

November/December 2024

# RESOURCE

engineering and technology for a sustainable world

## AI IN AGRICULTURE CONTINUED

Also inside

Agrivoltaics & rural electrification

The importance of peer review

The reliability of biomass preprocessing

The Past Presidents Challenge

PUBLISHED BY AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS



# Leading the Future



This past year, under Dana Porter’s strong leadership, the Board of Trustees has been disrupting for good! We challenged the status quo to drive member engagement and raise the value and impact of our Society. We also refreshed ASABE’s brand identity, created and implemented the Strategic Initiatives Council, and navigated a path to enable the success of our first two strategic initiatives: AMAA and CBSi.

Last year’s accomplishments set a high bar for the coming year, and we are ready for the challenge! To build on the “disruptions for good” that we created and to expand on our success, I am excited to launch the 2024-2025 campaign: Leading the Future!

The foundation of this campaign is to build a future-focused culture in our Society, a culture in which our priorities, actions, and resources are focused on providing long-term value to our members. In her keynote address at the 2024 AIM, Jenn Donahue explained the importance of building trust within teams, and how we can accomplish goals that seem impossible when we have positive relationships.

Our collaborations should inspire innovation. What better way is there to develop new ideas than with this group of engineers? Our long-term goals, and the strategies required to achieve those goals, are our roadmap for success. Leading the Future will be our vehicle.

In particular, we must continue to empower the growth and impact of AMAA and CBSi. These two strategic initiatives provide our greatest opportunities for growth, external impact, and affiliate engagement.



Each of us has an important role in Leading the Future. I challenge you to find a new way to make an impact on our Society.

The new Strategic Initiatives Council provides the structure and governance for these initiatives and enables the creation of further initiatives. Therefore, we will also focus on developing this new council and integrating its output into our existing organization.

We will also continue to provide no-cost membership to students. For students, this is a great opportunity to engage with ASABE. For ASABE, it’s a great opportunity to create a lasting impression on our future leaders. We will continue to focus on expanding our connections to students.

Each of us has an important role in Leading the Future. I challenge you to find a new way to make an impact on our Society. Engage with a committee that you haven’t been active with, find a new group to join, and advocate for ASABE at your workplace and in your professional community.

Most of all, share the value that ASABE has given you by telling your ASABE story. We all have an ASABE story!

I’m grateful for the opportunity to serve as ASABE President and advocate for our profession. Together, we are Leading the Future of agricultural and biological engineering!

Doug Otto  
doug.otto@newholland.com

## events calendar

### ASABE CONFERENCES AND INTERNATIONAL MEETINGS

To receive more information about ASABE conferences and meetings, call ASABE at 800-371-2723 or email [mtgs@asabe.org](mailto:mtgs@asabe.org).

#### 2025

Feb. 9-12 **Agricultural Equipment Technology Conference (AETC).** Louisville, Ky., USA.

July 13-16 **ASABE Annual International Meeting.** Toronto, Ont., Canada.

#### 2026

Jan. 11-17 **ASABE Global Symposium on Sustainable Microirrigation Advances: Drop to Boom.** Aguadilla, Puerto Rico, USA.

Feb. 8-11 **Agricultural Equipment Technology Conference (AETC).** Louisville, Ky., USA.

July 12-15 **ASABE Annual International Meeting.** Indianapolis, Ind., USA.

#### 2027

July 18-21 **ASABE Annual International Meeting.** New Orleans, La., USA.

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**Think Green!** The poly-bag protecting this magazine can be recycled. Just toss it in with your other recycling.

**ON THE COVER:**

Our AI journey continues on page 4. This smart robotic weed sprayer comes from **ASABE members Vinay Vjayakumar and Yiannis Ampatzidis.**



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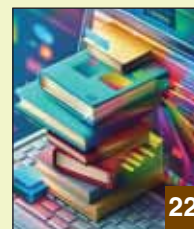


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# AI in Agriculture Continued

John Schueller

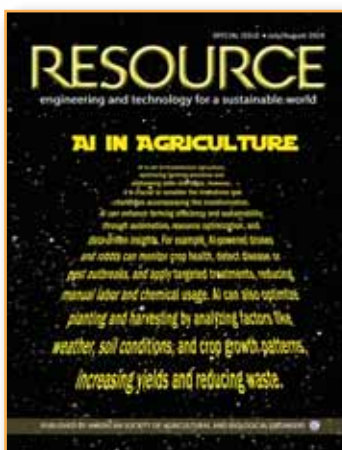


The special issue on AI in agriculture (the July/August 2024 issue of “Resource”) was organized by Tony Grift and Luis Rodriguez as a followup to their earlier article (“Artificial Intelligence: Super-Power or Super-Villain?”), which appeared in the July/August 2023 issue. The articles in the special issue showed the wide variety of work that ag and bio engineers are doing to incorporate AI into agricultural production. The progress to date and the potential are impressive.

Because there were so many submissions to the special issue, this issue continues that knowledge transfer. Ranveer Chandra identifies a broad range of applications and challenges for AI in agriculture, **ASABE member Isabella Condotta** discusses AI and computer vision in animal agriculture, and **ASABE member Reza Ehsani** and Zeinab Rezvani describes the potential of digital twin technology.

This is not the first occasion when AI has been a topic of interest for ASABE members. Over time, interest in AI in agriculture has waxed and waned with the general interest in AI. In the latter part of the 1980s, many ASABE members saw the potential for decision support systems in agriculture. The systems that were developed were often knowledge-based, especially expert systems.

Those expert systems were constructed with knowledge bases produced by interviewing human experts and used computer programs, called inference engines, to interrogate the knowledge base. The goal was to make automatic controllers perform as well as human experts. There were some successes, and some of the concepts have since been adopted in computerized control systems, but the results never lived up to the hype.



Perhaps the greatest problem was that the knowledge needed from the experts was not completely extracted and encoded because such an exhaustive effort was not practical or economically feasible. There was also the fundamental problem that human experts cannot verbalize all their knowledge. Much expert knowledge is tacit rather than explicit. For example, an expert herder can say “I should check that cow because something is wrong” without being able to explain how that conclusion was reached.

And even if the expert describes a specific problem (e.g., “There’s a hitch in the stepping motion”), acquiring all the knowledge needed for all potential problems and transferring it to a database is just not possible. To identify all the information needed, to organize it in a knowledge base, and to determine what that information really means is just too difficult. And then creating an expert system that can monitor complex situations and take appropriate action when needed is even more challenging.

As engineers, we like simple, deterministic systems. Unfortunately, that does not describe agriculture, where even the narrow subfields are complex. Inevitably, there are nonlinear, often unknown, interactions among a multitude of physical, chemical, and biological factors. It is therefore difficult to develop reliable mechanistic models that can optimize performance of such systems.

Although analytical models from first principles, such as Newton’s laws, provide a theoretical understanding, we are often forced to rely on empirical knowledge, such as the Wismer-Luth and Darcy-Weisbach equations. The development of empirical models requires laborious data gathering, identifying the appropriate model form, and

then doing the fitting. Having served on postgraduate supervisory committees in a dozen different academic majors, my experience is that ag and bio engineers are generally well-trained in such modeling tasks. However, traditional empirical modeling is still time-consuming and prone to errors.

AI makes large-scale data gathering and modeling much easier. It allows us to use all the data that the model was trained on and supplement it with further training. More significantly, AI can also form the model and do the fitting. The result can be a model that is multivariate, highly nonlinear, and that incorporates a wide range of data sources, including images and sounds. AI can also be used without the knowledge engineering and constraints that were required for expert systems forty years ago. The huge progress since then in computing speed, memory, and algorithms makes all this possible.

However, even well-trained AI models can provide wrong answers (or “hallucinations”). The training and queries must be appropriate, or else the same “garbage in, garbage out” problems will occur as surely as they did with punch cards long ago. Although “explainable AI” is a subject of much research, we generally cannot see an AI model’s reasoning well enough to judge the quality of its output. Because ag and bio engineers tend to be good at applied statistics, we should apply what we learned in the statistical design of experiments to improve AI performance.

Our first concern should be determining if the application space or the query of the AI model is within the inference space of the model, that is, if they are within the boundaries of what the model was trained on. Extrapolation and even near-edge cases are risky, and they are even more questionable when the model is inherently nonlinear.

In addition, unlike experiments with well-balanced statistical designs, AI model training may be dominated by certain, more common situations, causing the model to give more popular, but wrong, answers based on an overwhelming majority of situations that differ from the limited training within a particular subfield of agriculture.

Restriction errors and covariants are known in conventional statistics. For example, weather and geographic location are uncontrollable independent variables in field experiments. In their haste to create AI tools, developers may create models without sufficient replication for the many diverse independent variables.

In our profession, AI models must have reliability. For example, an AI system for outdoor weed detection should



Smart robotic weed sprayer (courtesy of ASABE members Vinay Vjayakumar and Yiannis Ampatzidis).

be trained and tested on a wide range of weather, time of day, soil background, weed mix and density, weed maturity, crop density, crop maturity, and cultural practices. The advantage of contemporary AI is that AI systems can now handle huge amounts of data and process information from many diverse situations. We need to take advantage of that capability with sufficient training.

The training must also have randomization, preferably as much as possible, for each independent variable. This is especially important because many crop production variables are covariant with time. For example, the training should include multiple planting dates to remove calendar date as a covariant.

Gathering the vast quantity of diverse information required to improve the reliability of an AI model through better training is a humungous task. Within our profession, we should work together to share the load. We need much more standard data, including images, and standardized metadata to achieve the full potential of AI in agriculture.

Let’s not be Luddites. AI has huge potential to become a powerful tool for agriculture. However, it needs to be applied carefully and with healthy skepticism because, like any tool, it can be used well or badly. Let’s moderate the hype, but let’s build this powerful new technology.

**ASABE Fellow John Schueller**, Professor, Department of Mechanical and Aerospace Engineering, and Department of Agricultural and Biological Engineering, University of Florida, Gainesville, USA, [schuajk@ufl.edu](mailto:schuajk@ufl.edu).

# Generative AI for Regenerative Agriculture: Unlocking the Potential of AI in Agricultural Production

Ranveer Chandra

The agricultural sector faces the monumental challenge of feeding a projected 9.7 billion people by 2050 while minimizing environmental impact. As traditional methods struggle to meet this demand sustainably, the integration of artificial intelligence (AI) into farming practices is emerging as a revolutionary solution. Generative AI, a subset of AI, shows immense promise by creating new data based on existing datasets. This article explores the potential of generative AI to revolutionize regenerative agriculture, delving into its applications, challenges, and future directions.

## Overview of AI and advances in generative AI

AI, the development of computer systems that perform tasks requiring human intelligence, has advanced rapidly due to increased computing power, data storage, and improved algorithms. AI can be divided into two categories: narrow AI, which is designed for specific tasks such as speech recognition, and general AI, which is aimed at mimicking human cognitive abilities, although this is still theoretical.

Machine learning, a critical subset of AI, enables computers to learn from data. Deep learning, involving artificial neural networks, allows the processing of complex data such as images and text. Generative AI, a newer branch, creates new data samples using models like generative adversarial networks (GANs) and variational autoencoders (VAEs). These models generate realistic and diverse outputs by learning patterns in the input data, with applications ranging from image generation to predictive modeling.

In agriculture, generative AI can help farmers better understand their land, crops, and livestock, as well as predict and adapt to environmental changes. By integrating generative AI, we can develop strategies for regenerative agriculture, focusing on soil health, reducing chemical inputs, and promoting biodiversity, leading to a more sustainable food system.

