the relationship between growth and end-use quality as it relates to environmental variability. Genotype by environmental interaction (GxE) is poorly understood, and an area of potential improvement for breeding trials. Multi-spectral images of the winter malt barley breeding lines, were captured in two contrasting Virginia locations for the 2021 and 2022 season. Phenotypic data was collected for yield, test weight, plant height, heading date. Malt quality analysis was done at USDA, Wisconsin and Hartwick College. Our goal is to determine the most informative growth stage(s) for agronomic and quality trait prediction relative the genetic architecture of these traits in

Return to Agenda

Virginia Tech germplasm. Early use of these correlations in the breeding process should increase the selection pressure on traits linked to malt quality, which is expected to accelerate the breeding timeline and improve the quality of released malt barley varieties.

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21. **Development of highly fermentable insoluble dietary fiber for a healthy gut microbiome**

[1]***Xueqian Su***, [1]*Haibo Huang,* [2]*Qing Jin, and* [1]*Hengjian Wang*

[1]Food Science and Technology, [2]School of Food and Agriculture; The University of Maine

Brewer's spent grain (BSG) is a major by-product of beer brewing and mainly consists of dietary fiber. However, most dietary fiber in BSG is insoluble dietary fiber (IDF) with recalcitrant structures, resulting in its poor fermentability during digestion. Subcritical water treatment (SWT) is an effective technique to breakdown the fiber structure, which can be further enhanced with the integration of acids like lactic acid (LA). Therefore, this study aims to modify the structure of IDF from BSG by LA-assisted SWT for improved functional properties and better fermentability in the human gut.

Dietary fiber from BSG after the removal of lipid, protein, and starch was subjected to SWT under different temperatures (140℃ and 180℃) and LA concentrations (0%, 0.5%, 1%, and 2%) to obtain modified IDFs. Chemical compositions and physicochemical properties were then analyzed for obtained IDFs. Water holding capacity (WHC), oil holding capacity (OHC), swelling capacity (SC), and glucose adsorption capacity (GAC) were measured to assess their functional properties. Structural properties were characterized using X-ray powder diffraction (XRD) and Fourier-transform infrared spectroscopy (FTIR). In-vitro fermentation was conducted using swine feces to determine their fermentability.

The hemicellulose content in modified IDFs significantly decreased with the increase of treatment temperature and LA concentration. This resulted in decreased yield, particle size and bulk density but increased WHC, OHC, SC and GAC in modified IDFs. XRD results showed higher crystalline index in modified IDFs and, FTIR analysis revealed the cleavage of C-O groups in hemicellulose and relatively higher intensity of aromatic ring structure in lignin after SWT. Modified IDFs can be better fermented to produce more short-chain fatty acids in the human gut during the later digestion stage. Gene sequencing of the fermented culture will be the next step to determine the gut microbiota composition and metabolites as affected by modified IDFs.

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22. **Come to the Table: Connecting Food, Farm, and Health**

[1]***Eric Bendfeldt***, [2]*Jayesh Samtani,* [2]*E. French Price,* [3]*Kim Niewolny,* [1]*Becky Gartner; VCE Rockingham County,* [4]*Marcus Comer,* [2]*Mizuho Nita,* [1]*Thomas Bolles; VCE Prince William County,* [1]*Andrea Wann; VCE Washington County,* [1]*Roy Flanagan; VCE Virginia Beach,* [1]*Kenner Love; VCE Rappahannock County,* [1]*Jeanell Smith; VCE Lynchburg and CALS Project Team*

Return to Agenda

[1]Virginia Cooperative Extension (VCE), [2]School of Plant and Environmental Sciences, [3]Agricultural, Leadership, and Community Education, [4]Virginia State University

"The Come to the Table: Connecting Food, Farm and Health as a Virginia food value chain research and extension initiative supported by Virginia Tech's College of Agriculture and Life Sciences' 2021 Internal Integrated Competitive Grant Program had two primary objectives: 1) develop and formalize an internal integrated multi-disciplinary food system planning approach across CALS and VCE Planned Program Teams and 2) build capacity for trans-disciplinary coordination, cooperation, and collaboration across VCE Planned Program teams and the land-grant universities to strengthen comprehensive food value chain coordination and responsiveness from field-to-fork for greater food system and community resilience. Key short-term outcomes of this initiative included 124 faculty and personnel from CALS, Extension, University, ARECs, throughout Extension districts responding to the Virginia Community, Local, and Regional Food Systems Programming survey to gauge the relevance and importance of values-based impacts to their professional roles within food system programming. The eight values-based impacts included the following: agricultural profitability; economic development and innovation; food security; healthy people; justice and fairness; safe, nourishing food and water; and sustainable farmland and natural resources. Although agricultural profitability had the most rankings of primary relevance to programming, food security ranked the highest in relevance followed by safe, nourishing food and water, healthy people, sustainable farmland and natural resources, and then agricultural profitability. When asked what area of values-based impact needs the most attention in their communities, food security and healthy people ranked first and second. In addition to the Virginia Community, Local, and Regional Food Systems Programming survey, the grant project team conducted a "Come to the Table: Connecting Food

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23. **MAKING A ROBUST SOYBEAN MEAL FOR ANIMAL DIET**

[1]***Ayoyinka Okedigba***, [2]*Luciana. Rosso,* [4]*Dajun Yu,* [2]*C. Shang,* [4]*Haibo Huang,* [2]*Bo Zhang, and* [3]*Daniel Capelluto*

[1]Chemistry Department, [2]School of Plant and Environmental Sciences, [3]Biological Sciences, [4]Food Science and Technology

Soybean is a nutritious crop containing proteins, vitamins, and minerals. Humans or animals cannot consume raw soybeans because they contain anti-nutritive agents such as trypsin inhibitors (TIs). The foremost soybean TIs are Kunitz trypsin inhibitor (KTI) and Bowman-Birk trypsin inhibitor (BBTI). TIs bind and inactivate trypsin, the enzyme responsible for the digestion of proteins in the body, resulting in poor digestion of soybean proteins and other health challenges. The methods employed by soybean processing companies to eliminate or reduce these anti-nutritive agents include thermal and chemical treatment and biotechnological processes. These methods are time-consuming and inefficient, making an alternative method to soybean processing a top priority. This project aims to screen 250 different soybean seed variants and identify the variant with TIs that shows the least affinity for trypsin. This will serve as a lead for crossbreeding to produce a hybrid soybean variant with TIs that display a much lower affinity for trypsin. TIs were extracted from soybean meal samples and purified using FPLC-driven gel filtration. The purity, identity, and affinity of the isolate for trypsin were determined using SDS-PAGE, mass spectrometry analyses, and isothermal calorimetric titration

Return to Agenda

(ITC), respectively. Preliminary results from ITC experiments indicate that purified soybean meal BBTI from one variant exothermically bound porcine trypsin with a dissociation constant (KD) of 120 ± 20 nM. KTI from the same meal sample displayed a 9-fold weaker affinity for trypsin (1.1 ± 0.4 µM). We have identified a BBTI variant (KD of 340 ± 40 nM) with four times less affinity for trypsin than the BBTI reference sample from Sigma (KD of 80 ± 20 nM). In the next step, the affinity of soybean TI for other animal serine proteases will also be determined to establish the impact of TIs on specific animal digesting enzymes.

