July/August 2021

RESOURCE

engineering and technology for a sustainable world

August 10, 2020: Derecho hits Iowa

The importance of engineers in agricultural structure design

PUBLISHED BY AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS

Getting Involved in an Unusual Year

As I'm writing this, I'm also preparing to host my second "Member Hour" tomorrow, an opportunity from the Membership Development Council for members to get involved and meet each other outside of the usual format. This is an example of how the seed sown by Past-President Steve Searcy's focus on member value has grown. Hopefully, you've had a chance to #getinvolved and catch one of these events and gain some value for yourself.

This past year, I challenged members to #getinvolved. In light of the pandemic, the timing of that message felt a bit off leading up to the 2020 Annual International Meeting. As you remember, we were scrambling to pivot to a virtual format while many other organizations were cancelling events left and right. My mind was spinning, and I debated if I should pivot my message as well. I concluded that, in these uncertain times, engagement in a professional society and developing a professional network are more important than ever.

Just as our founders came together more than a hundred years ago, we continue to come together in committees, councils, and technical communities to champion our Society and our profession. I look forward to catching up with many of you at #ASABE21 this July. Check out the latest program details at www.asabe.org/events. There will be great technical content, numerous social and networking opportunities, and many committee meetings. This year, we are also excited to allow undergraduate student members to register and attend free of charge, removing a big hurdle to their getting involved.

As the 2021 AIM approaches, consider getting involved in a committee outside the technical area that you tend to affiliate with by diversifying into Information Technology, Sensors, and Control Systems (ITSC) or Applied Science and Engineering (ASE), or by participating in an Executive committee. Most of these E-committees are open to all members, and they cater to a wide range of interests, such as K-12 outreach, issues management and social action, and global engagement. There are also many opportunities to support awards and student competitions through the M-committees and P-committees, respectively. To learn more about the options available, check out the full range of committees on the ASABE website and in the ASABE Member Roster.

As I have said in every article and every speech, this year wasn't what any of us expected, but we found opportunities for growth in each challenge that we overcame. Thank you again for the chance to lead our Society. I've grown through the experience, and I now have a better understanding of what really matters. I hope that you feel the same way, and that this past year has inspired you to get involved.

Candi
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events calendar

ASABE CONFERENCES AND INTERNATIONAL MEETINGS
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2021

July 12-16 **ASABE Annual International Meeting.** Virtual.

Dec. 6-10 **6th Decennial National Irrigation Symposium.** San Diego, Calif., USA.

2022

Jan. 9-14 **Soil Erosion Research under a Changing Climate.** Aguadilla, Puerto Rico.

Feb. 14-16 **Agricultural Equipment Technology Conference (AETC).** Louisville, Ky., USA.

May 16-19 **Sustainable Energy for Sustainable Future.** Escazu, San Jose, Costa Rica.

July 17-20 **ASABE Annual International Meeting.** Houston, Tex., USA.

2023

July 9-12 **ASABE Annual International Meeting.** Omaha, Neb., USA.

2024

July 28-31 **ASABE Annual International Meeting.** Anaheim, Calif., USA.

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ON THE COVER:
The straight line winds during the August 10, 2020, derecho in Iowa damaged many of the agricultural structures in its path.

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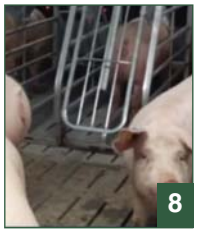
FEATURES

4 Derecho Emphasizes Engineers' Role in Agricultural Structure Design
Shawn Shouse, P.E., Meaghan Anderson, Candice Engler, Jay Harmon, P.E., Charles Sukup, P.E., Jerry Wille, P.E.