## Addressing key challenges in agriculture with AI

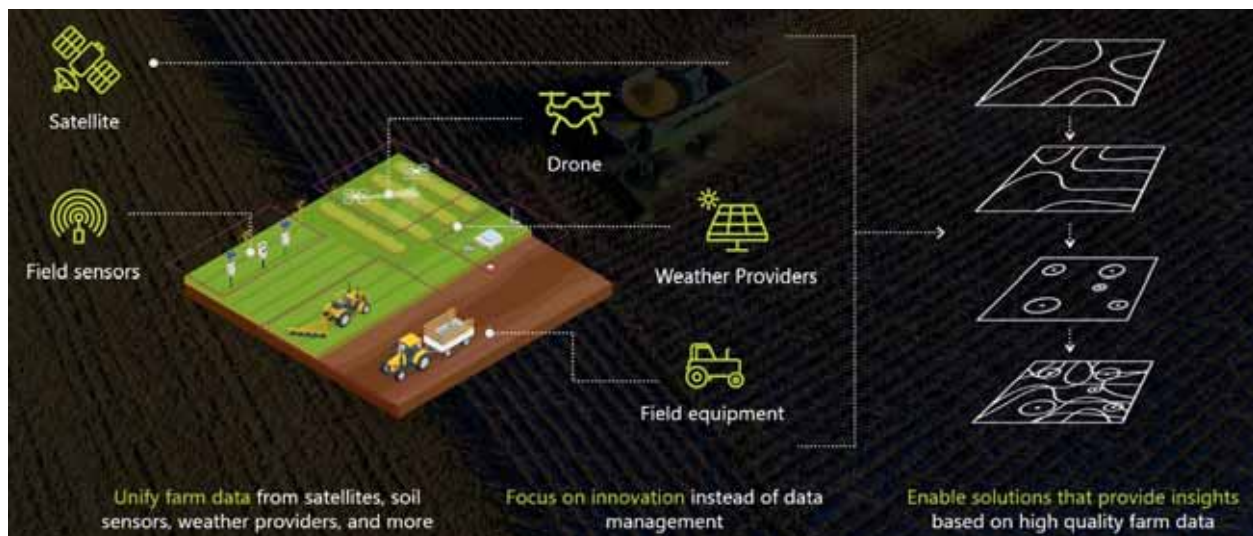
AI can revolutionize agriculture by increasing crop yields, optimizing resource utilization, and improving sustainability. Key applications include:

**Crop management:** AI monitors and analyzes factors that affect crop health and productivity, such as soil conditions, weather patterns, and pest infestations. AI-driven analytics help farmers make informed decisions on crop selection, planting times, and resource allocation, leading to increased yields and reduced waste.

**Precision agriculture:** AI-powered tools and sensors enable precise application of inputs like water, fertilizers, and pesticides. This approach, known as precision agriculture, improves resource efficiency and reduces the environmental impact of farming practices.

**Automated farm machinery:** AI supports autonomous machinery for tasks like planting, harvesting, and spraying with minimal human intervention. This automation reduces labor costs and increases overall efficiency.


**Livestock management:** AI-driven monitoring systems track the health, behavior, and productivity of farm animals, aiding in early disease detection and treatment. These systems optimize livestock operations, ensuring better animal welfare and productivity.



FarmVibes.AI is a cloud platform that enables multi-modal AI fusion of farm data to generate insights for farmers.



I am seeing this in my wheat crop. What is the problem with the crop?



- ✓ Analyzing the image: Privacy blur hides faces from Bing chat
- ✓ Searching for: septoria tritici symptoms and treatment
- ✓ Generating answers for you...

Your personal and company data are protected in this chat

It looks like your wheat crop is infected by a fungal disease called **septoria tritici blotch**. This disease causes elongated tan lesions on the leaves, with small black fruiting bodies (pycnidia) embedded in them. The disease can reduce the green leaf area for photosynthesis and cause significant yield loss and poor grain quality. The disease is more common and severe in wet and humid conditions, and it can spread by wind, rain, insects, or infected plant debris.

To manage this disease, you should use a combination of resistant varieties, cultural practices, and fungicides. Some resistant varieties are listed in [this table]. You should also avoid planting wheat after wheat, as this can increase the inoculum load in the soil. You should also remove or bury any infected plant debris after harvest, and control weeds that may harbor the fungus. Fungicides can be applied at different growth stages, depending on the disease severity and weather conditions. You should follow the label instructions and rotate fungicides with different modes of action to prevent resistance development. Some fungicides that are effective against septoria tritici blotch are listed in [this table].

I hope this information helps you to protect your wheat crop from septoria tritici blotch. If you have any other questions, please feel free to ask me.

An example of a farmer's question regarding a crop problem (*upper right*) and the AI system's response.

**Farm operations and supply chain management:** AI optimizes various aspects of farm operations, including inventory management, logistics, and sales forecasting. Integrating AI into the agricultural supply chain helps farmers predict demand, optimize transport routes, and reduce spoilage, benefiting both producers and consumers.

### Microsoft's FarmVibes.AI project

A significant challenge in implementing AI in agriculture is the lack of quality data from farms. Many farms lack connectivity, making it difficult to obtain accurate field information. Microsoft's FarmVibes.AI project addresses this gap using multi-modal AI, which combines different data sources for a comprehensive picture. Key models include:

**Seeing through clouds in satellite imagery:** More than 70% of the Earth's surface is covered by clouds, making optical cameras ineffective for satellite imagery. SpaceEye technology uses satellites that emit radio frequency signals that penetrate clouds and reflect based on the surface conditions. AI models like GANs can predict images through clouds, producing cloud-free imagery with better than 90% accuracy.

**Microclimate prediction:** Farm weather can vary significantly from nearby weather stations. By integrating farm sensor data with weather station predictions, AI can forecast a farm's microclimate accurately. The DeepMC technique merges weather data, resulting in precise microclimate predictions.

**Heatmap generation:** Creating accurate heatmaps for soil moisture or soil carbon levels requires numerous sensors or samples, which can be expensive. AI can predict optimal sampling locations by combining ground sample data with aerial imagery to create models that predict values in unsampled areas. These AI-generated heatmaps can be three times more accurate than conventional maps.

FarmVibes.AI has proven effective in real-world applications, aiding farmers in planning, planting, production, and post-harvest stages, ultimately leading to more sustainable agriculture. For instance, a farmer in eastern Washington State used FarmVibes.AI for informed decisions on crop planting, weed elimination, and cover crop management, resulting in increased yields and reduced chemical use.

## Generative AI for agriculture

Generative AI offers unique opportunities for advancing regenerative agriculture. By combining generative AI with FarmVibes.AI, personalized results for farms can be generated. Farmers can ask questions in natural language and receive context-specific answers, incorporating local knowledge and satellite image analysis.

For example, ChatGPT and Bing Chat assist farmers in answering queries, including image-based questions. A farmer can take a picture of an unexpected issue and converse with Bing Chat for insights. This combination of generative AI and local context provides actionable information tailored to specific farm conditions. Some early examples of generative AI in agriculture include:

**Agronomist copilot:** Microsoft researchers used the GPT-4 language model to pass the crop advisor exam with a score of better than 90%. This achievement highlights the potential of AI-driven assistants for helping agronomists diagnose problems and respond to farmers' questions. Future agronomists could be supported by AI copilots, accessing agricultural knowledge, analyzing data, and providing recommendations based on specific needs.

“Generative AI can revolutionize regenerative agriculture by providing valuable insights and tools for optimizing operations, reducing environmental impact, and increasing productivity.”

**Farmer.chat and KissanGPT:** These farmer-facing applications were developed for India and leverage AI to provide agricultural knowledge and support. Using agricultural knowledge embeddings, these applications understand and answer farmers' questions. Designed to be user-friendly and accessible, they help farmers make better decisions, improving crop yields and resource management.

**Jugalbandi:** Navigating government policies and subsidy programs can be daunting for farmers. Jugalbandi uses AI to help farmers understand and access government support in local dialects. By translating policy queries into AI-understandable formats, it provides concise answers, ensuring that farmers can access necessary resources.

These examples demonstrate generative AI's transformative potential in agriculture. Developing and deploying AI-driven solutions that address farmers' unique needs and challenges can lead to a more sustainable, efficient, and productive agricultural future.

## Current challenges and future directions

While generative AI holds immense promise for agriculture, several challenges remain:

**Data quality:** The effectiveness of generative AI models depends on the training data quality and quantity. Ensuring accurate, reliable data from sensors, drones, and satellites is crucial for robust AI models.

**Scalability:** As the adoption of generative AI grows, scalable solutions for diverse farming operations are needed. This requires developing new algorithms, hardware, and data management systems.

**Rural broadband access:** Reliable, high-speed internet in rural areas is essential for effective AI implementation. Limited connectivity hinders AI adoption, preventing farmers from fully benefiting from these technologies. Expanding rural broadband access is crucial.

**Ethical considerations:** AI in agriculture raises ethical questions about data privacy, ownership, and security. Establishing guidelines and regulations to protect farmers and consumers is essential as generative AI becomes widespread.

**Interdisciplinary collaboration:** Harnessing generative AI's potential in regenerative agriculture requires collaboration between AI, agriculture, environmental science, and related fields. This interdisciplinary approach will develop comprehensive solutions addressing agriculture's complex challenges.

## Conclusion

Generative AI can revolutionize regenerative agriculture by providing valuable insights and tools for optimizing operations, reducing environmental impact, and increasing productivity. Facing the challenge of feeding a growing global population underscores the importance of embracing innovative solutions like generative AI.

By investing in research, fostering interdisciplinary collaboration, and addressing challenges, we can unlock generative AI's transformational potential in agriculture. This will benefit farmers and consumers and contribute to a sustainable, resilient global food system.

**Ranveer Chandra**, CTO Agri-Food, Microsoft Corporation, Redmond, Washington, USA, ranveer@microsoft.com.

# From Data to Decisions: The Role of AI in Animal Agriculture

Isabella Condotta



**A**s an agricultural engineer from the University of São Paulo, Brazil, my career began with a fascination with how technology could transform animal agriculture. While still a freshman, I was introduced to precision livestock farming, and that early exposure inspired my journey into applying AI to animal agriculture. I completed my graduate studies at the University of São Paulo and the U.S. Meat Animal Research Center and held a postdoctoral fellowship at the University of Nebraska-Lincoln.

My motivation stems from a deep commitment to improving animal welfare and environmental sustainability. After seeing the transformative potential of AI in various applications, I was inspired to harness these technologies to address critical challenges in livestock management. The ability to continuously monitor animal behavior, health, and well-being through advanced technologies drives my passion for this field.

Now, as an assistant professor at the University of Illinois at Urbana-Champaign, I lead the Illinois Digital Animal Systems Lab (I-DigitAL), where we develop AI-powered tools to monitor and manage livestock. Our mission is to reduce animal stress, enhance well-being, and foster environmental sustainability, while promoting more efficient and productive systems. AI models, combined with computer vision and sensor technologies, allow us to gather and analyze real-time data, providing actionable insights that can help farmers better manage their animals.

## Transforming animal agriculture

In our lab, we leverage AI and computer vision across several key areas of animal agriculture. For instance, we use AI to predict body weight and condition in swine, beef and dairy cattle, and poultry—crucial for determining animal nutritional and health management. Gait analysis, another area of focus, helps detect early signs of lameness in swine and cattle, enabling timely intervention.

Our research also includes AI systems that monitor feeding behavior in dairy cows, pigs, and poultry to correlate with intake and performance metrics, thereby detecting deviations from normal patterns that could signal health or management issues. In grazing animals, we use AI to predict feeding behavior and intake by integrating

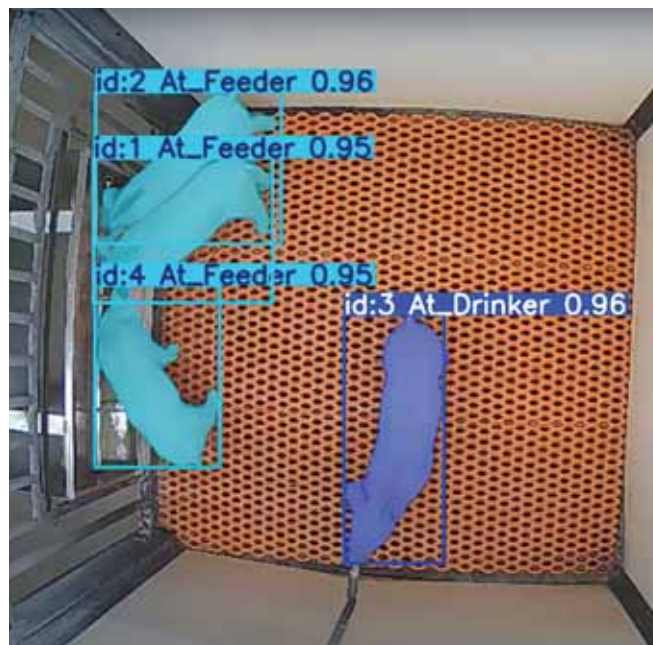
multispectral imaging, GPS, and audio data to optimize pasture use and nutrient intake.

Additionally, in swine, we are studying systems for automated estrus detection, using AI to analyze behaviors and physiological changes related to reproduction. Beyond reproduction, we study sow-piglet interactions to predict behaviors like piglet crushing—a major welfare concern—and assess maternal ability through automated behavior analysis.

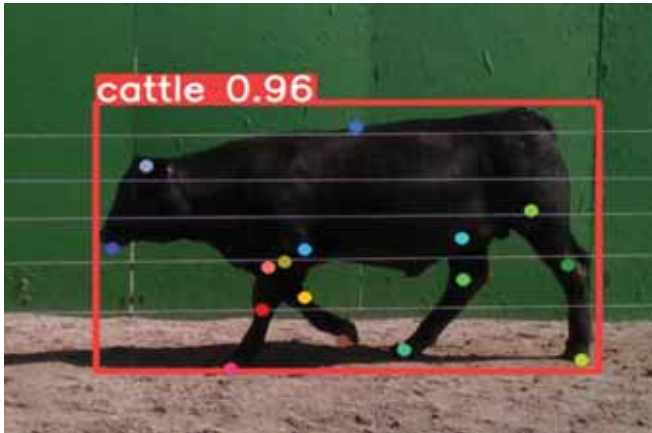
Across species, these AI systems enhance our ability to monitor animals in real-time, providing more efficient precision management.