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24. **Winter Wheat Response to Sources of Sulfur and Application Date**

[1]***Michelle Lee*** *and Joseph Oakes*

[1]Eastern Virginia Agricultural Research and Extension Center

Nitrogen is an essential nutrient for the production of winter wheat, and sufficient levels of sulfur will result in maximum nitrogen response. Therefore, crops such as winter wheat that have high nitrogen needs have high sulfur requirements as well (Anuvia Plant Nutrients, 2019). The Anuvia product SymTrx is an Enhanced Efficiency Fertilizer (EEF) that's geared towards reducing nutrient losses, while increasing nutrient availability to the plant. These products deliver sulfur to the plant in the usable form of sulfate. This differentiates these products from other nutrient sources, because other sulfur-containing products deliver sulfur in the elemental form, which must be oxidized by soil bacteria in order for plants to utilize it (Anuvia Plant Nutrients, 2019). The objective of this study is to examine the effect of sulfur sources and application date on tiller development and grain yield. Research was conducted during the 2020-2021 and 2021-2022 growing seasons. Treatments consisted of: Control (No S) (At Plant Application), Ammonium Sulfate (At Plant Application), SymTRX 20S (At Plant Application), SymTRX 10S (At Plant Application), Control (No S) (December Application), Ammonium Sulfate (December Application), SymTRX 20S (December Application), SymTRX 10S (December Application), SymTrx 10S (Split Application), and SymTRX 10S + Comp1-MES10 (At Plant Application). MAP (11-52-0), Potash (0-0-60), and ESN (44-0-0-0S) were supplemented to achieve the same total amount of N, P, and K in each treatment. Aerial normalized difference vegetative index (NDVI) was taken using an UAV to observe tiller density in response to fertility treatments. The at-plant applications of the SymTRX products and Ammonium Sulfate caused increased tiller densities early; however, later applications eventually increased tiller density to match the at-plant applications. As the growing season progressed, NDVI indicated that the tiller densities leveled out which resulted in yield differences being insignificant. The Anuvia products did not result in a yield increase over the control for either application date or in a split application.

Return to Agenda

25. **Quantifying Sclerotinia blight severity and effective fungicide application strategies in peanuts using aerial multispectral imaging technique**

[1]***Jitender Rathore***, [1]*Abhilash Chandel, and David Langston*

[1]Biological Systems Engineering; Tidewater Agricultural Research and Extension Center, [2]School of Plant and Environmental Sciences; Tidewater Agricultural Research and Extension Center

Peanuts are largely affected by soilborne diseases such as Sclerotinia blight (SB) caused by the fungus Sclerotinia minor. Scouting for this disease is time-consuming, labor-intensive, and expensive. Also, current-day technology has not been previously used to characterize the distribution of this disease in the field. This study evaluates the feasibility of aerial multispectral imagery for high throughout detection and quantification of SB infection and distribution in field-grown Virginia-type peanut cultivar 'Bailey-II'. Multi-spectral imagery was also used to quantify the impact of fungicide treatments used to control SB. A complete randomized block experiment was developed with four replicates of sixteen different treatments consisting of different application schedules and fungicide combinations. Fungicides pydiflumentofen, azoxystrobin & benzovindiflupyr, fluazinam and pyraziflumid were applied at different days after plantation (DAP) sequences. A small unmanned aerial system (SUAS) equipped with a multispectral imaging sensor on-board was used to image the treatment plots at peak vine growth. Synchronously, plots were evaluated for SB severity. Total of 23 vegetation indices (VIs) were extracted and evaluated for correlation with the severity ratings and yield. Results demonstrated that fluazinam applied (0.47 liters per hectare, quantity 18.66 mL/mx and 0.79 liters per hectare,quantity 28.29 mL/mx) after 100 DAP was the most effective in reducing SB severity (p=0.01). Out-extracted VIs, Green Leaf Index (GLI) demonstrated the highest correlation with SB ratings (r=-0.88), followed by Normalized Difference Vegetation Index (NDVI, r=-0.87), Infrared Percentage Vegetation Index (IPVI, r=-0.87), and Modified Simple Ratio (MSR, r=-0.86). SB was severe in this experiment and significantly impacted yield (r=-0.69 , p= 2.4e-07). The VIs, GLI (r=0.73), Visible Atmospherically Resistant Index, NDVI, and IPVI (r=0.70) demonstrated strong, significant correlations with disease severity and yield (r=0.70–0.72). The study demonstrated that aerial multispectral imaging can be instrumental for the high-throughput quantification of peanut diseases, and correlating disease severity with yield, which may be useful towards precision fungicide applications. Machine learning algorithms are also being developed for furthering disease-onset prediction accuracy and robustness across different agroecosystems.

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26. **Overview of Southwest Virginia Agricultural Research and Extension Center**

[1]*Lee Wright and* [1]*Jessica McAllister*

[1]Southwest Virginia Agricultural Research an Extension Center

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Return to Agenda

27. **Overview of Shenandoah Valley Agricultural Research and Extension Center**

[1]*Gabriel Pent*

[1]Shenandoah Valley Agricultural Research an Extension Center

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28. **Overview of Middleburg Agricultural Research and Extension Center**

[1]*Sally Johnson and* [1]*Tait Golightly*

[1]Middleburg Agricultural Research an Extension Center

Return to Agenda

Poster Presentations: Session 2

2:30- 3:30 p.m.