8 RFID Improves Production of Breeding Sows
Brian Strobel, P.E.



14 ASABE International 1/4-Scale Tractor Student Design Competition
The 24th annual event goes virtual
Amanda Corban

15 ASABE 2020-2021 Annual Report
A year of getting involved ... mostly virtually

19 Indigenizing ASABE: Why We Should, and How We Can
Qualla Jo Ketchum

23 The 2021 Davidson Prize Winners
LeafSpec from Purdue University and LeafSpec LLC
DRI-Stack System from Haber Technologies, Inc.
Fendt 9350 DynaFlex® Draper Header with AutoDock™

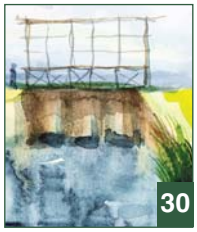
DEPARTMENTS

2 President's Message
Events Calendar

13 YPC News & Notes
A circular economy can offset carbon emissions

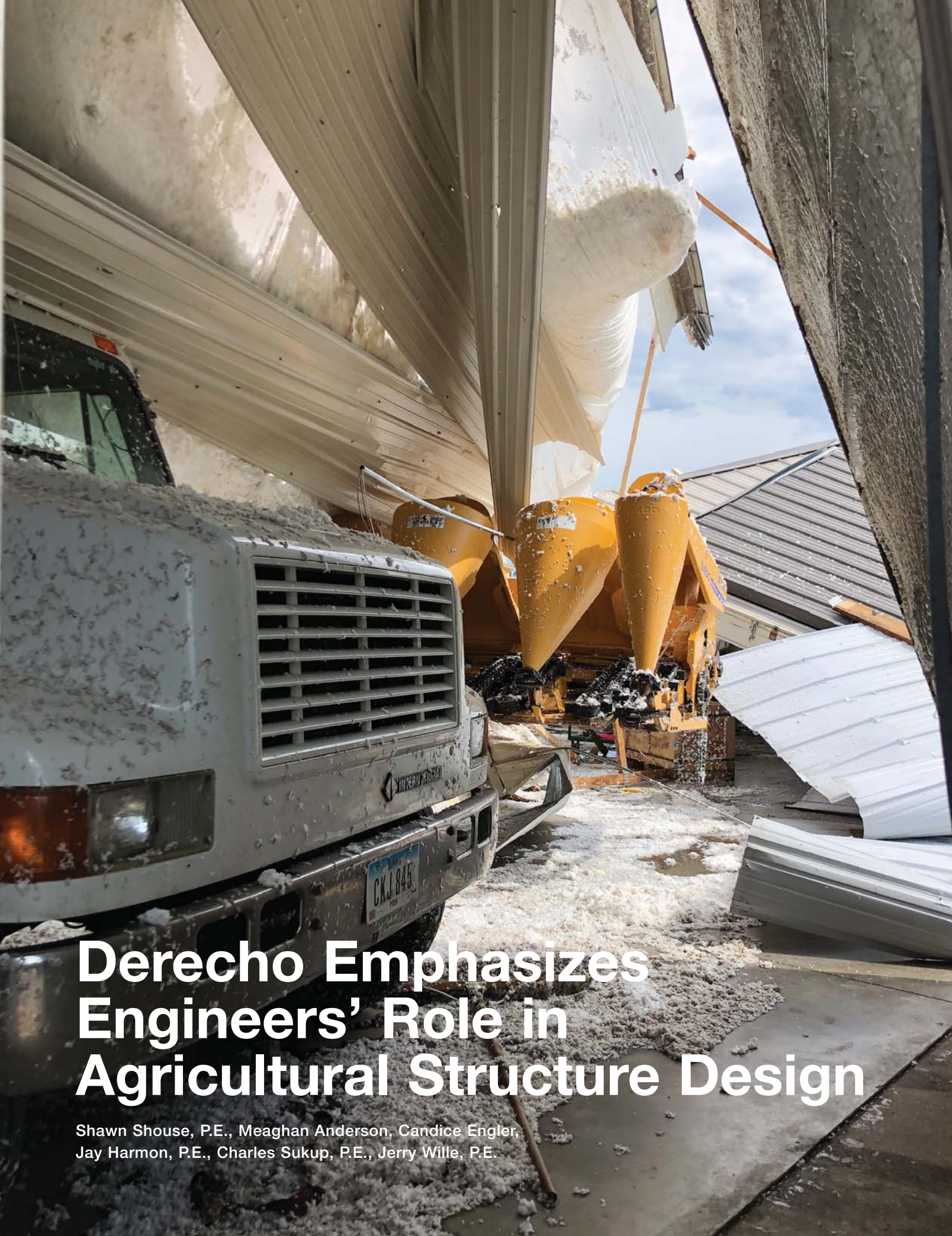
27 Meet the Fellows

28 ASABE Foundation Work in Focus
A student competition challenge is coming



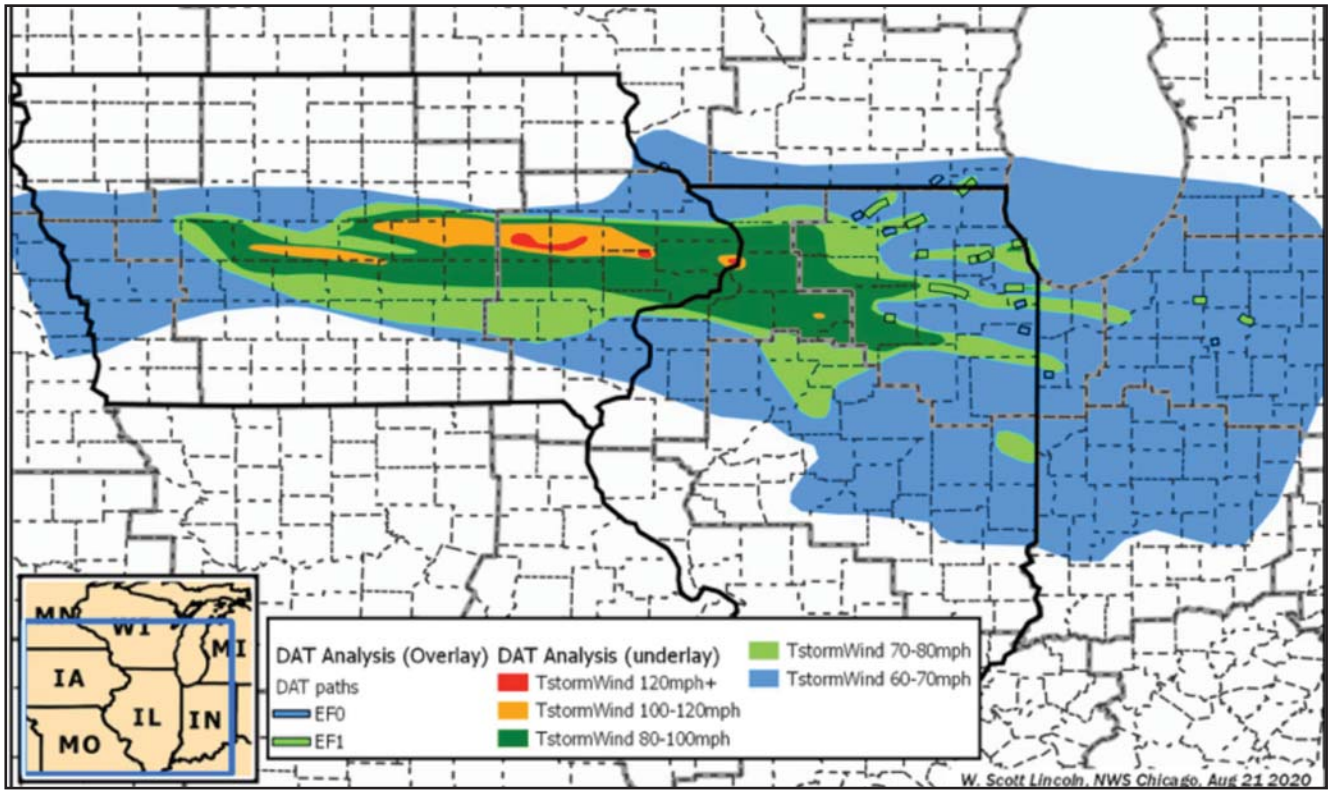
29 Professional Listings

30 Last Word
Dam! Why should you care?
Sherry Hunt



Derecho Emphasizes Engineers' Role in Agricultural Structure Design

Shawn Shouse, P.E., Meaghan Anderson, Candice Engler, Jay Harmon, P.E., Charles Sukup, P.E., Jerry Wille, P.E.