## Barriers to widespread adoption

Despite its transformative potential, AI in animal agriculture faces significant challenges, and adoption of these technologies is not yet widespread. One major hurdle is the cost of implementing AI systems, particularly for smaller operations. Many farms lack the infrastructure to support the complex hardware and software required for real-time data analysis.



AI-based tracking of piglet feeding behavior.



AI-based keypoint detection for gait analysis.

Data privacy is another concern. AI-based systems collect vast amounts of data, raising questions about who owns this data and how it is used. Farmers may hesitate to adopt systems that they feel compromise their autonomy or put their sensitive information at risk.

There are also practical limitations to consider. While AI has shown great success in controlled research environments, applying these systems on real farms is much more complex. Farms are dynamic, with unpredictable environmental factors, animal behaviors, and technology maintenance challenges. AI systems trained in research settings must be adaptable enough to handle the conditions of commercial operations, and this adaptability remains a challenge.

Finally, there's a learning curve for farmers and farm workers. Although AI can make decision-making more efficient, it requires a fundamental shift in how farms are managed. Successful implementation depends not only on the technology but also on educating farmers on how to integrate this technology into their operations.

### Commercial applications vs. research

While research is advancing rapidly, commercially available AI tools are still in their early stages. Some companies have introduced AI-based products, such as automated milking systems that use computer vision to assess cow health, and feeding robots that adjust rations based on real-time data. These products represent real progress in precision livestock farming, but their reach is currently limited to large, technologically advanced farms.

In contrast, academic research, such as the projects in our lab, is pushing the boundaries of AI's capabilities in livestock management. As a result, our systems are often tested in smaller, controlled environments before being scaled for commercial use, and that takes time.

However, the research being done today lays the foundation for the future. As AI becomes more accessible and adaptable, the systems developed in academic settings will likely transition into broader commercial use, potentially revolutionizing the industry.

### A vision of widespread AI adoption

If AI becomes widely adopted in animal agriculture, the impact would be profound. Real-time data collection and analysis could enable farmers to make more precise management decisions, leading to healthier animals, reduced waste, and more efficient use of resources. AI could transform how we think about farming, shifting the focus from reactive problem-solving to proactive, data-driven decision-making.

In a future where AI is fully integrated into livestock farming, we can envision systems that not only detect health issues before they become serious but also optimize animal welfare and environmental sustainability. By tracking and predicting behavior, feeding patterns, and reproductive cycles, AI could significantly reduce the environmental footprint of animal agriculture while promoting animal well-being.

### To the next generation of engineers

To young engineers who are just starting their journey in AI, the future of farming depends on your creativity, empathy, and technical skill. AI has potential to address some of the biggest challenges facing agriculture today, but it requires careful thought and collaboration across disciplines.

The true success of AI in agriculture should not be measured by the complexity of the algorithms but by the benefits in the field. I encourage you to create tools that can improve the lives of animals, farmers, and consumers. Always keep in mind the practical, ethical, and environmental implications of your work. Stay curious, embrace innovation, and, most of all, strive to make a positive impact.

**ASABE member Isabella Condotta**, Assistant Professor, Department of Animal Sciences, University of Illinois at Urbana-Champaign, USA, [icfsc@illinois.edu](mailto:icfsc@illinois.edu).

### Further reading

- Condotta, I. C., Brown-Brandl, T. M., Pitla, S. K., Stinn, J. P., & Silva-Miranda, K. O. (2020). Evaluation of low-cost depth cameras for agricultural applications. *Computers and Electronics in Agriculture*, *173*, 105394. <https://doi.org/10.1016/j.compag.2020.105394>
- Ferziger, S. S., Condotta, I. C., Brown-Brandl, T. M., Shi, Y., & Rohrer, G. A. (2023). Deep-learning-based behavioral time budgets for sows with high and low piglet mortality rates. ASABE Paper No. 2300833. <https://doi.org/10.13031/aim.202300833>
- Li, J., Green-Miller, A. R., Hu, X., Lucic, A., Mohan, M. M., Dilger, R. N., Condotta, I. C., & Ahuja, N. (2022). Barriers to computer vision applications in pig production facilities. *Computers and Electronics in Agriculture*, *200*, 107227. <https://doi.org/10.1016/j.compag.2022.107227>
- Xiong, Y., Condotta, I. C., Musgrave, J. A., Brown-Brandl, T. M., & Mulliniks, J. T. (2023). Estimating body weight and body condition score of mature beef cows using depth images. *Translational Animal Science*, *7*(1), txad085. <https://doi.org/10.1093/tas/txad085>

# Applications of Digital Twin Technology in Agriculture

Reza Ehsani and Zeinab Rezvani

**D**igital twin (DT) technology has gained significant traction across various industries, including agriculture, by offering transformative benefits through its ability to create digital replicas of physical objects, systems, and processes. These digital replicas facilitate real-time monitoring, analysis, simulation, and optimization of operations by providing a synchronized reflection of the actual system.

The applications of DT technology have evolved dramatically with the advent of the internet of things (IoT), artificial intelligence (AI), and big data analytics, turning DT technology into an effective tool for real-time simulation and prediction. By the 2010s, industries such as automotive, aerospace, and manufacturing had adopted DT technology to optimize performance and reduce operating costs.

## The role of DT in agriculture

In agriculture, DT technology has shown immense potential for optimizing resource management, improving productivity, and fostering sustainability. Digital twins can serve as virtual models that mirror the real-time conditions of crops, soil, and machinery, offering growers a powerful tool to enhance efficiency and sustainability. DT technology has proven particularly useful in areas such as precision soil fertility management, yield forecasting, dis-

ease and pest management, and sustainable irrigation management.

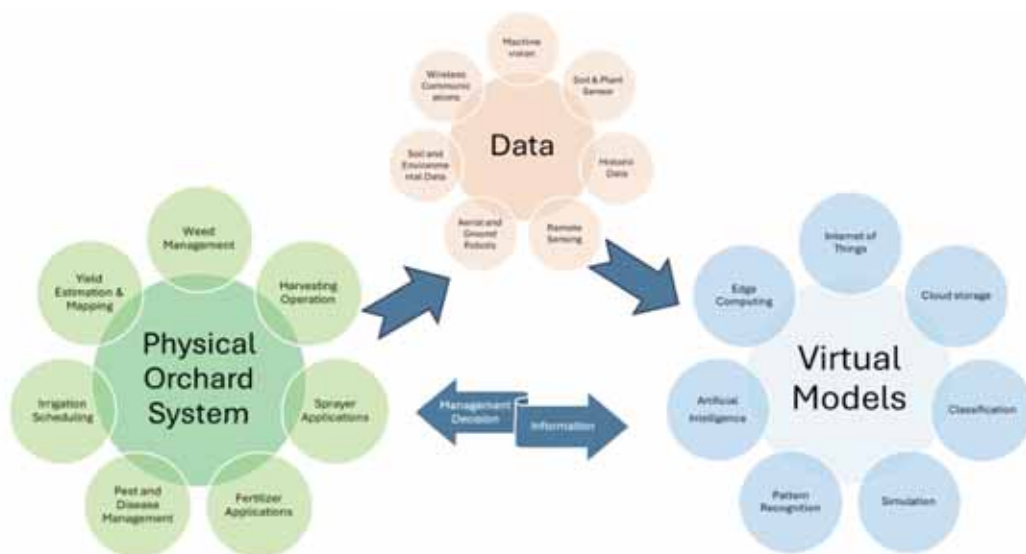
In general, the concept of DT is the same for row crops and tree crops, but the implementations might be different due to differences in field operations. The diagram below illustrates the elements of a DT system for tree crop production.

## Sustainable irrigation management

Irrigation management is an area where DT technology significantly contributes to sustainable agriculture. By continuously monitoring soil moisture or plant water stress in different sections of a field or orchard, DT systems help optimize irrigation scheduling and water use efficiency, ensuring that the plants receive the proper amount of water at different growth stages.

DT technology can help growers implement water-saving strategies in regions facing water scarcity and drought by employing data-driven models that use cost-effective data to predict plant-specific water stress, further enhancing agriculture's resilience to climate change.

Moreover, the ability to analyze soil and crop water needs in real-time reduces nutrient leaching and other adverse effects of improper water usage. This promotes more sustainable farming practices while lowering operating costs.



The elements of a digital twin system for tree crop production.

## Yield forecasting and crop management

Beyond soil and water management, DT technology plays a crucial role in yield forecasting and crop management. By simulating crop growth and yield based on real-time and historic data, DT enables growers to make informed decisions that optimize productivity and reduce the risk of crop failure.

In addition to yield optimization, DT can help growers manage complex interactions between crops and environmental factors such as pests, diseases, and weather patterns. By providing predictive insights, these models

still in the research and development stage. There is also a steep learning curve associated with interpreting the vast amount of data generated by these systems.

However, as DT technology continues to mature, its costs are expected to decrease, making it more accessible to growers worldwide. Additionally, ongoing advances in AI and automation will likely simplify the operation of DT systems, further reducing the technical barriers.

## Future prospects for DT in agriculture

Looking ahead, DT technology is poised to revolutionize agriculture through its integration with autonomous machinery and robotics. For instance, DT technology could coordinate the activities of self-driving tractors, drones, and irrigation systems, creating a highly efficient and fully automated farming environment.

Additionally, the ability to model complex ecosystems will allow the development of more sustainable and resilient farming practices. These models could account for factors such as biodiversity, carbon sequestration, climate change, and overall environmental health, promoting long-term agricultural sustainability.

“DT technology is poised to revolutionize agriculture through its integration with autonomous machinery and robotics.”

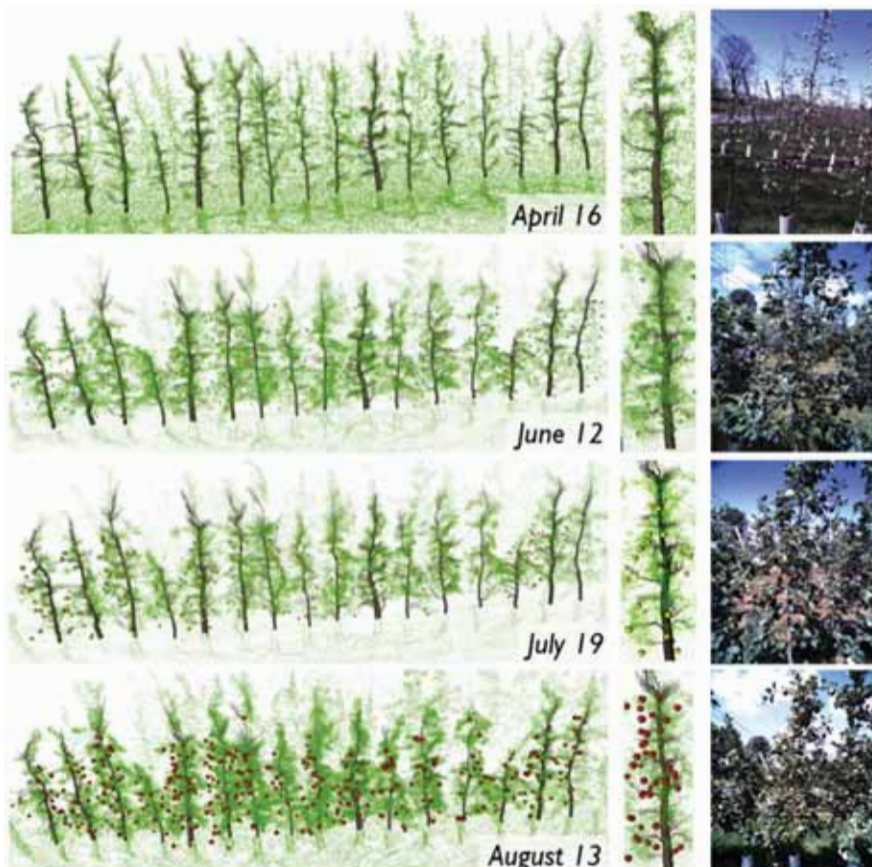
allow proactive measures to mitigate potential threats, improving the resilience of agricultural systems

Through a project supported by the IoT4Ag Engineering Research Center (<https://iot4ag.us/>), a sensor system and related algorithm were developed that illustrates the concept of DT for an apple orchard. The sensor system captures data for creating a digital twin of the orchard and updates its status using data from LiDAR, RGB cameras, GPS, and IMU devices.