29. **Documenting the relationship between the light reflectance of out-of-play areas and pollinator presence at Virginia golf courses**

[1]***Shannon Bradley*** *and* [1]*Alejandro Del Pozo*

[1]Entomology; Hampton Roads Agricultural Research and Extension Center

Non-playable areas of golf courses have the potential to serve as pollinator habitats. These areas receive no inputs, less disturbance and reduced foot traffic, making them ideal for preserving beneficial insects. There is currently a lack of information characterizing these areas and the abundance of pollinating insects found within them. This research aimed to catalog the canopy of the plants, record insect abundance, and correlate this information using light reflectance at two golf courses in Virginia during 2022. Ten sampling points were monitored at each golf course, where insects were classified to order, canopy cover was calculated, and light reflectance was collected. The light reflectance of the pollinator spaces was gathered remotely and proximally, using a DJI Phantom 4 Multispectral drone and an ASD Field Spectrometer, respectively. The light reflectance was used as a proxy for plant health and to calculate indices that can be used to determine characteristics of the plants, such as nitrogen related stress or chlorophyll content. Twelve light reflectance indices were compared to the confirmed presence of the pollinators in out-of-play areas, with SIPI (Structure Intensive Pigment Vegetation Index) found to have the strongest correlation. Additional drone flights and pollinator spaces would benefit this research in refining the wavelengths of interest. Further work with the indices is required to accurately determine which could highlight locations of out-of-play areas serving as pollinator habitats. The use of remote sensing and light reflectance has the potential to help golf course superintendents to locate, promote and preserve pollinator habitats.

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30. **Soil Nutrient Levels and Weather Factors associated with Salmonella prevalence on Virginia Produce Farms**

[1]***Camryn Cook***, [1]*Claire M. Murphy,* [1]*Renee R. Boyer,* [1]*Monica Ponder,* [2]*Steven L. Rideout,* [2]*Rory O. Maguire, and* [1]*Laura K. Strawn*

[1]Food Science and Technology, [2]School of Plant and Environmental Sciences

Soil can be a route of contamination of fresh produce. Growers routinely manage soil nutrient levels, and little research exists on synergistic or antagonistic effects on foodborne pathogens. This study aimed to (i) determine Salmonella prevalence (ii) investigate macro- and micronutrient levels (soil factors), and weather factors associated with each microbial target in soil. Three produce farms in Virginia were selected from different regions (eastern, western, and northern VA). Farms were sampled four times to capture seasonal differences. Five soil samples were collected from 20 plots

Return to Agenda

(25m2) and pooled in equal quantities to form one sample per plot. A total of 240 samples were collected. Samples (25g) were processed for Salmonella using a modified FDA BAM method. PCR was used to confirm presumptive Salmonella-positive samples using a single gene (invA). Soil factors and weather factors were tested for each plot and evaluated for their association with each microbial target using Bayesian univariable logistic (Salmonella) regression in RStudio. Salmonella prevalence was 4.2% (10/240) in soil samples. Of the ten Salmonella-positive samples, nine samples (90%) were from one single farm in eastern VA. Organic Matter (OM) and pH had a non-negligible association with Salmonella prevalence (0.82 and 0.20 times less likely to detect Salmonella when you see an increase in OM and pH). Alternatively, higher relative humidity three days before sampling resulted in a non-negligible association with Salmonella prevalence (0.33 times less likely to detect Salmonella when you see higher relative humidity three days prior to sampling). Additionally, heavier winds seven days prior to sampling also resulted in a non-negligible association. Therefore, findings reveal some soil nutrient levels were associated with Salmonella prevalence in VA soils, yielding a potential monitoring tool to forecast soil properties favorable for Salmonella.

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31. **Identification of morphokinetic parameters predictive of bovine in vitro blastocyst production and cryopreservation survival via time lapse video analysis and machine learning**

[1]Jada Nix, *[1]Mackenzie Marrella, and [1]Fernando Biase*

[1]School of Animal Sciences

In vitro produced bovine embryos present distinct morphokinetic profiles which support or inhibit their development and cryopreservation survival. We hypothesized that specific morphokinetic profiles can predict development and cryopreservation outcomes. Using an incubator with a built-in camera and microscope, we have collected and annotated time lapse videos of bovine early embryonic development. This was followed by cryopreservation, thawing, and survival evaluation of embryos which reached the blastocyst stage. Our analysis reveals a significant relationship between the timing of the first cell division, synchrony of cell divisions, or reverse cell divisions with embryo development to the blastocyst stage ($P<0.001$). Furthermore, after 30 hours post-fertilization, each additional hour that an embryo has not completed its first cell division results in a 19-fold greater chance of developmental arrest before reaching the blastocyst stage ($P<0.0001$). Embryos presenting asynchronous or reverse cell divisions are also more likely to undergo developmental arrest prior to blastocoel cavity formation (30-fold and 255-fold greater, respectively, $P<0.0001$). Major characteristics impacting cryosurvival are the duration of time between the first cell division and morula formation, as well as the stage of development at cryopreservation ($P<0.001$). Using a machine learning approach, we have identified classification models that can predict an embryo's ability to reach the blastocyst stage and survive cryopreservation at 80% and 70% accuracy, respectively. Overall, we have identified key features of bovine early embryonic development which influence development and cryopreservation competence. The use of machine learning models for prediction of embryo competence can increase success rates of in vitro embryo production and survival post-transfer into a recipient.

Return to Agenda

32. **Depth video data enabled prediction of dairy cow body weight**

[1]***Ye Bi***, [1]*Leticia M. Campos,* [1]*Mark Hanigan, and* [1]*Gota Morota*

[1]School of Animal Sciences

Obtaining accurate estimates of cow body weight is critical in farm management because they are associated with the growth, nutritional status, and health of cows. However, it requires human labor or expensive equipment to frequently collect body weight records. Therefore, the objective of this study was to use computer vision and deep-learning techniques to predict cow body weight from video data. We set up an Intel Realsense D415 camera at the Virginia Tech Kentland farm to collect top-view videos for 10 Holstein and 2 Jersey cows for 28 days, twice per day. Real body weight records were also obtained by the Afimilk system simultaneously. A total of 40,405 depth images and depth CSV files were obtained. We explored three approaches to segment the cow body from the background, including single thresholding, adaptive thresholding, and Mask R-CNN. Four image descriptors, length, width, height, and volume, were estimated from segmented images and then fitted in ordinary least squares (OLS) and random forests (RF). Two cross-validation designs, forecasting and leave-several-cow-out, were used to evaluate prediction performance. The correlation between image descriptors and body weight ranged from 0.84 to 0.95. The predictive correlations from the forecasting cross-validation were 0.97 and 0.98 for OLS and RF, respectively. The mean absolute percentage errors were less than 6% and 3% for OLS and RF, respectively. We obtained mean absolute percentage errors of less than 10% on average for the leave-several-cow-out cross-validation. Our results suggest predicting cow body weight from depth video data is feasible.