Wind speed analysis of the August 10 derecho from the National Weather Service.

Most Iowans will long remember August 10, 2020. The day started with significant optimism that a storm cell over eastern South Dakota and Nebraska would hold together and bring much-needed rain to western Iowa. In early August, nearly 80% of the state was rated as abnormally dry or in drought, and more than 20% of the state was in severe or extreme drought, centered in western Iowa. The storm not only held together but picked up speed and persisted for 14 hours before finally breaking apart over Ohio. It brought wind gusts of 80 to 120 miles per hour for much of central and east central Iowa, enough to flatten many of the agricultural structures in its path.

Prior to that storm, many Midwesterners were not familiar with the term "derecho" (pronounced duh-RAY-cho), which is very different from a tornado. Derecho comes from the Spanish word for "straight" and is also referred to as straight-line wind. The term was first used in 1888 by a professor at the University of Iowa and refers to a thunderstorm complex that produces a damaging wind swath at least 250 miles (400 km) long with wind gusts exceeding 60 mph (90 kph). The August 10 derecho that swept across the Midwest brought intense winds that wreaked havoc on trees, crops, power lines, and structures. One major insurance company stated that the August 10 derecho was the most expensive wind-related loss that it had ever covered.

How structures failed

Farm buildings and grain storage structures were particularly vulnerable to the intense winds. The large surfaces of agricultural buildings are often unsheltered, and high winds cause tremendous uplift on roof surfaces, especially at the edges and peak. The roof fasteners intended to resist this uplift pulled through the roof sheathing, which then blew away, leaving the buildings with no diaphragm strength. Tall sidewall columns failed, shifting greater stresses to neighboring members, causing further failure.

Meanwhile, the walls of empty grain bins began to deflect inward, presenting a flatter surface to the wind and capturing more wind pressure. This pressure increased the stresses on the connections between the bin walls and roofs, and particularly on the anchor bolts that secured the bins to their concrete foundations. The most severe failures occurred when these anchor bolts failed or were pulled out of the foundation.

These failures were varied and complex and, without forensic investigation, it is difficult to know exactly what occurred in every case. During the August 10 derecho, the wind forces in some areas may have exceeded the design standards for the structures. The design wind speeds (per ASCE 7-10), which are based on 3 second gusts, are 105 mph for risk category I structures and 115 mph for risk category II structures in most of the derecho area. Even where the design wind speeds were not exceeded, the resulting damage often indicated weaknesses in the design or construction. These vulnerabilities illustrate the importance of appropriate design standards, especially in locations where code enforcement is lacking.

> “Engineers design structures that are safe and functional. Unfortunately, many buildings are constructed that have not been properly designed.”

As engineers, we grieve with the victims of the derecho and their struggle to rebuild what was lost. We also vow to learn from this event and improve our design standards for agricultural structures.

The value of engineering

Agricultural engineers help to develop standards, such as the ASABE standards, for the design, construction, and inspection of farm structures. Commercial manufacturers of steel buildings and grain bins follow these standards. We also work with suppliers, manufacturers, construction managers, and risk management professionals to determine improvements to materials and methods, and to revise the standards to reflect these improvements.

Engineers design structures that are safe and functional. Unfortunately, many buildings are constructed that have not been properly designed. Too many structures are built with typical construction practices, rather than an engineering design specific to the site and the intended function, and few rural areas have code enforcement authorities.