By continuously monitoring the trees and the fruit size and shape, estimating yields, and tracking spatial patterns and anomalies, the digital twin of the orchard provides a dynamic, real-time model of the physical orchard that simulates the orchard's behavior and conditions. The model includes tracking of fruit growth over multiple sessions.

## Overcoming challenges in adoption

Despite the benefits of DT technology, several challenges hinder its widespread adoption in agriculture. The upfront investment required for IoT devices, sensors, and other digital infrastructure can be prohibitively high for many growers. In addition, some of the required technologies are



A 4D semantic map of an apple orchard captures the growth rate of each fruit over time.

DT technology can also foster greater collaboration across the agricultural supply chain. By providing real-time updates on crop growth, quality, and resource use, DT technology can improve decision-making at every stage of the supply chain, contributing to a more resilient and sustainable food system.

In conclusion, DT technology can transform agriculture by enabling real-time monitoring, simulation, and optimization of different operations in crop production. Its potential to improve productivity, reduce environmental impact, and promote sustainability makes it a vital tool for growers. As adoption increases and the technical barriers diminish, DT technology will play an integral role in shaping the future.

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### Further reading

- Brocca, L., Barbetta, S., Camici, S., Ciabatta, L., Dari, J., Filippucci, P.,..., Blnaccorsi, B. (2024). A digital twin of the terrestrial water cycle: A glimpse into the future through high-resolution Earth observations. *Frontiers in Science*, 1, 1190191. <https://doi.org/10.3389/fsci.2023.1190191>
- Catala-Roman, P., Navarro, E. A., Segura-Garcia, J., & Garcia-Pineda, M. (2024). Harnessing digital twins for agriculture 5.0: A comparative analysis of 3D point cloud tools. *Applied Sciences*, 14(5), 1709. <https://doi.org/10.3390/app14051709>
- Dai, M., Shen, Y., Li, X., Liu, J., Zhang, S., & Miao, H. (2024). Digital twin system of pest management driven by data and model fusion. *Agriculture*, 14(7), 1099. <https://doi.org/10.3390/agriculture14071099>
- El Saddik, A. (2018). Digital twins: The convergence of multimedia technologies. *IEEE Multimedia*, 25(2), 87-92. <https://doi.org/10.1109/MMUL.2018.023121167>
- Githens, G. (2007). Review of Product life cycle management: Driving the next generation of lean thinking by Michael Grieves. *Journal of Product Innovation Management*, 24(3), 278-280. [https://doi.org/10.1111/j.1540-5885.2007.00250\\_2.x](https://doi.org/10.1111/j.1540-5885.2007.00250_2.x)
- Grieves, M. (2011). *Virtually perfect: Driving innovative and lean products through product lifecycle management*. Cocoa Beach, FL: Space Coast Press.
- Kalyani, Y., Vorster, L., Whetton, R., & Collier, R. (2024). Application scenarios of digital twins for smart crop farming through cloud-fog-edge infrastructure. *Future Internet*, 16(3), 100. <https://doi.org/10.3390/fi16030100>
- Kanaga Priya, P., & Reethicka, A. (2024). A review of digital twin applications in various sectors. In *Transforming Industry Using Digital Twin Technology* (pp. 239-258). Springer.

- Liu, Y., Ong, S., & Nee, A. (2022). State-of-the-art survey on digital twin implementations. *Advances in Manufacturing*, 10(1), 1-23. <https://doi.org/10.1007/s40436-021-00375-w>
- Manocha, A., Sood, S. K., & Bhatia, M. (2024). IoT-digital twin-inspired smart irrigation approach for optimal water utilization. *Sustainable Computing: Informatics Systems*, 41(2), 100947. <https://doi.org/10.1016/j.suscom.2023.100947>
- Peladarinos, N., Piromalis, D., Cheimaras, V., Tserepas, E., Munteanu, R. A., & Papageorgas, P. (2023). Enhancing smart agriculture by implementing digital twins: A comprehensive review. *Sensors*, 23(16), 7128. <https://doi.org/10.3390/s23167128>
- Pires, F., Cachada, A., Barbosa, J., Moreira, A. P., & Leitão, P. (2019). Digital twin in industry 4.0: Technologies, applications, and challenges. *IEEE 17th International Conference on Industrial Informatics (INDIN)*. <https://doi.org/10.1109/INDIN41052.2019.8972134>
- Purcell, W., & Neubauer, T. (2023). Digital twins in agriculture: A state-of-the-art review. *Smart Agricultural Technology*, 3, 100094. <https://doi.org/10.1016/j.atech.2022.100094>
- Tagarakis, A. C., Benos, L., Kyriakarakos, G., Pearson, S., Sørensen, C. G., & Bochtis, D. (2024). Digital twins in agriculture and forestry: A review. *Sensors*, 24(10), 3117. <https://doi.org/10.3390/s24103117>
- Zhang, C., & Kovacs, J. M. (2012). The application of small unmanned aerial systems for precision agriculture: A review. *Precision Agriculture*, 13, 693-712. <https://doi.org/10.1007/s11119-012-9274-5>



# GIVING TUESDAY

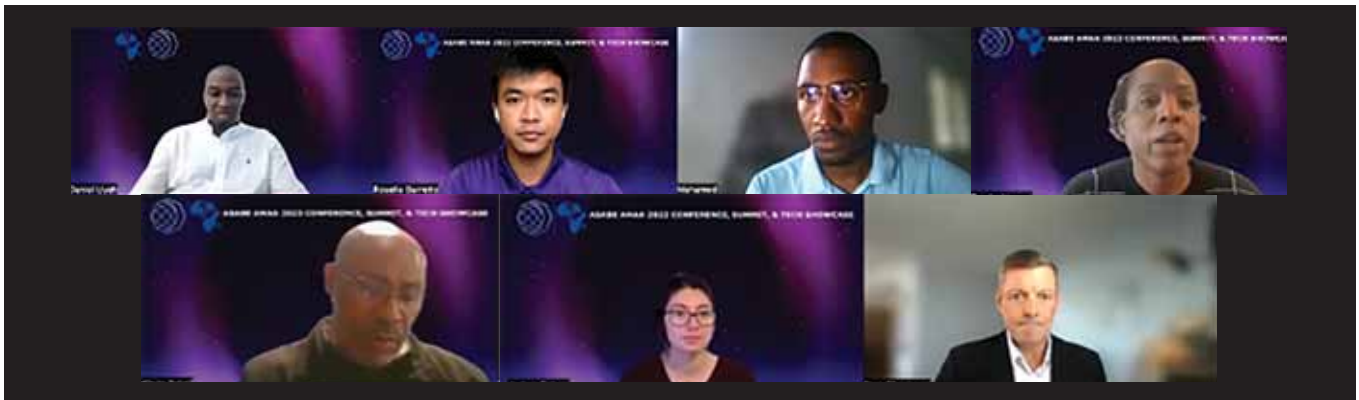
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**DECEMBER 3, 2024**

# Navigating the Professional Landscape of Agri-Food Systems in Africa

Insights from the YPC Career Panel at the 2023 AMAA Conference



The YPC Career Panel at the AMAA International Conference (from top left: Daniel Uyeh, Roselle Barretto, Mahamed Lamine Guindo, Taisha Venort; bottom row: Klein Ileleji, Jaden Tatum, and Daniel Thompson).

The agricultural landscape in Africa is undergoing a significant transformation, shaped by technological advances, entrepreneurial initiatives, and the growing involvement of young professionals. During the 2023 ASABE Alliance for Modernizing African Agri-Food Systems (AMAA) Conference and Technology Showcase, experts from various sectors gathered virtually to discuss how emerging leaders can navigate this evolving field.

The event featured a session organized by **ASABE member Taisha Venort, Jaden Tatum, and Roselle Barretto**, all members of the YPC's Global Engagement committee. The goal of this committee is to provide young professionals with insights into the rapidly shifting agri-food sector, while showcasing how they can actively shape its future.

The session focused on gathering perspectives of the professional landscape in African agri-food systems and current challenges in career development for young professionals. It brought together a panel of experts with diverse backgrounds, including academia, industry, and international development.

This diversity of experience highlighted that there was no one-size-fits-all approach to success in agriculture, particularly in Africa. The evolving nature of the sector demands flexibility, adaptability, and creativity, all of which were central themes in the discussion.

## Digital technology and its role in agriculture

The agricultural sector in Africa is no longer limited to traditional farming methods. Digital technologies are playing an increasing role in reshaping the industry. One of the panelists, Daniel Thomson, a global program manager at the U.S. Agency for International Development, emphasized that agriculture is now intertwined with the digital world.

Thomson, who has extensive experience in driving sustainability programs across West Africa, spoke about the rapid pace of change within the sector, particularly the role of technology in enhancing productivity and profitability. He stressed that young professionals must stay informed and be ready to adapt to new technological tools that are emerging at an astonishing rate.

Thomson's point was reinforced by other panelists who agreed that the future of agriculture in Africa lies in digital transformation. **ASABE member Klein Ileleji**, a professor at Purdue University and the founder of JUA Technologies, drew attention to the importance of mobile technology in driving this change. Ileleji's company specializes in manufacturing solar-powered food dryers for smallholder farms. He pointed out that the rise of mobile phone ownership across Africa has been a game-changer for the agricultural sector and is now a key part of the agricultural ecosystem in Africa.

Mobile phones are becoming powerful tools for accessing crucial information, financial technologies, and market data that can revolutionize farming practices. More adults across the African continent have access to mobile phones than ever before, providing farmers with real-time updates on weather patterns, market prices, and farming techniques.

This accessibility is particularly valuable in rural areas, where conventional sources of information are limited. During the session, Ileleji noted that many attendees of the conference were likely participating through their mobile devices, a testament to how technology is breaking down barriers to knowledge and participation.

### The new frontier of smart agriculture

Another critical area of discussion was the emergence of smart agriculture, which uses data and digital tools to make farming more efficient and sustainable. **ASABE member Daniel Uyeh** of Michigan State University and Mahamed Lamine Guindo of Dakar American University of Science and Technology are both experts in this field. Uyeh, who regularly travels across Africa to conduct training programs, emphasized the need to equip young African professionals with the skills to use smart agriculture tools, such as sensors that monitor soil moisture levels, drones that survey crops, and data platforms that provide farmers with actionable insights about their operations.

Guindo, who is developing an app called AideChamp to assist Senegalese farmers in managing their farms more



effectively, echoed Uyeh's points. Both experts stressed that Africa's agricultural sector must continue to embrace technology to remain competitive and resilient in the face of climate change, population growth, and food security challenges. These tools are already transforming farming practices across the continent, and young professionals who can deploy these technologies are poised to become leaders in the sector.

Smart agriculture is not exclusive to large-scale farmers. Smallholder farmers, who make up a significant portion of the agricultural workforce in Africa, are increasingly adopting these tools to improve their productivity. The panelists pointed out that international aid organizations are shifting their focus from providing material resources to building local capacity through education and technology transfer. This change in strategy aligns with the broader trend of using innovation to address the specific challenges facing African agriculture.

### Entrepreneurship meets innovation

While technology is essential, the panelists also underscored the importance of entrepreneurship and innovation. Africa's agricultural sector faces many obstacles, from limited infrastructure and financial resources to climate-related disruptions. However, these challenges also present opportunities for young professionals with an entrepreneurial mindset. Uyeh shared a personal anecdote about how he sold juice during his youth to earn extra income. This early entrepreneurial experience, he said, laid the foundation for his current work in smart agriculture.

Uyeh's story reflects a broader trend: success in African agriculture often comes from those who are willing to think outside the box and take risks. The panelists encouraged young professionals to develop creative solutions to the problems they encounter, whether through launching new ventures or working within established organizations to foster innovation. Entrepreneurship is critical in a sector where formal career paths are not always well defined, particularly in rural areas where traditional job opportunities may be limited.

The role of entrepreneurship in African agriculture is growing, and the panelists agreed that fostering an entrepreneurial spirit among young professionals is key to addressing the continent's agricultural challenges. For example, companies like JUA Technologies, founded by Ileleji, are examples of how innovation can meet local needs while creating opportunities for young people. Ileleji's solar food dryers are designed specifically for use by smallholder farmers, provid-



**Africa's agricultural sector needs to continue to embrace technology to remain competitive.**



**Young professionals can drive meaningful change in Africa's agricultural sector.**

ing them with a sustainable way to preserve their crops and reduce post-harvest losses. By building businesses that address real-world problems, young professionals can drive meaningful change in the agricultural sector.

### **Overcoming brain drain and talent retention**

One of the recurring themes in the session was the challenge of retaining talent on the continent. Many young African professionals, especially those with advanced degrees and specialized skills, are drawn to opportunities abroad, where salaries are higher and career development prospects are more robust. This brain drain has been a significant issue for Africa's agricultural sector, as it deprives local organizations and companies of the talent needed to modernize and grow.