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33. **Eastern Shore AREC: Graduate Research and Development**

[1]***Thomas Badon***, [1]*Dhiraj Srivastava,* [1]*Ricardo Gandini Taveras,* [1]*Joseph Haymaker,* [1]*Mary Michael Lipford,* [1]*Alexis Suero Mirabal, and* [1]*Andrew Fletcher*

[1]Eastern Shore Agricultural Research and Extension Center

The Eastern Shore Agricultural Research and Extension Center (ESAREC) is dedicated to conducting cutting-edge applied research that is specifically tailored to the needs of local farming operations for the 21st century. ESAREC's farm crew, consisting of two full-time employees and two seasonal workers, is focused on incorporating farm management software and smart farming techniques to increase the efficiency of labor and land use, while ensuring high-quality outcomes for researchers. The soils laboratory at ESAREC is staffed by three graduate students who are conducting research on nutrient cycling and soil health, phosphorus fertility in edamame production, and phosphorus phase and transport in the environment. Additionally, the weed science research team is working on integrating unmanned aerial systems (UAS) and machine learning for weed mapping, conducting aerial spray drone experiments to evaluate their potential for weed control and reduction of herbicide usage, as well as building a weed digital library in partnership with the United States Department of Agriculture. The horticulture laboratory is staffed by two graduate students who are researching tomato heat stress mitigation along with nitrogen and irrigation management in potato production. Overall, ESAREC is committed to producing state-of-the-art research that addresses the

Return to Agenda

needs of the local farming community and helps to ensure the Eastern Shore remains a leader in commercial agriculture production.

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34. **Highly sensitive and Low-Cost Nanomaterials-Enabled Biosensors for the Detection of Subclinical Ketosis in Dairy Cows**

[1]***Shannon Chick***, [1]*Katharine Knowlton, and* [1]*Azahar Ali*

[1]School of Animal Sciences

Ketosis is a metabolic disease that typically occurs shortly after calving. During the transition period of dairy cows, the energy demand for milk production increases significantly and cows enter a negative energy balance due to not consuming enough energy, which can cause an excessive amount of ketone bodies in a cow's body fluids. Severe ketosis can be easily spotted as cows will lose a large amount of body condition within a short period of time. This loss of body condition can lead to the cow taking longer to become pregnant, having lower milk quality, and can leave the cow susceptible to other infections. Subclinical ketosis is detected by measuring the level of beta-hydroxybutyrate in serum samples. Thus, the quantification of subclinical ketosis can improve the health and productivity of dairy cows. The design for this biosensor will include a microfluidic device with a 3D-graphene structure on the working electrode that will increase sensitivity. The biosensor will use an enzyme solution made of one-part hydroxybutyrate dehydrogenase and one-part NADH. The goal of this work is to use the enzyme solution along with the 3D-graphene structure to create a more sensitive and selective biosensor for subclinical ketosis in dairy cattle. With the use of this biosensor, farmers will be able to detect ketosis at its earliest stages and can improve herd health management decisions. In addition to this, we also aim to develop biosensors to improve dairy herd management by detecting different animal diseases, such as mastitis or lameness, and antibiotic residue in animal excrement. At the CAIA Big Event poster session, our interest is to present the sensor design and potentially implement new biosensor devices into precision livestock farming.

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35. **Machine Learning in Plant Genomics:Predicting gene functions in plants with single cell genomic data**

[1]***Prakash Raj Timilsena***, [1]*Sai Deepak Gattidi,* [2]*Jose Dinneny, and* [1]*Song Li*

[1]School of Plant and Environment Sciences, [2]Department of Biology; Stanford University

The rapid sequencing of genomes and transcriptomes in bioenergy crops and other plant species has outpaced the rate at which they can be accurately annotated. Even in a model organism like Arabidopsis thaliana, majority of the gene functions have not been validated with wet lab experiments. Traditional computational methods for assigning gene functions largely rely on sequence homology which does not account for gene expression activities in different tissue and cell types. In this project, we tested whether gene expression data can be used to improve the gene function annotation. We compared bulk- and single-cell RNA seq datasets from roots and assessed the performance of seven machine learning algorithms for predicting gene functions.

Return to Agenda

We found that random forest works the best among these methods. We further asked whether single-cell genomic data can provide additional information because expression data from more diverse cell types are captured by scRNA-seq as compared to bulk RNA-seq. Surprisingly, we found that the bulk RNA-seq have better accuracy in predicting many gene functions as compared to scRNA-seq data. A comparison of scRNA-seq datasets from different tissues showed that leaf single cell RNA-seq data provides higher accuracy in predicting the chloroplast and photosynthesis related genes as compared to root scRNA-seq data. This observation suggests that the specificity of the information content in single cell datasets from different tissues is biologically relevant. Because of the diversity of cell types captured by scRNA-seq, we found that increasing number of UMAP clusters can help to improve the prediction accuracy for single cell data. The future direction of this work is to incorporate stress responsive scRNA-seq data and regulatory networks (DAP-seq) information to further expanding the prediction of novel gene functions in oil seed crops. Experimental validation for selected genes will be performed in the coming years.

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36. **I2GROW: Intelligent and Integrated Greenhouse Gas Removal With Indoor and Controlled Environment Agriculture.**

[1]***Song Li***, [1]*John Bovay,* [1]*Juhong Chen,* [1]*Eva Colla'kova',* [1]*Farrokh Jazizadeh,* [1]*Blake Johnson,* [1]*Jactone Ogejo,* [1]*Hasan Seyyedhasani,* [1]*Kaylee South, and* [1]*Boris Vinatzer*

[1]School of Plant and Environmental Sciences

In the United States, residential and commercial buildings have released more CO2 than the entire agriculture sector. On the other hand, the CO2 concentration in buildings can increase to 3000 ppm, a level that can promote plant growth. The goal of this project is to establish a testbed for applications of advanced AI and sensor technologies to reduce CO2 emission for indoor and controlled environment agriculture through the recycling of CO2 generated by human activities. This project includes five specific aims. (1) smart growth: developing phenotyping platforms to monitor plant growth under elevated CO2 and alternative nutrients from food waste. (2) smart building: using hybrid light and modeling to reduce energy consumption for indoor agriculture. (3) smart health: developing methods based on metagenomic sequencing, biosensors, and CRISPR technologies for plant and human pathogen detection; (4) cross-cutting activities: economic modeling, surveys, and integrated machine learning from plant phenotypic data and environmental data; and (5) outreach, extension, workforce training, and K-12 education. The I2GROW project emphasizes both testing existing technologies and developing new ones that can benefit small- and medium-scale producers. This project involves a transdisciplinary team of scientists and engineers. An advisory board has been assembled to include members from academia, industry, and a government research and training institute to provide annual evaluation and feedback. The project directly addresses the USDA, Climate-smart Agriculture for Future Farms (CAFF) program priorities through testing climate-smart technologies for GHG reduction, extension activities, and formal and non-formal education for the next-generation producers.