The proper design of agricultural structures is often overlooked because the safety risk is considered low, or because the budget for the project is limited. However, many agricultural structures can cost well over $1M, and in addi-

Building damage from the August 10 derecho.

Grain bin damage from the August 10 derecho.

tion to sheltering workers, they can contain equipment that costs far more than the building. These inconsistencies among structures, not knowing if a building was properly designed or to what standard it may have been designed, make it difficult for farmers to evaluate their buildings and compare bids for new projects.

Engineering ensures consistency. Engineers assess the environmental conditions and develop designs with appropriate safety margins. Structural loads are determined based on probable occurrences of snow, wind, earthquake, and other loads. This analysis determines the load conditions for the building site. The structure is then designed to transfer all the loads and forces to the foundation through a continuous path. This structural integrity is a critical element of engineering design. Engineers may also perform inspections during construction to ensure that the project is adhering to the design.

Most of all, engineering can prevent catastrophic failure. No design can be guaranteed not to fail, but engineering minimizes the risk of failure and is always a good investment. As engineers, we protect the health and welfare of our clients as well as their property. Our professional standards allow farmers to modernize their operations while minimizing the impacts of natural disasters, such as the August 10 derecho. By designing sustainable farms, we support sustainable agriculture.

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RFID Improves Production of Breeding Sows

Brian Strobel, P.E.

Animal husbandry practices for breeding sows are similar to other livestock species in that producers target the animals' nutritional needs based on their genetics, visual body score, and production stage. Sows are most similar to dairy cows in their needs. For gilts and sows, producers want to have animals in ideal condition for breeding, throughout gestation, and then ready for ad-lib feeding in lactation. Overfeeding adds undue expense for the producer, while underfeeding affects important biological and reproductive functions.

Two production mantras that we often hear are: "He who has the data wins" and "I want to be better tomorrow than I was yesterday." Especially with today's higher labor costs, producers want technology that saves time and helps them make informed decisions. One of these technologies, radio frequency identification (RFID), is in various stages of implementation in the swine industry.

RFID can provide readily available data on each animal. In farrowing operations, this information can reduce feed costs and improve the number and size of piglets, thereby increasing farm income. As shown in figure 1, a passive RFID system consists of:

- A transponder, or RFID tag, on each animal that transmits digital data.
- A receiver, or RFID reader, that sends an interrogation signal to the RFID tag.
- A computer that hosts the software and transmits the collected data to the user.

Figure 1. Reading a passive RFID tag.

Feed is the most expensive input in animal production. Because of the need to optimize animal nutrition, automatic data collection has become popular. For sows, this data collection usually requires ear tags. A visual tag in the left ear and an RFID tag in the right ear ensure positive identification even if one of the tags gets lost or becomes unreadable.

Individual RFID tags

Each RFID tag contains a microchip with a unique serial number, as well as an antenna. Each RFID tag also contains unique data on its assigned sow. The RFID reader automatically identifies and tracks the RFID tags, allowing the producer to track each sow throughout the growth, gestation, and farrowing process. Current RFID systems collect data in real-time, or in blocks of data every 15 minutes for large data sets.

While RFID ear tags are used for swine and dairy herds, other wearable RFID devices include leg bands for poultry, and subcutaneous implants for household pets. Livestock RFID tags use a low-frequency band and are readable within 24 inches (60 cm) of the RFID reader. Figure 2 shows that low-frequency RFID tags operate at 125 to 134 kHz. These passive devices do not require a battery. RFID systems use other frequency bands for wireless tracking of commercial supply chains. This automatic tracking replaces time-consuming physical inventory counts. Factories, warehouses, and retailers use high frequency (HF) to ultra-high frequency (UHF) bands to track products at higher speeds.

Two types of RFID tags are used on livestock farms. Federal ID tags are used for interstate commerce. These tags uniquely identify individual animals throughout the world. The first three digits of the tag number identify the country of origin. For the U.S., the first three digits are 840, while Canada is indicated by 124. These numbered tags can also be visual, non-RFID tags. In either case, federal ID tags display the words “unlawful to remove”.