Ileleji highlighted the importance of creating competitive opportunities for young professionals in Africa. He noted that his company makes a concerted effort to hire and retain local talent, offering them continuous training and career development opportunities. This approach helps to keep skilled professionals in Africa, and it fosters a culture of innovation and growth within the company. The panelists agreed that employers across the continent must invest in their employees by providing mentorship, training, and clear career progression paths to prevent talent from leaving.

Building a competitive and appealing job market in African agriculture requires more than just better wages. It also requires creating a sense of purpose and opportunity. Young professionals are more likely to stay in Africa if they feel they are making tangible impacts on their communities and contributing to the continent's development. By fostering an environment that supports professional growth and rewards innovation, African companies and organizations can attract and retain the best and brightest in the sector.

### **Education and continuous learning**

The panelists also emphasized the importance of education and continuous learning for young professionals in agriculture. Formal education in fields such as agricultural

engineering, biology, and environmental science provides a strong foundation, but the rapidly changing nature of the industry means that learning cannot stop at graduation. Young professionals must stay up to date with the latest technologies, farming techniques, and market trends to remain competitive.

Guindo and Uyeh both stressed the value of hands-on experience through internships, fieldwork, and professional training programs. In addition, online courses, webinars, and professional development opportunities are becoming increasingly important as more young professionals turn to digital platforms for learning. The ability to continuously learn and adapt to new challenges is essential for those seeking to build long-term careers in agriculture.

### **A bright future for African agriculture**

The YPC Career Panel offered critical insights into the future of the agri-food sector in Africa. The panelists emphasized the importance of embracing digital technologies, cultivating an entrepreneurial mindset, building strong professional networks, and continuously seeking education and training opportunities. Young professionals have a unique opportunity to play a central role in the transformation of African agriculture, and the future of the sector depends on their ability to innovate, adapt, and lead.

As the agricultural landscape in Africa continues to evolve, the next generation of leaders will be instrumental in driving change and ensuring food security for the continent. By leveraging technology, fostering entrepreneurship, and investing in talent, African agriculture can thrive in the face of global challenges. The future is bright, and young professionals are at the heart of that transformation.

With this perspective, ASABE is committed to supporting young African professionals in the agri-food sector. The YPC's Global Engagement committee is working on developing partnerships toward effective capacity building across relevant sectors for young professional who are navigating the African agricultural labor market. To get involved, contact the committee's co-chairs Klein Ileleji (ileleji@purdue.edu) or **ASABE member Margaret Gitau** (mgitau@purdue.edu).

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## Career Advice from a Young Professional

**C**ongratulations on graduating with your engineering degree and securing a job at a reputable company! As you embark on your first day of work, seated in your pristine new office with your inaugural assignment in hand, you might find yourself thinking, “What have I gotten myself into?” Suddenly, the preparation provided by your degree may seem insufficient for the tasks ahead.

Rest assured, you are not alone. Even the most seasoned engineers have experienced moments of uncertainty. In my journey as a young professional, I’ve navigated numerous challenges, undergone complete career shifts, and relocated across the country multiple times. As a result, the knowledge I’ve gained is invaluable, and I wouldn’t change my path even if I could. Reflecting on my 12+ years of experience, here are the top five pieces of advice I would offer to new engineers:

### 1. Ask questions

One of the biggest challenges I faced at the start of my career was the hesitation to ask questions. It’s important to understand that no one expects you to know everything right away. Your colleagues, superiors, and peers are valuable resources, so draw on their knowledge and experience. Asking questions helps you learn, and it demonstrates your eagerness to grow and your commitment to your job. Engage in active listening, take notes, and follow up on any uncertainties. The more questions you ask, the more confident and competent you will become.

### 2. Find a mentor

Every engineer has been in your position. Don’t be discouraged if a colleague with years of experience seems far ahead of you. Instead, seek mentorship from that colleague. A mentor can provide you with guidance, support, and insight that you won’t find in textbooks or training manuals. Mentors can offer career advice, share their own experiences and lessons learned, and help you navigate the complexities of the workplace. A strong mentoring relationship can be a game-changer in your professional development. Schedule regular meetings to discuss your goals, challenges, and progress, and be open to feedback and new perspectives.

### 3. Broaden your experience

Embrace new responsibilities and expand your skill set. Your initial job may not align perfectly with your area of expertise, so view it as an opportunity for growth. Volunteering for projects outside your comfort zone can provide you with a broader perspective and make you more versatile as an engineer. Participate in cross-functional teams, attend workshops and seminars, and stay updated on the latest industry trends and technologies. The knowledge and skills that you acquire through diverse experiences will enhance your resume and prepare you for future opportunities.

### 4. Recognize your accomplishments

It is crucial to acknowledge your achievements as an engineer. If your supervisor commends your performance, take it to heart. Many engineers, particularly those early in their careers, struggle with imposter syndrome—the feeling of being a fraud or not belonging. This can be a significant barrier to self-confidence and professional growth. To combat imposter syndrome, keep a record of your achievements and milestones, no matter how small they may seem at the time. Reflect on the progress you’ve made and the challenges you’ve overcome. Recognizing your accomplishments will boost your self-esteem and reinforce your sense of belonging in your field.

### 5. Maintain a work-life balance

Feeling overwhelmed is natural, and it happens to everyone. Prioritize a healthy work-life balance and be especially mindful of your mental health. A balanced life is key to sustained productivity and satisfaction in your career. Make time for activities that you enjoy and that help you relax and recharge. Whether it’s building, reading, hiking, or crocheting, having a life outside of work is paramount to your performance on the job. Additionally, set boundaries between work and your personal life, and make sure you get enough rest. A well-rounded person is a more effective and innovative engineer.

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# Enhancing the Reliability and Efficiency of Biomass Preprocessing

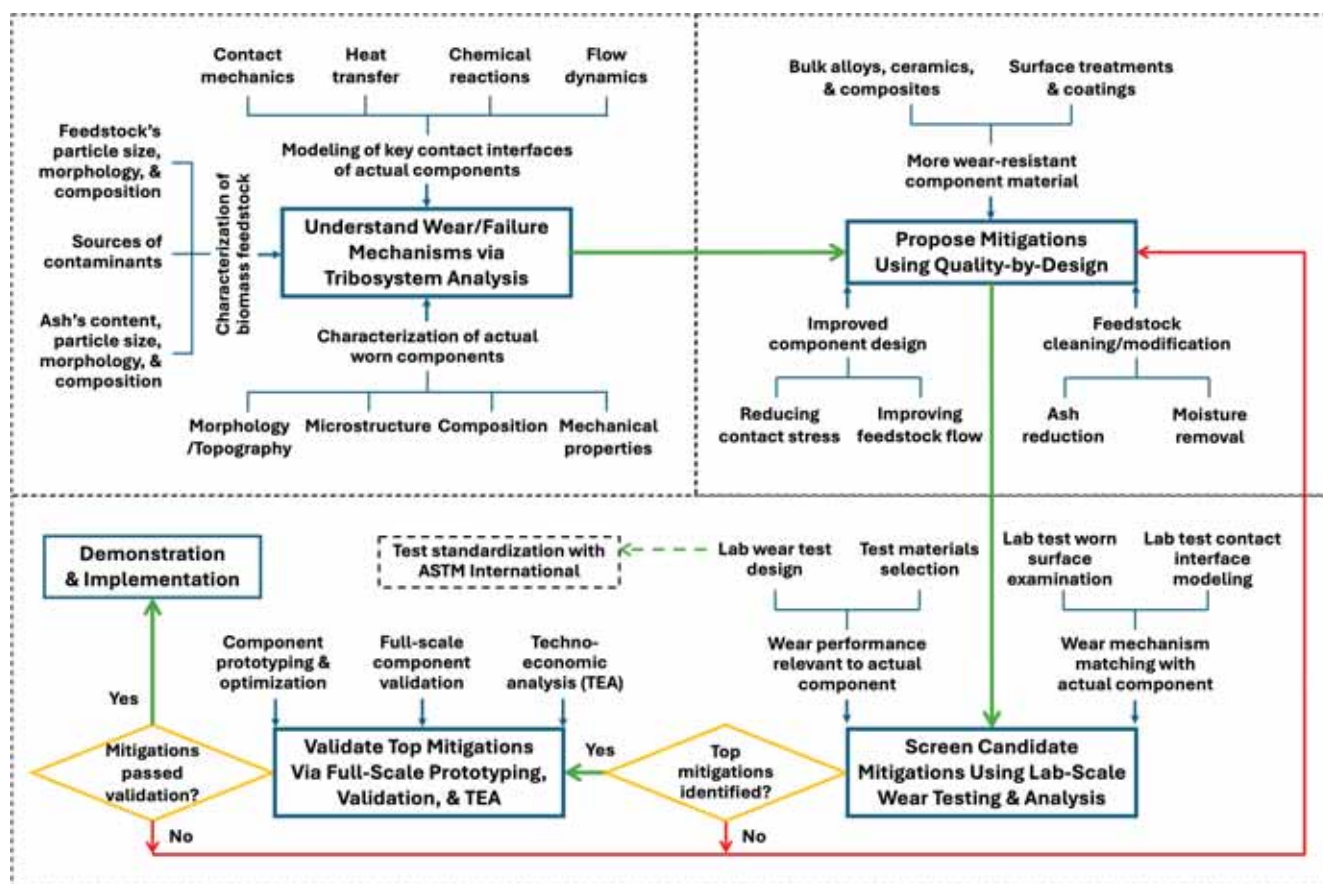
Jun Qu and Erin Webb, P.E.

**B**iomass preprocessing, a crucial step in bioenergy production, involves breaking down raw biomass into smaller, more manageable pieces for further processing and conversion. However, significant challenges can be encountered during this step due to the harsh conditions in the processing equipment.

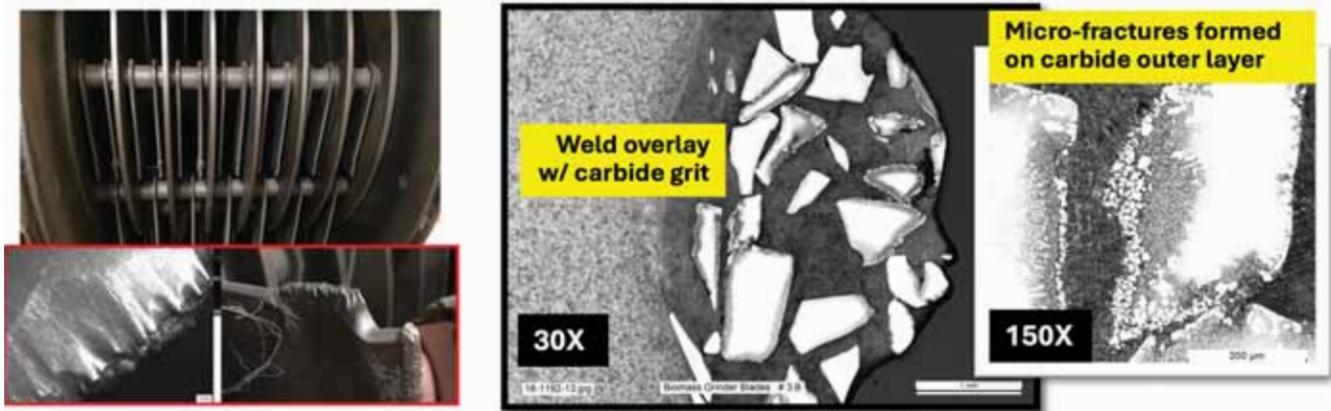
The hammering, milling, and shredding operations that reduce the biomass size also entrain hard, abrasive particles that can wear down the cutting and shearing tools. This wear leads to degraded performance, reduced product quality, and

impaired efficiency in downstream biomass conversion processes. The result is increased operating costs, frequent downtime for equipment maintenance, and lower overall economic viability of bioenergy production.

The Feedstock-Conversion Interface Consortium (FCIC), a collaboration between the U.S. Department of Energy (DOE) National Laboratories and the bioenergy industry, is addressing these challenges with a team consisting of materials scientists, mechanical and chemical engineers, and systems researchers.



Flowchart for investigating equipment wear problems in biomass preprocessing.



The failure mechanism of hammers with a carbide weld overlay was revealed by microstructural examination and chemical analysis. A significant amount of cobalt diffused out of the carbide grit during the thermal spray, causing massive microscale porosity and consequently vulnerability to microfracture.

Their mission is to develop a deep understanding of the failure modes and wear mechanisms that affect biomass comminution equipment, such as mills and shredders, and to create predictive wear models that inform material selection and design improvements. By doing so, they aim to enhance the durability and efficiency of biomass processing equipment, ultimately improving the economics of bioenergy production.