Return to Agenda

37. **Virginia Cooperative Extension Programming Overview**

[1]Dan Goerlich, *[1]Cathy Sutphin, and [1]Jeremy Johnson*

[1]Virginia Cooperative Extension

Building local relationships and collaborative partnerships since 1914, Virginia Cooperative Extension helps people put scientific knowledge to work through learning experiences that improve economic, environmental, and social well-being. We take concrete action that advances the well-being of all Virginians. Whether we're building a more resilient food system, supporting local economies, or mentoring youth, we help manage our natural resources, bridge access to knowledge, and shape a brighter future for our communities. Extension faculty and staff come from a variety of backgrounds. This helps us better understand the distinct needs of all Virginians. It is through this lens that we can accurately and effectively assess, prioritize, and respond to local and state needs. Virginia Cooperative Extension has an existing network of facilities (107 city and county unit offices, 11 Agricultural Research and Extension Centers, six 4-H centers, and two university campuses and satellites), professional extension staff, and university specialists to deliver vital educational programs to the public. This network is enhanced by a connection to the resources of the land grant universities across the nation and is located in every county and major city in the state.

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38. **Deep Residual Learning for Activity Recognition of Pigs using Accelerometer and Gyroscope Sensors**

[1]***Yingqi Pei***, [1]*Sook Shin Ha,* [1]*Pranjal Ranjan, and* [1]*Sanjana Bharadwaj*

[1]The Bradley Department of Electrical and Computer Engineering

Activity recognition of pigs is an important field of study in modern animal husbandry. The accurate and efficient recognition of pigs' activities can provide valuable insights into their behavior and health status, which can improve their living conditions and well-being. Our work focuses on using deep residual learning for activity recognition in pigs as an alternative to traditional machine learning approaches based on motion sensor readings of accelerometers and gyroscopes. The work highlights the advantages of deep neural residual models, such as eliminating the need for feature extraction and their ability to learn complex patterns and relationships directly from raw time domain data. This is quantified in terms of higher accuracy and lower inference time as compared to machine learning models, which require handcrafted features as input. The best performing residual deep network uses the 34-layer 2D convolutional neural network model, where the residual connections to improve the flow of information through the network due to their skip connections. The results also show the benefit of using natural time-ordered data in the preprocessing stage, reflected in a higher test accuracy as compared to the alternative approaches adopted in previous related works. As part of the next steps, data augmentation is on the agenda, including other activities like sleeping which will help to gauge the health of the pigs better. The future work will also focus on optimizing the models and work on some embedded unsupervised learning inside the sensor to save power.

Return to Agenda

39. **Small unmanned aerial system-based spectral imaging for evaluating peanut maturity in field conditions**

[1]***Jitender Rathore***, [1]*Abhilash Chandel, and* [2]*Maria Balota*

[1]Biological Systems Engineering; Tidewater Agricultural Research and Extension Center, [2]School of Plant and Environmental Sciences; Tidewater Agricultural Research and Extension Center

Identifying optimum peanut harvest time is challenging as the crop continues to flower and produce pods amid supportive agroclimatic conditions. We evaluated high-resolution spectral imagery to quantify peanut pod maturity. Four recently developed Virginia-type cultivars, 'Bailey-II', 'Emery', 'N.C.20' and 'Walton', were planted in randomized strips, with and without prohexadione calcium growth regulator (Apogee® BASF). A small unmanned-aerial-system (SUAS) with a multispectral imaging sensor on-board was used to image the plots at different growth stages beginning 15-weeks after planting and continued during pod and seed maturity. Concurrently, peanut maturity (PM) was determined using the pod mesocarp color method and peanut maturity index (PMI) was computed as PMI (ratio of number of oranges, brown pods to total pods). Total 24 vegetation indices (VIs) were extracted and evaluated for correlation with the PMI. The normalized difference red edge (NDRE) and modified nonlinear index (MNLI) showed the closest relationship to the PMI. Specifically, for Bailey-II the best association between PMI was with NDRE ($r= 0.87$, $p< 0.001$); for Emery, GEMI ($r = -0.71$, $p<0.001$); for N.C.20, MSR ($r= -0.72$, $p<0.001$); and for Walton, NDRE ($r = -0.82$, $p<0.001$). Machine learning models RF, SVM, KNN, PLSR and LASSO were formulated using reflectance features to predict the PMI. KNN yielded highest prediction accuracy ($R2= 0.70$ RMSE= 24%), and lowest observed with PLSR ($R2= 0.62$, RMSE= 27%), while for others R2 ranged, 0.63-0.70, and RMSE ranged 24%-30%. High-resolution spectral imagery coupled with data-run approaches can be effective in accounting and predicting PM to guide precision peanut harvest.

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40. **Evaluation of Robot Capabilities for Rumen Exploration**

[1]***Ryan Wright***

[1]School of Animal Sciences

The exploration of the rumen environment aids in the understanding of physiological processes that occur within it. In order to accurately explore the rumen environment with minimal disruption to the natural processes, a small object capable of navigation via external control is ideal. A small, 3D-printed robot made of plastic and silicone, equipped with a DF Robot Bluno beetle V1.1 microprocessor connected to a lithium-ion rechargeable battery with 40 servo motors to generate an undulating swimming action, was developed and programmed to mimic the swimming motions of a fish. The objective of this work was to determine if the robot was capable of swimming in conditions that simulated the rumen environment with the longer-term goal of facilitating eventual rumen exploration and navigation. For this experiment, the robot's motion and navigation were tested to determine how effectively the device could traverse an environment similar to the rumen. The robot was controlled using a Bluno Link via USB and directed through MATLAB and Arduino IDE. The robot was first tasked with swimming from one end of a water filled container to the other. A 2 x 4 factorial

Return to Agenda

was then used to simulate various particle sizes and concentrations. The two particle sizes were generated by using either flour and alfalfa cubes as a solute with each being tested in concentrations of 10, 20, 30, and 40 percent (by weight) within the water. The time taken to navigate through each combination of substrate was recorded as well as the initial and final position of the robot within the environment.