The second type of RFID tags are production tags. These tags are unique to an individual farm, and producers can use whatever numbering system they prefer. Producers only need to ensure that the numbers they use are unique within their own herd. The first three numbers of these RFID tags indicate the tag manufacturer and have nothing to do with the state or country of origin.

The most important function of an RFID numbering system is its uniqueness. Other requirements for RFID tags are

Frequency Bands	Antenna	Data & Speed	Read Range	Usage
Low Frequency (LF) 125 kHz 134 kHz	**Induction Coil on Ferrite Core, or Flat ...**	**Low Read Speeds – Small Amount of Data ...**	**Short to Medium 3-5 feet**	**– Access Control – Animal Tagging – Inve ...**
High Frequency (HF) 13.56 MHz	Induction Coil Flat 3-9 Turns	Medium Read Speed Small to Medium Amount ...	Short 1-3 feet	– Smart Cards – Item or Case level Taggi ...
Very High Frequency (VHF) 433 MHz – Acti ...	Internal Custom Design	High Read Speed Large Amount of Data	High 1-1000 feet	– Asset Tracking – Locationing – Contain ...
Ultra High Frequency (UHF) 860 MHz – 960 ...	Single or Double Dipole	High Read Speed Small to Medium amount o ...	Medium 1-300 feet	– Pallet or Case Level Tagging – DOD & W ...

Figure 2. RFID frequencies used in industry (from https://rfid4u.com/).

Figure 3. Functions of an RFID tag (from Dyche, 2017).

shown in figure 3. The RFID tags must reliably interact with the RFID reader, and they must be removeable when the animal leaves the herd or is slaughtered.

Stationary RFID readers

The RFID reader sends out a signal that energizes the RFID tag. The RFID reader does not need to be within line-of-sight of the tag. However, the dielectric properties of nearby materials, such as metal, concrete, and water, can disrupt the signal transmission between the tag and the reader. The "sensitivity" is the readable distance of a tag. "Shadowing" occurs when a second tag is read at the same time.

The RFID readers in gestating sow pens should be located where the sows visit daily, such as the feeders or waterers. Multiple RFID readers can be installed in a pen and communicate with each other to track the sows at any location. For gestating sows, producers are usually interested in the duration of each visit to the feeder and the sow's activity at that location. Water dispensed and body weight can also be monitored.

Locating the RFID readers where the animals remain for several minutes, such as at the feeders in figure 4, allows reliable data collection. The goal is to collect data on each sow on each day. These data, along with other behaviors, are indicative of animal health and can help producers monitor and treat individual animals in the herd. Collecting and analyzing these daily records lead to improved herd management.

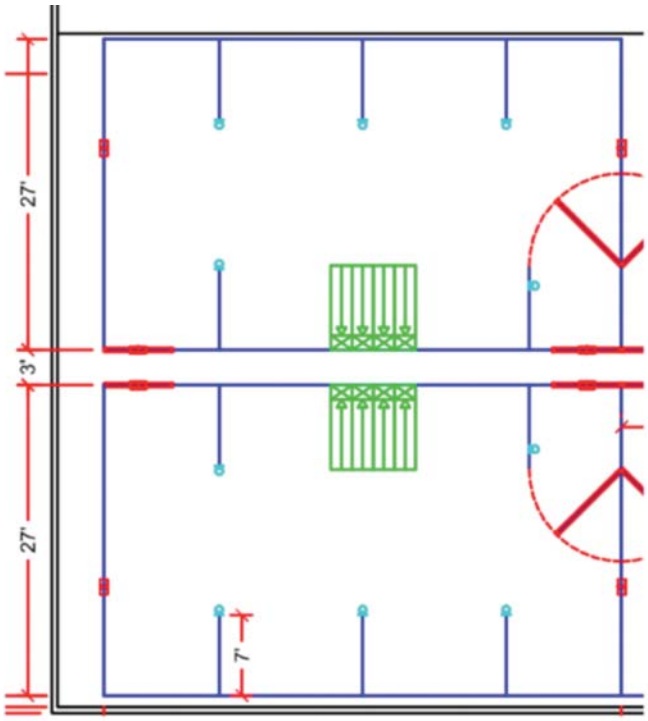

Figure 4. Gestation pen layout showing RFID readers at the feeders (green x's on the center aisle). Light blue circles are waterers (*courtesy of Jyga Technologies*).