### Mitigating wear in biomass processing equipment

To tackle the wear issues in biomass preprocessing, the FCIC team developed a systematic approach to investigate and address the wear challenges faced by comminution equipment. For example, in a study of the commonly used hammer mills, the mechanism behind the expected excessive wear of hammers with a carbide weld overlay was revealed by microstructural examination and chemical analysis.

In another case, after determining the wear modes of a Crumbler rotary shear, optimized geometric tool designs were employed to improve the tool life and cutting efficiency. This approach also demonstrated the feasibility of addressing biomass fouling on the screw feeder used in pyrolysis. Analytical models have been developed for both erosion and abrasion to correlate the tool wear to the processing parameters, feedstock properties, and blade mechanical properties.

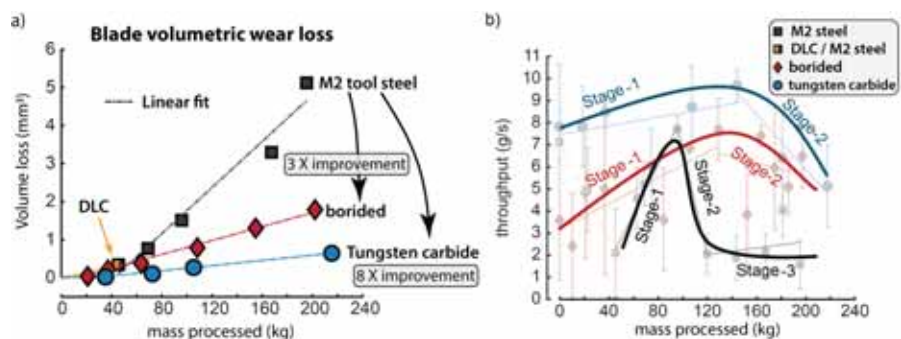
A notable example of the team's work is a case study on knife mills, a common type of equipment used for biomass size reduction. Through detailed tribosystem analysis, including contact mechanics modeling and characterization of worn knives, the team identified the primary wear modes, which included erosion on the rake face and abrasion on the flank face of the knives.

Given that both erosive and abrasive wear were present, the team focused on finding materials that could balance hardness and fracture toughness, to resist both abrasion and erosion. They tested several candidate materials and surface treatments, including different tool steels, a composite insert of tungsten carbide-cobalt (WC-Co), iron and nickel boriding surface treatments, and a diamond-like carbon (DLC) coating.

### Results from bench-scale and full-scale testing

In bench-scale wear tests, the iron borided steel and WC-Co insert outperformed the baseline and other candidate materials, showing superior resistance to both abrasion and erosion. Although the DLC coating offered excellent abrasion resistance, it was quickly eroded, making it less suitable for the harsh conditions encountered in biomass processing.

The promising materials were then tested in a full-scale knife mill. The results were significant. Knives made from WC-Co and iron borided steel demonstrated wear reductions that were 8 and 3 times less, respectively, compared to the standard M2 tool steel. Moreover, these advanced knives achieved 2 to 3 times higher throughput rates and exhibited lower and more stable power consumption during biomass processing.



Prototype blades of iron borided steel and WC-Co demonstrated (a) 3 to 8 times improved tool life and (b) 2 to 3 times higher throughput compared with commercial M2 tool steel blades in full-scale knife mill testing.

Interestingly, the team also observed higher wear on stationary knives compared to rotary knives, a phenomenon that was explained through contact mechanics analysis. This insight could lead to further improvements in knife design and material selection for even greater durability and efficiency.

“ A dynamic, first-plant techno-economic analysis (TEA) conducted by the team suggests that the use of more wear-resistant blade materials could substantially reduce milling costs, making bioenergy production more economically viable.

As the team continues to share its findings with the broader biomass community, the adoption of these advanced materials and designs is expected to enhance the reliability and efficiency of biomass preprocessing operations across the industry. This, in turn, will contribute to the growth and sustainability of the bioenergy sector, helping to meet the world's increasing demand for renewable energy sources.

By developing science-based tools and solutions to address the challenges of biomass preprocessing, the FCIC is playing a pivotal role in advancing the bioenergy industry toward a more reliable and cost-effective future.

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### Economic impact and future directions

The advances in material selection for biomass preprocessing equipment have far-reaching implications for the bioenergy industry. A dynamic, first-plant techno-economic analysis (TEA) conducted by the team suggests that the use of more wear-resistant blade materials could substantially reduce milling costs, making bioenergy production more economically viable.

### The Research Team

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### Further reading

FCIC. (2024). Feedstock-Conversion Interface Consortium. Washington, DC: U.S. Department of Energy. Retrieved from <https://www.energy.gov/eere/bioenergy/feedstock-conversion-interface-consortium>

Fenske, G. R., & Ajayi, O. O. (2029). Application of an erosion wear model to predict wear of hammer milling components. Oak Ridge, TN: U.S. Department of Energy, Office of Scientific and Technical Information. <https://doi.org/10.2172/1763729>

Fenske, G. R., & Ajayi, O. O. (2022). ABRADE model. Lemont, IL: Argonne National Laboratory. Retrieved from <https://www.anl.gov/amd/abrade-model>

Grejtak, T., Lacey, J. A., Kuns, M. W., Hartley, D. S., Thompson, D. S., Fenske, G. R., Ajayi, O. O. & Qu, J. (2023). Improving knife milling performance for biomass preprocessing by using advanced blade materials, *Wear*, 522, 204714. <https://doi.org/10.1016/j.wear.2023.204714>

He, X., Darsell, J. T., Tumuluru, J. S., Wang, W., Meyer, H. M., Keiser, J. R., Rohatgi, A., Howe, D., & Qu, J. (2024). Mitigating municipal solid waste fouling in biofuel conversion via screw surface modifications. *Biomass and Bioenergy*, 188, 107337. <https://doi.org/10.1016/j.biombioe.2024.107337>

Lee, K., Lanning, D., Lin, L., Cakmak, E., Keiser, J. R., & Qu, J. (2021). Wear mechanism analysis of a new rotary shear biomass comminution system. *ACS Sustainable Chemistry and Engineering*, 9(35), 11652-11660. <https://doi.org/10.1021/acssuschemeng.1c02542>

Lin, L., McKiernan, C., Lanning, D., Keiser, J. R., & Qu, J. (2023). Contact pressure analysis to allow improved design for the clearing plate in a biomass comminution system. *Biomass Conversion and Biorefinery*, 04805-6. <https://doi.org/10.1007/s13399-023-04805-6>

Roy, S., Lee, K., Lacey, J. A., Thompson, V. S., Keiser, J. R., & Qu, J. (2020). Material characterization-based wear mechanism investigation for biomass hammer mills. *ACS Sustainable Chemistry and Engineering*, 8(9), 3541-3546. <https://doi.org/10.1021/acssuschemeng.9b06450>

Wang, R., He, X., Lin, L., Flores-Betancourt, A., Lee, K., Dunning, T., & Qu, J. (2023). Investigation of biomass fouling on screw feeder in preconversion of pyrolysis. *ACS Sustainable Chemistry and Engineering*, 11(13), 4934-4942. <https://doi.org/10.1021/acssuschemeng.2c06363>

# ASABE's *Introduction to Biosystems Engineering*

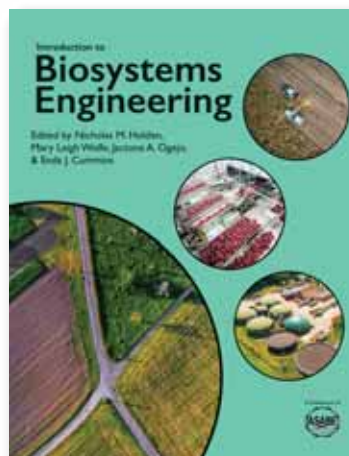
Submit a chapter to contribute to the ongoing success of this online resource

**B**e a part of ASABE's continuing effort to introduce the world to biosystems engineering through open educational resources!

Consider preparing a chapter on a topic of your expertise. A chapter should cover a specific topic, and not be too broad. Think of it as one week of work for a first or second year university student interested in studying biosystems engineering.

In January 2021, *Introduction to Biosystems Engineering* was published jointly by ASABE and Virginia Tech Publishing. As an open educational resource (OER), each chapter and the compilation of 23 chapters are available for free download and for hard copy purchase at cost. As of November 2024, the compilation of chapters has been downloaded over 58,000 times, while individual chapters have been downloaded on average over 3,000 times, with the maximum being over 12,000 times!

From the outset, the editors' plan has been to expand the number and topics of the chapters. While the inaugural chapters are aligned with six of the ASABE technical communities, contributions of new chapters from all technical



When a new chapter is published, it is available online for free download. When 20 to 25 new chapters have been published, a compilation of those chapters will be made available for free download and hard copy purchase at cost, just like the first compilation.

Take a look at the chapters that have been published and you will see that writing a chapter based on your expertise is not that difficult. Each chapter (8,000 to 9,000 words long) follows the same outline:

- The chapter title
- The authors and their affiliations
- Key terms
- A list and description of the variables
- A brief introduction (one or two paragraphs)
- The learning outcomes (“After reading this chapter, you should be able to...”)
- Concepts that are important for understanding the chapter’s topic
- Applications that bring the concepts to life in the context of industry and research
- Example problems and their solutions based on the presented concepts
- Image credits
- References

Further details, including how to contribute a chapter, are available on the ASABE website at: <https://asabe.org/BEdetails>

Specific formatting guidelines are available at: <https://asabe.org/IBEauthors>

The current downloadable chapters are available at: <https://asabe.org/IntroBE>

To initiate your contribution to *Introduction to Biosystems Engineering* or for more information, contact the editors at: [IntrotoBE@asabe.org](mailto:IntrotoBE@asabe.org)

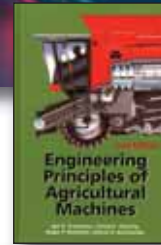
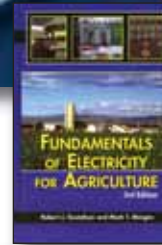
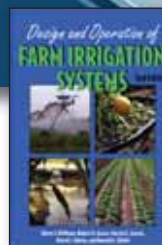
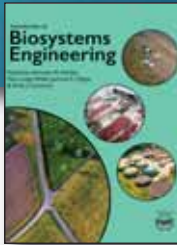
We look forward to hearing from you!

**As of November 2024, the compilation of chapters has been downloaded over 58,000 times, while the individual chapters have been downloaded on average over 3,000 times, with the maximum being over 12,000 times!**

communities are welcome. The global appeal demonstrated by the number of downloads, and the positive feedback from instructors who use the chapters in their courses, confirms that this plan should be implemented.

# ASABE's P-515 Committee Takes on a New Name

Brian Steward, P.E.,  
Derek Heeren, P.E.,  
Dennis Buckmaster, P.E.,  
and Griffiths Atungulu



**A**SABE's P-515 committee has a new name—Teaching and Learning Resources—that better reflects its goals and vision. For many years, P-515 had been known as the Textbooks and Monographs committee, and textbooks continue to be very important for capturing the knowledge of the discipline.

However, after some thoughtful discussions and considerations, it was clear that newer media formats, such as online teaching materials, are increasingly relevant to our profession. The committee's new name reflects this broader scope.

## What does the P-515 committee do?

The Teaching and Learning Resource committee approves funding requests for the development and revision of educational resources. The funding source is the endowed Pinches Schwab fund of the ASABE Foundation. Its annual earnings are available to support ASABE member authors who are developing educational resources. Our newest open-access textbook—*Introduction to Biosystems Engineering*—was supported by these funds.

P-515 encourages textbook projects, and the committee is also promoting the development of electronic resources. These publications go through a peer-review process and are published in the ASABE technical library. Currently, two collections of electronic resources are available: Teaching materials for a gin operations course and Case studies and modules for data science instruction.

## Results of the member survey

In 2021, ASABE members were invited to complete a survey on their perceptions of ASABE's textbooks. This survey was initiated after an analysis showed that the median age of ASABE's textbooks was 21 years (as of 2019). These textbooks represent the curated knowledge of our discipline, and they should be maintained to define this core knowledge. Thus, the survey was intended to create a sense of urgency about the revision process as well as the development of new materials.

From the survey results, the committee members gained a sense of which textbooks are seen as the highest priorities to revise and maintain. The list of textbooks that the respondents could choose from were those with the highest sales.