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41. **Resources to Engage the Cyberbiosecurity Workforce Pipeline: Empowering Agricultural Educators and Middle School Girls in STEM**

[1]***David Smilnak***, [1]*Hannah Scherer,* [2]*Anita Walz,* [3]*Erika Bonnett, and* [2]*Kindred Grey*

[1]Agricultural, Leadership, and Community Education, [2]University Libraries, [3]Virginia Cooperative Extension; 4-H

Starting in Spring 2021, the Initiating the Rural Cyberbiosecurity Workforce Pipeline Through Empowering Agricultural Educators & Supporting Middle School Girls project has been working with a transdisciplinary team of scientists, middle school teachers, and extension agents to develop educational resources that can help middle-school-aged youth learn about the opportunities that exist in cyberbiosecurity.

The activities were piloted in middle school agriculture classes and 4-H learning environments and revised based on educator and learner feedback. Factsheets were evaluated by scientific and cybersecurity education experts and in part by the Center for Advanced Innovation in Agriculture Graduate Student Affiliates. The resources have been introduced to school-based agricultural educators and extension agents at state-level professional development conferences and to members of a national cybersecurity education network. Implementation by a new cohort of educators is underway to collect further input from the field. To date, youth have found the activities engaging, educators are excited about the possibility of innovating their agricultural education programs, and the factsheets provide spark novel ideas for further activities that can be modified and/or developed. Produced as Open

Educational Resources (OER), the materials are freely available online for educators to download and can be remixed for use in a variety of educational settings. Educators are encouraged to use our resources, revise them for their own setting, and contribute their new versions and ideas to the growing OER collection. All factsheets, facilitator guides, and handouts are available for free electronic download.

This work was supported by [a local] Cyberbiosecurity Seed Grant program and the USDA National Institute of Food and Agriculture, Women and Minorities in Science, Technology, Engineering, and Mathematics Fields (WAMS) Grants Program.

Return to Agenda

42. **Preventing Mastitis and Saving Water Usage with Artificial Intelligence: A Computer Vision Solution to Improve Cow Health and Fram Sustainability**

[1]***Mautushi Das***, [1]*Chun-Peng James Chen, and* [1]*Gonzalo Ferreira*

[1]School of Animal Sciences

Detecting and counting cows in a scene has significant practical applications in farming, ecology, and security. For instance, farmers can use it to monitor their livestock, and the detection can aid the monitoring of anomalous behavior for biosecurity purposes. Our primary objective is to design a computer vision (CV) system that can detect and count the number of cows living in a farm environment. Our specific focus is on creating a pipeline that optimizes the timing of "alley flushing," which is a method for removing accumulated cow manure. During alley flushing, the risk of Mastitis increases due to the potential for direct contact between splashes of manure and the cow's udder. By counting cows with the CV system, we aim to time flushing to minimize Mastitis risk. To monitor the cows, we have selected the Amazon Ring camera as our monitoring sensor for its cost-effectiveness. The captured images were processed through our CV system, which combines image segmentation and deep learning-based techniques to count the number of cows in a given scene. We tested our current CV system on 50 images of cows in the alleyway at Virginia Tech Dairy Complex (VTDC), and it achieved a mean absolute error of 3.8 cows. The errors were primarily caused by the camera's low resolution, which blurred the contours of cows standing further away from the camera. Moreover, our CV system utilized a pre-trained model for a dataset of common objects (COCO dataset), which resulted in suboptimal prediction performance when identifying cows specifically. We will continue increasing the accuracy by fine-tuning the model using snapshots obtained from VDTC. We also aim to develop a decision-making algorithm to determine the ideal timing for alley flushing based on the cow count. This will help to minimize the risk of Mastitis and improve farm hygiene.

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43. **Manure Microbiomes in Earthen Pit and Concrete Storage: Nitrogen and Carbon Transformation Processes**

[1]***Bela Haifa Khairunisa***, [1]*Jactone Arogo Ogejo,* [2]*Usha Loganathan, and Biswarup Mukhopadhyay*

[1]Biological Systems Engineering, [2]Biochemistry

During the storage of dairy manure for future use as nitrogen fertilizer in crop production, nitrogen and carbon are lost in gaseous forms through microbial and physiochemical transformations. With a long-term goal of developing strategies to minimize these losses, we have characterized the microbial processes occurring in two manure storage systems, Earthen Pit (EP) and Concrete Storage (CS). We first analyzed the 16S rRNA-V4 amplicons generated from manure samples collected from several locations and depths of the storages, yielding a catalog of the archaea and bacteria that were present therein. Then, we inferred the respective metabolic capabilities and developed schemes for nitrogen and carbon transformation pathways operating at various locations of EP and CS. Our results showed that the manure microbiome composition was more complex and exhibited more location-to-location variation in EP than CS. Further, the inlet and a location with hard surface crust

Return to Agenda

in EP had unique consortia. With regards to nitrogen transformation, the microbiomes in both storages had the potential to generate ammonia but lacked the organisms for oxidizing it to nitrate and further to gaseous compounds as anammox and autotrophic nitrifiers were not detected in either storage. However, microbial conversion of nitrate to gaseous N2, NO, and N2O via denitrification and to stable ammonia via dissimilatory nitrite reduction (DNRA) seemed possible. Minor quantity of nitrate was present in manure, potentially originating from oxidative processes occurring on the barn floor. Higher prevalence of nitrate-transforming microbes at the near-surface locations and all depths of the inlet were found as a result of this instance. For carbon transformation, hydrogenotrophic Methanocorpusculum species were the primary methane producers, and it exhibited higher abundance in EP. These findings suggested that microbial activities were not the main drivers for nitrogen loss from manure storage, and commonly reported losses are associated with the physicochemical processes.