**Survey responses to the question:  
Which of the following would be significantly more useful when revised?**

Textbook Title	Publication Year	No. Responses
<i>Engineering Principles of Ag Machines</i> , 2nd Ed.	2006	20
<i>Off-Road Vehicle Engineering Principles</i>	2003	16
<i>Fundamentals of Electricity for Agriculture</i> , 3rd Ed.	2004	15
<i>Agricultural Buildings &amp; Structures</i>	1996	12
<i>Principles of Process Engineering</i>	1997	11
<i>Soil &amp; Water Conservation</i> , 7th Ed.	2013	10
<i>Design &amp; Operation of Farm Irrigation Systems</i> , 2nd Ed.	2007	8
<i>On-Farm Drying and Storage Systems</i>	1994	8
<i>Environmental Control for Animals &amp; Plants</i> w/CD	1990	7
<i>Food &amp; Process Engineering Technology</i>	2004	6
<i>Livestock Energetics and Thermal Environmental Mgt</i>	2009	2
<i>Landscape Irrigation Design</i>	1995	1
<i>Engine &amp; Tractor Power</i> , 4th Ed.	2004	0
<b>Total Responses</b>		<b>116</b>

## Summary of new topics suggested by the survey respondents.

Subject Areas	New Topics
Digital Ag, Data Analytics	Digital agriculture, data analytics for agriculture, precision agriculture, precision livestock farming; Agricultural data management, preparation, analysis, and modeling; Artificial intelligence; IoT in agricultural; Machine learning; Statistics for ABE, imaging
Machinery Systems	Fluid power/hydraulic system design; In-vehicle networking and ISOBUS systems; Functional analysis of modern ag machinery
Bioprocessing	Process automation; Engineering properties of biological materials; Engineering properties of biological materials
Natural Resources Conservation	Water resources; Stream and wetland processes and restoration engineering
Animal Production	Animal production technology; Farm structure
Ag Safety	Autonomous agricultural vehicle (AAV) safety considerations

Specifically, the respondents were asked: Which of the following would be significantly more useful when revised? The responses tended to be distributed across ASABE's technical communities and indicated a priority for some textbooks over others.

The survey respondents were also asked to identify the topics that are most important for capturing a curated knowledge base that establishes ASABE's expertise, new topics that should be prioritized in the development of textbooks, and new ways that should be pursued for packaging and disseminating knowledge. The respondents suggested new topics across the broad range of ABE, including many topics in digital ag and data analytics.

Finally, the respondents were asked how authors might be incentivized to contribute to textbooks or similar projects. Many of the respondents reported that time was a constraint, and they suggested financial compensation for the time and effort involved in developing textbooks and similar projects.

Several respondents suggested non-financial forms of assistance that could support the development process. Recognition was also noted as a way to incentivize contribu-

tors, as well as establishing value for the work for use in professional evaluations.

### How you can help

If you are planning to prepare educational materials that ASABE might host or publish, consider submitting a pre-proposal to the P-515 committee. After the initial review, you may be invited to provide a more complete proposal with more details about your project. To apply, go to [www.asabe.org/PinchesSchwab](http://www.asabe.org/PinchesSchwab).

Your contributions to ASABE's teaching and learning resources are a great way to disseminate what you are doing in the classroom, while getting professional recognition for your instructional innovation.

**ASABE member Brian Steward, P.E.**, Professor, Agricultural and Biosystems Engineering, Iowa State University, Ames, USA; **ASABE member Derek Heeren, P.E.**, Professor, Biological Systems Engineering, University of Nebraska, Lincoln, USA; **ASABE member Dennis Buckmaster, P.E.**, Professor, Agricultural and Biological Engineering, Purdue University, West Lafayette, Indiana, USA; **ASABE member Griffiths Atungulu**, Associate Professor, Food Science, University of Arkansas, Fayetteville, USA; [bsteward@iastate.edu](mailto:bsteward@iastate.edu).

## Summary of responses to the question: How might authors be incentivized to contribute to textbooks and similar projects?

Incentivization Themes	No. of Responses	Sample Responses
Compensation for time and effort required	14	"Need to buy out author time so they have some bandwidth to focus on a textbook," "Usually the problem is available time..., not financial compensation," "Comped membership fees and conference registration. Potentially free membership for life."
Assistance with the development	8	"Help with figures," "Substantial editorial and graphic arts support would ease the time burden. The subject matter experts could provide content if there was good editorial support," "help as needed with formatting."
Recognition	7	"Recognition as an author is good enough for me," "ASABE gift and awards," "Peer review of textbooks and similar resources adds recognition and value," "Special distinction."
Evaluation outcomes	2	"Has to be valued equally to research for promotion/tenure," "[Authors are incentivized] when textbooks get the same recognition as publications in scientific journals."

# The Importance of Peer Review for ASABE Journals

Kati Migliaccio, P.E., Patricia Smith,  
and Kasiviswanathan Muthukumarappan

**T**he publication of a manuscript in a peer-reviewed journal is a multi-step process. The quality of the final article is the result of many contributors, including authors, editors, reviewers, and publishing staff. All these people play a role in the development of an article. However, the peer-review process ultimately determines when and how the research is ready for publication. After the authors, the reviewers contribute the most to the quality of the final product.

For the past three years, ASABE has offered a continuing professional development (CPD) workshop at the ASABE Annual International Meeting (AIM) on training both new and experienced reviewers for our journals. Our experience with the journals and with reviewers has emphasized the need for mentoring reviewers within our Society to produce constructive reviews, which improves the overall quality of our journals.

You may have heard the term “constructive” before, but it can be hard to translate this term into reviewer comments that improve a manuscript. As authors, we have all submitted manuscripts and received reviews that were less than glowing (and perhaps resulted in shedding a tear or cursing “Reviewer 2”). As reviewers, our instinct is to point out only what is wrong with a manuscript, which often leads to “destructive” comments.

Destructive comments provide little insight into how to improve the manuscript (comments like “Explain this”), and

they lack the detail needed to make specific corrections (comments like “The abstract is poorly written”). Destructive comments are easy to write because they require no justification. Such comments reflect little effort on the part of the reviewer for improving the quality of the manuscript.

On the other hand, constructive comments provide clear guidance on how to improve a manuscript. Constructive comments, when implemented, improve not only the journal article but also the impact of the research. Our journals reflect both ASABE as a professional society and our discipline in general. Therefore, we have a responsibility to contribute our best efforts to the review process.

In essence, reviewers serve as gatekeepers, protecting the integrity of the research, and as writing mentors. Reviewers provide an expert perspective on the manuscript’s content and provide thoughtful feedback for the authors’ benefit. Our goal is for authors to seek out ASABE journals for their research because our journals have a reputation for quality and integrity in the review process.



Many people contribute to preparing a manuscript for publication.

and as writing mentors. Reviewers provide an expert perspective on the manuscript’s content and provide thoughtful feedback for the authors’ benefit. Our goal is for authors to seek out ASABE journals for their research because our journals have a reputation for quality and integrity in the review process.

## Best practices for constructive reviews

One way to create a community of outstanding reviewers is to develop best practices for constructive reviews. Some suggestions from past CPD workshops are listed here, along with contrasting examples of destructive and constructive comments:



### Start with a positive comment

**Destructive:** “This paper needs to be completely rewritten.”

**Constructive:** “This paper addresses research that is relevant and impactful on water resources management in karst systems. Some suggestions for improvement of the text are provided in the next section.”

### State facts rather than feelings

**Destructive:** “I don’t like the way you stated this.”

**Constructive:** “Please add some clarifying text on the risk associated with pathogen doses for the sources indicated.”

### Use words that lead to understanding and action

**Destructive:** “This paragraph is confusing.”

**Constructive:** “The second sentence of this paragraph contradicts the first sentence.”

### Specify where and how the comment applies

**Destructive:** “The authors use too many pronouns.”

**Constructive:** “In the Methods section (lines 36-54), the authors often use ‘it’ and ‘they.’ However, it is not clear what these pronouns refer to. Please clarify this section by using specific nouns.”

### Explain why a representation does not convey the intended message

**Destructive:** “Figure 1 is not useful.”

**Constructive:** “The authors identify Figure 1 in the text when referring to how the treatments were significantly different. However, no statistics or error bars are shown in Figure 1.”



Examples of destructive comments from reviewers.

### How you can help

Dedication to the quality of the peer review process distinguishes our journals from those of many other publishers. We know that timely publication of research is of utmost importance, and we are committed to balancing the time required for a constructive review with the assurance that accepted manuscripts will be published in a timely manner. As a result, we are dedicated to training new reviewers and refreshing veteran reviewers in the art of conducting a constructive review.

If you are interested in becoming a reviewer for ASABE journals, visit the ASABE journal website and select “volunteer to review” (<https://www.asabe.org/VolunteerToReview>). Resources to guide you through the review process are also available on the ASABE journal website. You can also reach out to the community editors:

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**ES:** Kasiviswanathan Muthukumarappan ([muthukum@sdstate.edu](mailto:muthukum@sdstate.edu))

**ESH:** Michael Pate ([michael.pate@usu.edu](mailto:michael.pate@usu.edu))

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**MS:** Heping Zhu ([heping.zhu@usda.gov](mailto:heping.zhu@usda.gov))

**NRES:** Kati Migliaccio ([klwhite@ufl.edu](mailto:klwhite@ufl.edu))

**PAFS:** Shafiqur Rahman ([shafiqur68@gmail.com](mailto:shafiqur68@gmail.com))

**PRS:** Kingsley Ambrose ([rambrose@purdue.edu](mailto:rambrose@purdue.edu))

Our CPD workshop on the reviewer process will be offered again at the 2025 AIM. Look for announcements about this workshop as the AIM approaches. Most of all, our thanks to all of you who contribute to the discipline, and to our Society, through your participation in the peer review process!

**ASABE Fellow Kati Migliaccio, P.E.**, Professor and Chair, Agricultural and Biological Engineering, University of Florida, Gainesville, USA, [klwhite@ufl.edu](mailto:klwhite@ufl.edu); **ASABE Fellow Patricia Smith**, Professor and Department Head, Biological and Agricultural Engineering, Texas A&M University, College Station, USA, [patricia.smith@ag.tamu.edu](mailto:patricia.smith@ag.tamu.edu); **ASABE Fellow Kasiviswanathan Muthukumarappan**, Maynard A. Klingbeil Endowed Department Head and Distinguished Professor, Agricultural and Biosystems Engineering, South Dakota State University, Brookings, USA, [muthukum@sdstate.edu](mailto:muthukum@sdstate.edu).

# ASABE Foundation Work in Focus

## Take the Past Presidents Challenge

Maury Salz

**T**he global challenges of food security, sustainable farming, and climate resilience grow more pressing by the day, and agricultural and biological engineers are at the forefront in addressing these challenges. We are designing solutions that can feed the world and protect our planet.

ASABE has long been a leader in nurturing talent and fostering collaboration within our profession. However, the future of agricultural engineering depends on the support of those who believe in our mission. This is where the ASABE Foundation comes in—and why your donation matters.

### Empowering the next generation

The ASABE Foundation is dedicated to investing in the next generation of ag and bio engineers through grants and scholarships. Your donation enables young engineers to explore new ideas, gain critical skills, and connect with mentors. By contributing to the Foundation, you are supporting students who are driven to solve the global challenges—students who will develop new technologies that make agriculture more sustainable and ensure a reliable food supply for future generations.

### Fueling innovations

Donations to the Foundation also fund strategic initiatives that drive progress in ag and bio engineering. From modernization of agrifood systems to advancing circular bioeconomies, the strategic initiatives supported by the Foundation have a profound impact. Your donation helps provide the resources necessary for groundbreaking endeavors that push the boundaries of what is possible.

### The ripple effect

Your support of the Foundation is a commitment to the future of our profession. By investing in the Foundation, you are helping to cultivate a new generation of engineers who will take on the global challenges with creativity, passion, and determination.

In addition, every dollar donated to the ASABE Foundation has a ripple effect beyond our profession. You're not just funding a scholarship or a strategic initiative—you're fostering a culture of innovation that benefits society as a whole.

### Double your impact

This year, ASABE's past presidents are leading by example in contributing to the ASABE Foundation. From September to November 2024, 32 past presidents have contributed more than \$25,000 to the foundation to boost our matching capability this year. Please thank a past Society president for their past service to the Society and their continued support of the Foundation the next time you see them. The combination of their service and financial support to ASABE is a testament of support for our members growth.

With the \$25K from the Past President and another \$50K from the Foundation General fund, this year we have an increased capability to match more contributions. Every dollar you donate to the Foundation before the end of 2024, up to \$75,000, will be matched \$1 for \$1 as a result of this year's Past President's Challenge. Generate twice the impact of your investment with one donation! I encourage you to visit our online giving page ([www.asabe.org/Get-Involved/ASABE-Foundation/Support-the-Foundation](http://www.asabe.org/Get-Involved/ASABE-Foundation/Support-the-Foundation)) and make your gift today. Together, we can engineer a better tomorrow!

**ASABE Foundation President Maury Salz**, Honey Creek, Iowa, USA, [salzmaury@hotmail.com](mailto:salzmaury@hotmail.com).