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44. **Using a Social Vulnerability Lens for Exploring Food Insecurity and Negative Mental Health Outcomes for Low Income Mothers of Young Children**

[1]***Sarah Misyak***, [1]*Maria DeNunzio,* [2]*Kathryn Hamilton,* [1]*Rachel Liebe, and* [2]*Liesel Ritchie*

[1]Human Nutrition, Foods, and Exercise, [2]Sociology

Food insecurity is a complex social issue in the United States that contributes to the proliferation of health disparities. Existing literature shows a positive relationship between food insecurity and negative mental health symptoms and outcomes, yet there is limited research on factors influencing this relationship. A better understanding of the relationship between food insecurity and mental health is needed to identify potential areas for intervention, particularly among mothers of young children with low income. The objective of this CAIA-funded study was to reframe food insecurity in the U.S. as a hazard resulting from human-caused disasters in the structures of society. We examined food insecurity and negative mental health outcomes through a social vulnerability lens. Many variables that contribute to social vulnerability are also risk factors for food insecurity, including gender, single-parent households, participation in nutrition assistance programs, and racial identity. The conservation of resources model and impact of event scale are concepts from stress and trauma studies that are applicable to the study of food insecurity. The hazard and disaster concepts were used to advance a conceptual framework of the relationship between food security and mental health. Findings of our literature review and data analysis show current gaps in initiatives related to assisting mothers with low income as they deal with food insecurity and related adverse mental health outcomes—an understudied yet critical issue. These results advance CAIA's mission by demonstrating ways the Center and other institutions can support rural communities through resources to improve food systems, equity, and the quality of life for Virginia populations. Our interdisciplinary approach is innovative in alignment with CAIA'S mission and lends new opportunities for others from the natural and physical sciences to consider what public health and social sciences bring to bear on pressing issues facing our region and the country at large.

Return to Agenda

45. **Farmers' User Experience Related to Digital Advancements in Agriculture**

[1]***Shreya Mitra***, [2]*Mehul Bhanushali,* [3]*Brianna Posadas,* [4]*Abhilash Chandel,* [5]*Matthew Chappell,* [6]*Katheryn Parraga-Estrada, and* [7]*Robin White*

[1]Agricultural, Leadership and Community Education, [2]Computer Science, [3]School of Plant and Environmental Sciences, [4]Biological Systems Engineering; Tidewater Agricultural Research and Extension Center, [5]Tidewater Agricultural Research and Extension Center, [6]Virginia Seafood Agricultural Research and Extension Center, [7]School of Animal Sciences

Digital advancements in agriculture are a priority, particularly in developed nations. Literature states that digitalization will be a boon for the agriculture community in general, but not much is known about ground reality, when it comes to farmers' experiences with technology and how it interferes with their agrarian decision-making. This study highlights farmers' user experience about digital technology usage in agriculture. A focus group was conducted by Virginia Tech at the Tidewater Agricultural Research and Extension Center with farmers as a part of the USDA-funded National Agricultural Producers Data Cooperative (NAPDC) program. Farmers were asked to identify challenges and potential solutions while adopting technologies in agriculture. The challenges pertained to keeping up with evolving technology, determining how to use data for in-farm decision-making, a lack of on-farm connectivity and data protection; lack of support in terms of training and demonstration for technology worthiness; and a lack of cost and infrastructure support. Plausible solutions highlighted by the respondents included the requirement for third parties to stay up to date on technology, be early adopters and beta testers, as well as provide unbiased and authentic validation reports that highlight economic risks and benefit-cost ratios surrounding technology usage. The respondents also identified the role of universities and government organizations throughout the solution development process, and the need for better commercial network connectivity, or "hotspots," in the field. At the end, focused in-person precision agriculture training programs from extension agents and or universities, and government subsidies for digital advancements were also identified as critical solutions towards adoption of technologies and data-run solutions in farms. Results from this study will inform technology developers, policymakers, economists, extension workers, university researchers, and government agencies on how to design a strong infrastructure that is inclusive of farmers' requirements and digitally empowers them towards production agriculture.

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46. **Building airborne inoculum surveillance networks in Virginia for improved plant disease management**

[1]***Yuan Zeng***, [1]*David Reed,* [2]*Boris Vinatzer, and* [3]*David Langston*

[1]Southern Piedmont Agricultural Research and Extension Center; School of Plant and Environmental Sciences, [2]School of Plant and Environmental Sciences, [3]Tidewater Agricultural Research and Extension Center; School of Plant and Environmental Sciences

Monitoring airborne inoculum of plant pathogenic fungi using spore samplers is crucial because they serve as risk indicators of disease epidemics and provide early warning on emerging and re-emerging

Return to Agenda

plant diseases so growers can respond with fungicide treatments and other management practices. The concept of monitoring airborne inoculum has existed for decades, but traditional methods for spore counting, such as microscopic examination, hindered its application on a large scale. Spore sampling combined with quantitative PCR (qPCR) significantly shortened the turn-around time and has been applied in several pathosystems, but with most cases being a single pathogen. However, co-infection of two or more pathogens on the same plant host is ubiquitous in nature. Climate change and agricultural practices can also shift fungal pathogen diversity and composition, making it difficult to predict which pathogen to expect when and, therefore, which qPCR assay to use. Consequently, the adoption of high-throughput sequencing (HTS)-based approaches, which can identify multiple fungal taxa and their populations at the same time, should be considered. Soybean and corn are important grain crops in the U.S., and their acreages have increased in Virginia. Management strategies, especially fungicide application recommendations, are based on crop developmental stages (i.e., calendar-based). These calendar-based fungicide applications likely lead to incorrect decision-making (e.g., spray when unnecessary and not spray when necessary) and the development of fungicide-resistant pathogens. There is also an increasing demand for pesticide-free agricultural food products. To achieve the goal of minimizing fungicide application while maintaining effective disease control, we will combine data from modern HTS and low-cost, DIY rotating-arm spore samplers and IoT-enabled environment sensing technologies to characterize the impacts of airborne inoculum and a range of environmental factors on soybean and corn fungal pathogen life cycles, disease severities, and crop yield and quality.