The graphic features the ASABE Foundation logo at the top left, which includes a globe icon and the text "ASABE Foundation American Society of Agricultural and Biological Engineers". Below the logo, the text reads "Double Your Impact: Past Presidents Challenge 2024". Underneath, it states "Every dollar donated between now and December 31, 2024 will be matched - dollar for dollar!". A QR code is positioned on the left side of the lower half. To the right of the QR code is a circular collage of four images showing diverse groups of people, likely students and engineers, engaged in various activities. At the bottom, the slogan "Let's engineer a better tomorrow together." is displayed in a stylized font.



## Meet the Fellows

# Honoring the Newly Elected



The 2024 class of ASABE Fellows.

**A**SABE recognized 11 new Fellows at the 2024 Annual International Meeting in Anaheim, California. In this issue of *Resource*, we highlight two of these fellows. Throughout the next few issues we will highlight the others.

Fellows must have a minimum of 20 years of active practice in, or related to, the profession of engineering, the teaching of engineering, or the teaching of an engineering-related curriculum. The designation Fellow has honorary status, to which members may be elected but may not apply.

As the ASABE Constitution states, Fellows are “of unusual professional distinction, with outstanding and extraordinary qualifications and experience in, or related to, the field of agricultural, food, or biological engineering.” Election to Fellow is one of the highest distinctions an ASABE member can achieve.



**Evangelyn C. Alocilja**, Professor, Michigan State University, is honored for her pioneering work in nano-biosensors for agriculture and food systems, global engagement on affordable diagnostics for sustainable health, and biosystems engineering education.

Alocilja is a professor in the Department of Biosystems and Agricultural Engineering at Michigan

State University (MSU). She contributes to the department through her teaching, research, and other service. Her research and patent accomplishments at MSU are prolific. Alocilja has mentored undergraduate and graduate students, post-doctoral and visiting scholars, and has been successful in entrepreneurship endeavors. Her record of securing competitive grants for her program has contributed to on-site biosensing applications in various scenarios, from food safety to the environment and human health.

Throughout her career, Alocilja has focused on bringing nanotechnology-enabled biosensors into agriculture and food systems, and to the intersection of health, agriculture, food, and the environment. Her contributions to global research and outreach led her to establish the Global Alliance for Rapid Diagnostics (GARD), which comprises GARD Research, the GARD Academy, the GARD Innovation Challenge, and the GARD Forum, with worldwide membership. Alocilja also leads faculty in developing the MSU biosystems engineering program and in forming the biomedical engineering concentration. She led development of an entrepreneurial engineering course that is now part of the university-level entrepreneurship and innovation minor for any undergraduate program at MSU.



**Daniël Berckmans, P.E.**, Full Professor Emeritus at KU Leuven, Adjunct Distinguished Professor at the University of Tennessee, and Chief Technology Officer for BioRICS, is honored for his exceptional contributions in establishing and advancing the field of precision livestock farming.

As full professor emeritus at KU Leuven, Berckmans works on publishing, promoting PhDs, and co-promoting theses for bioscience engineering. Berckmans also hosts seminars and gives presentations to support the M3-BIORES team in the biosystems department. As adjunct distinguished professor in the Department of Biosystems Engineering and Soil Science at the University of Tennessee, Berckmans mentors the UT team for precision livestock farming. As a founder, board member, and CTO of BioRICS, his responsibilities include coordinating development as well as testing and implementation of real-time algorithms for monitoring humans and animals.

Berckmans is considered the worldwide academic leader in precision livestock farming, which involves improving animal health and welfare by real-time monitoring of animals through images, sounds, sensors and biological, physiological, and environmental measurements. In his previous academic capacity as professor at KU Leuven, he headed the M3-BIORES division with a team of 25 to 30 PhD students and up to 20 MS students. In 2015, he was a driving force in starting a new MS program in human health engineering. This program is the first European MS program focusing on real-time monitoring of human health conditions. Berckmans has promoted over 250 MS theses, assumed the role of promoter of 26 PhDs, and was member of over 64 PhD commissions in nine countries.

# ASABE Journals

Recent research from our publications

*ASABE has been a trusted source of authoritative research for well over a century. Our peer-reviewed journals contain pioneering research in ag and bio engineering. Here are some highlights from our most recently published journals. All journal articles are available free of charge as a member benefit at [elibrary.asabe.org/toc.asp](http://elibrary.asabe.org/toc.asp).*



## Applied Engineering in Agriculture

Vol. 40(5): 537-551  
[doi.org/10.13031/aea.16104](https://doi.org/10.13031/aea.16104)

### Comparison of Infrared Thermometry and Soil Water Derived Stress Indices and Crop ET in Cotton

ASABE member Robert C. Schwartz, ASABE member Paul D. Colaizzi, Alfonso Domínguez, R. Louis Baumhardt, Mauricio Ulloa

#### Highlights

- A crop water stress index (CWSI) was calculated using a theoretical approach.
- Averaged daily rather than one to two hour daily maximum CWSI correlated better with soil-based crop water stress.
- Crop ET scaled with the CWSI accurately predicted ET for a dissimilar canopy and irrigation level.
- Sub-hourly canopy resistance and transpiration were inferred from canopy temperature measurements.



## Journal of the ASABE

Vol. 67(6): 1447-1458  
[doi.org/10.13031/ja.16018](https://doi.org/10.13031/ja.16018)

### Epoxy Coating of Biofiber: An Effective Modifier of Biofiber Physical and Flow Properties for Improved Tensile Behavior of Biofiber-Reinforced Biocomposite

ASABE member Oluwafemi A. Oyedeji, ASABE member Xianhui Zhao, Jenesis

Cochrane, Hannah Snider, Hannah Ruth Brown, Tomas Grejtak, Jun Qu, C. Luke Williams, ASABE Fellow Erin Webb

#### Highlights

- Loblolly pine and corn stover fiber were successfully surface-treated with epoxy.
- Surface-treated fibers produced biocomposites with improved tensile properties.
- Surface treatment process results in a more evenly dispersed fiber bulk structure.
- Tensile strength and Young's modulus of the biocomposite reached 58 MPa and 5 GPa, respectively.



## Journal of Natural Resources and Agricultural Ecosystems

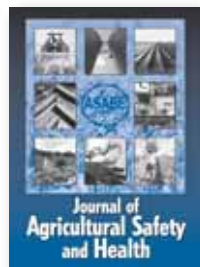
Vol. 2(4): 153-165  
[doi.org/10.13031/jnrae.15973](https://doi.org/10.13031/jnrae.15973)

### Water Quality Sampling Provides Insight into Nutrient Sources and Pathways in an Agricultural Watershed in the Midwestern USA

Noah Rudko, Sara K. W. McMillan, ASABE Fellow Jane Frankenberger, Danielle Winter Lay, Amanda Limiac

#### Highlights

- Hysteresis and flushing indices were calculated for 23 storm events.
- Wetter conditions led to a dilution effect for nitrate during storm events.
- Travel times were faster for all nutrients during the winter, likely due to lack of vegetative cover.
- Results can be used to choose practices that effectively target specific nutrient sources and pathways.



## Journal of Agricultural Safety and Health

Vol. 30(4): 163-180  
[doi.org/10.13031/jash.15915](https://doi.org/10.13031/jash.15915)

### Factors Influencing Worker Safety in Grain Handling: An Advisory Panel Perspective

Elzerie Derry, ASABE member Gretchen A. Mosher, ASABE member Kingsly Ambrose

#### Highlights

- Findings confirmed that out-of-condition grain is a primary causal factor in grain entrapment and engulfment.
- The advisory panel confirmed that grain quality has implications for grain dust explosions.
- Findings highlighted a lack of in-depth knowledge expected from an expert panel, specifically on aspects of protective grain quality traits.



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# Agrivoltaics: The Next Chapter in Rural Electrification

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Scott Cedarquist

**H**istorically, ASABE members were very involved in the rural electrification of U.S. farms and ranches. After I joined the ASABE staff in 2001, I got to know several members who started their careers working for a utility in that capacity. Today, huge opportunities exist for ASABE members to get involved in the production of on-site photovoltaic electricity.

Last July, I attended the Solar Farm Summit in Rosemont, Illinois. This was the second year for the event. Nearly 400 organizations were represented, and the enthusiasm of the more than 800 attendees was palpable.

From a University of Illinois researcher, I learned that more than five million acres of solar panels are expected to be built in the Midwest in the coming years. At a presentation by the American Farmland Trust, I learned that more than ten million acres of solar panels are expected nationwide.

These solar farms will produce electricity, but they will also need vegetation management. That can be done with groundcovers, mowing, and herbicides, or by crop production or livestock grazing. Agricultural production along with solar power is called agrivoltaics, and that topic was the focus of the 2024 Solar Farm Summit. The amount of land being converted will create significant opportunities to grow food while producing power.

One of the most common methods of agrivoltaics is controlled grazing of sheep under and around the solar panels. Sheep are docile and less likely to damage the panels than other animals, such as goats, cattle, and bison. I'm not a big consumer of lamb or mutton, and I expect domestic demand for this protein source to be limited. However, the U.S. currently imports a significant portion of the lamb and mutton that we consume. Those imports could be replaced, or enhanced, with a larger domestic supply.

There is also a huge interest in grazing cattle under and around the solar panels, but agrivoltaic systems must be designed for these large animals, which would involve a greater upfront cost. The most obvious cost would be the installation of taller supports for the panels. Working on the higher panels would then require ladders or elevated platforms, which also means additional cost.

Today, huge opportunities exist for ASABE members to get involved in the production of on-site photovoltaic electricity.

Many traditional crops can be produced under or between solar panels. The Solar Farm Summit had presentations on fruits and vegetables, as well as row crops and hay. For some crops, the shade provided by the panels is beneficial and reduces moisture loss. Solar panels are usually designed to track the sun—facing east in the morning, pivoting during the day, and finally facing west at the end of the day. To allow access and accommodate farm operations, this autotracking can be manually overridden. And as with cattle grazing, higher panels can accommodate larger equipment.

A great example of agrivoltaics is underway in Ohio. The Oak Run Solar Project is projected to produce up to 800 MW of electricity and plans to farm at least 2,000 acres on the project site by incorporating dual-use solar practices. This project is beyond the aspirations of any other dual-use site that I have seen.

As I learn more about agrivoltaics, I see more and more places where the expertise of ASABE members can be a benefit. Starting with the selection and preparation of the solar farm site, preserving the existing topsoil and drainage is paramount. A common issue is that the installation contractor wants to “level” the site and move topsoil to lower areas. In addition, installation of the steel supports can damage existing drainage tiles.

Where livestock will be introduced, the height of the panels, the strength of the supports, and protection of the wiring and other components must be considered. Where farm equipment will be used, adequate access and turning areas need to be included. Where supplemental irrigation may be needed, planning ahead for water needs and equipment access can pay long-term dividends. For all of these examples, as well as many others, ASABE members have the necessary knowledge and skills.

To learn more about agrivoltaics, an ASABE Engage site has been created for communication and updates. This is a self-join committee, so interested individuals must sign up. To join the agrivoltaics discussion group on the Engage platform, you must also be registered to the ASABE database. Contact an ASABE staff member if you do not have this access.

Once you have the appropriate access, you should be able to sign into Engage. At the top, pull down the listing of committees and communities. You will see those that you are currently on and those that you may join on your own. Select the “join” button near agrivoltaics, and select to receive emails in real time. It usually takes a few hours for the system to update, and you should then have access to prior discussions and the ability to start your own interactions.

Another group interested in agrivoltaics is ASABE Technical Committee ES-210: Renewable Power Generation. This committee has a long-standing interest in solar energy. At the 2024 AIM, it decided to initiate a standards project for agrivoltaic terminology. Furthermore, ASABE has been holding periodic conference calls with the Solar Energy Industries Association (SEIA) regarding the need for agrivoltaic standards, and SEIA is very interested in working with us on this project. Look for updates on these and other agrivoltaic topics in the near future.

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*Accompanying photo:* Agrivoltaics using single-axis tracking arrays with double rows of solar panels surrounded by a soybean crop (photo courtesy of **ASABE member A.J. Both**, Rutgers University, North Brunswick N.J.).

### Further reading

AFT. (2023). Press release on smart solar recommendations. Washington, DC: American Farmland Trust. Retrieved from <https://farmland.org/aft-releases-smart-solar-recommendations-to-help-policy-makers-advance-solar-and-strengthen-farm-viability/>

Oak Run. (2024). Project website. Madison County, OH: Oak Run Solar Project. Retrieved from <https://www.oakrun-solarproject.com>

Solar Farm Summit. (2024). Highlights from SFS24 on July 8-10, 2024. Washington, DC: American Farmland Trust. Retrieved from <https://solarfarmsummit.com>

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