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47. **Rumen sensing as an alternative approach to predict volatile fatty acid concentration in dairy cows**

[1]***Katherine Amirault***, [1]*Barbara Roqueto dos Reis, and* [1]*Robin White*

School of Animal Sciences

This study investigated the effectiveness of short-term dietary interventions in altering volatile fatty acid (VFA) production in the rumen and the capability of a commercially available sensor to predict ruminal VFA utilizing fermentation parameters such as carbon dioxide, conductivity, and temperature. Four ruminally cannulated Holstein dairy cows at maintenance were individually housed, fasted for 12-24 hours and then assigned to one of four treatments in a replicated 4x4 Latin square crossover design. Treatments consisted of hay and a topdress containing corn grain, soybean meal, or a mixture of the two. Rumen fluid samples were collected every hour for twelve hours and analyzed for VFA concentrations. Rumen CO2, conductivity, and temperature measurments were taken every three minutes during the sampling period using an OrionTM Carbon Dioxide Electrode and OrionTM DuraProbeTM 4-Cell Conductivity Probe (Thermo Fisher Scientific, Waltham, MA) that was deployed in the cows' rumen. Concentrations of individual VFA were analyzed statistically using a linear mixed effects model with a fixed effect for treatment and sensed measurements and a random effect for animal and period. A backward elimination approach was used to determine the ability of the sensor to predict individual VFA concentration. The models were evaluated using concordance correlation coefficient (CCC). Dietary intervention was found to have a significant effect ($P<0.05$) on total VFA concentration, while only time and the interaction of time and soybean meal had a significant effect on total branch chain VFA concentration. Linear associations among measured VFA and sensing data were significant ($P<0.05$) for major VFA concentrations but not

Return to Agenda

significant (P>0.05) for total branch chain VFA. Overall, results indicated that treatment diets did induce a shift in produced VFA, and the sensor was successful in predicting VFA concentrations in the rumen.

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48. **A Look at Eastern Virginia AREC**

[1]***Joseph Oakes*** *and* [1]*Michelle Lee*

[1]Eastern Virginia Agricultural Research and Extension Center

A general overview of Eastern Virginia AREC

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49. **Using Remote Sensing Data to Determine Optimal Installation Locations for Capacitive Soil Moisture Sensors on Golf Course Fairways**

[1]***Travis Roberson***, [1]*David McCall,* [1]*Caleb Henderson,* [1]*Matthew Tucker,* [2]*Wendell Hutchens,* [3]*Chris Thorup, and* [3]*Henrik Rosendahl*

[1]School of Plant and Environmental Sciences, [2]Horticulture; University of Arkansas, [3]Spiio, Inc.,

Water is our world's most vital resource and is crucial for all ecological and societal enterprises, however, not all water consumption purposes are accepted so freely. The expenditure of water for golf management is a necessary requirement to maintain these intensively managed surfaces at a premier standard. The act of depleting water resources for a recreational activity perturbs the public's perception of golf courses when no tangible output is produced such as agricultural food commodities. However, approximately 16,000 golf courses in the United States contribute 33 billion dollars in gross economic impact, making them the largest component of the turfgrass industry. Their large socioeconomic impact, garners recognition for water regulations to reduce their water consumption footprint. Best management practices such as establishing drought tolerant turfgrass cultivars, updating obsolete irrigation systems, and the use of innovate, wireless soil moisture sensors have helped shift the trend of how golf courses are managed and reduce the amount of water they consume. However, implementing advanced technologies such as wireless soil sensors in an erroneous manner can be more detrimental by providing an individual with inaccurate data, leading to management decisions with severe ramifications. No method to our knowledge exists to objectively determine the quantity and geolocations of where to install soil sensors on golf courses. The objective of our research is to use remotely sensed data to determine the quantity and locations of soil sensors required too accurately provide a representative continuous sample of a location to make future irrigation decisions.

Return to Agenda

50. **Polyhydroxyalkanoate production by haloferax mediterranei using feedstock from food waste**

[1]***Xueyao Zhang***, [2]*Amro Hassanein,* [2]*Naresh Amradi,* [2]*Stephanie Lansing, and* [1]*Zhi-Wu Wang*

[1]Biological Systems Engineering, [2]Environmental Science and Technology; University of Maryland

Haloferax mediterranei (HM) is one of the most promising candidate organisms for industrial polyhydroxyalkanoate (PHA) production since it can accumulate higher PHA compared with mixed culture, simultaneously, its growth requirements (ideal salinity of 7-30%) make it easier to achieve a pure culture environment. Besides, HM can utilize a wide range of simple carbon sources, such as sugars and glycerol, for PHA synthesis, significantly widening the range of feedstocks. In this study, unrefined volatile fatty acids (VFAs) from food waste after anaerobic digestion (AD) were used as the feedstock to produce PHA, which can significantly reduce PHA production costs. A sequencing batch reactor (SBR) was built to enable continuous PHA production. The outcomes of this study include: (1) understanding the maximum PHA productivity when unrefined VFAs were used as feedstocks and thus elucidating the possibility of marketable bio-based plastics production in the form of PHAs with the integration of food waste AD system; (2) determining optimal parameters of SBR operation for HM growth and high PHA production efficiencies such as cycle time and feast/famine ratio; (3) determining optimal parameters of VFAs feedstock such as pH, salinity, and carbon/nitrogen ratio. This is the very first effort to create a PHA production method with the feedstock of food waste, which may shed light on a sustainable bioplastic production industry.

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51. **Smart Technology Adoption in Oyster Production: Economic Feasibility and Consumer Perceptions**

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Oyster culture, despite being one of the oldest forms of aquaculture, is relatively behind in terms of technology adoption for efficient production as compared to other forms of aquaculture. With the goal of enhancing on-bottom oyster production, while preserving environmental health and sustaining economic viability of shellfish farm operations, an integrated team consisting of diverse expertise is developing a smart sustainable aquaculture management framework (S3AM) framework. The technology is expected to enable farmers to plant seed precisely, monitor crop inventory, monitor water quality, and create an optimal harvest path. Consequently, seed mortality, habitat destruction and fuel consumption could be reduced while improving harvest efficiency and environmental health. The incorporated sensing and imaging tool will help farmers to navigate the location of market size oysters that prevent farmers from pulling dredge randomly; while saving time and reduce nautical miles travelled. But the question can be raised about its economic viability. Therefore, we will develop cost model based on East, West and Gulf coast production region based on three different production scales (200; 2,000, and 6,000 bushels/year). The cost model includes long-term real estate cost, equipment cost and annual costs and returns. In addition, net returns, break-even price above variable cost/total cost, break-even yield above variable/total cost and percentage contribution of each input to the total production cost will also be measured to assess the economic performance of the framework. Furthermore, to know the consumer perceptions

Return to Agenda

about use of technology for oystering a choice experiment will be conducted among 2000 Chesapeake Bay region oyster consumers. We expect that this project will assist shellfish growers to understand the technology, make informed decision regarding the technology adoption that ultimately would enhance their quality of life.

Return to Agenda