Figure 5. An RFID reader above a sow's head during feeding. The sow's time at the feeder is logged by the reader.

Figure 5 shows a stationary RFID reader directly above a sow's head, at an angle that allows natural feeding behavior when the sow's head is in the feed trough. The white light in the center of the RFID reader indicates that the reader has identified the sow's RFID tag. In response, the automated system supplies that sow's feed allocation.

Feed allocations in gestation are typically much lower than the sows would voluntarily consume because producers try to optimize body condition. In addition, gilts tend to spend more time feeding than sows because they are learning the positive association of using the feeder despite the lower feed allocation. Gilts and naïve sows learn this positive association by entering the feeding station and getting fed. The RFID system can monitor this behavior for each animal.

Mobile RFID readers

Wireless handheld RFID readers can also be used to scan RFID tags at various locations within a pen. This means that visual ear tags aren't always needed to identify individual animals. Caked dirt or manure can obscure the digits on visual tags, but a handheld RFID reader can identify animals regardless of these conditions. As shown in figure 6, handheld readers are usually sensitive enough to read RFID tags from several feet away.

RFID data collection, using ether stationary or mobile readers, reduces labor costs. Wireless systems also simplify in-barn wiring requirements. Currently, RFID tags cost about $1.50 each. As shown in figure 7, passive tags don't require a battery, which reduces their weight and cost. While RFID tags can be reused on other animals, most are not, and the original animal's records need to be removed from the data set. The replacement rate is about 3% to 5%. Typically, gilts are tagged between days 180 and 220, just prior to first breeding.

Figure 6. A wireless handheld reader can read RFID tags similar to a stationary reader.

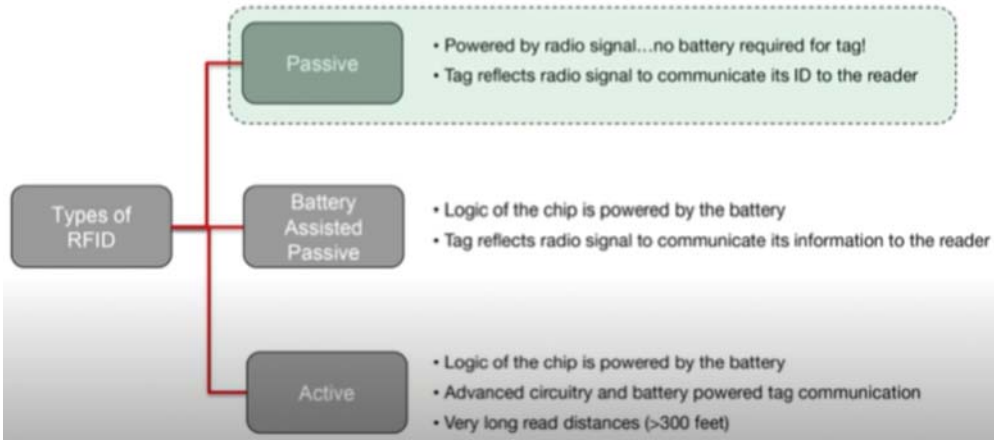

Figure 7. Types of RFID tags (from Dyche, 2017). Livestock RFID tags are passive types.

RFID readers for low-frequency RFID tags typically cost between $300 and $700 and are powered by a standard AC outlet. The lifespan of an RFID reader may be five years or more. Protecting the power cord from damage is key to extending the useful life.

The future of RFID in animal production

Could subcutaneous implants become available for farm animals, as in the pet industry? Because RFID tags eventually need to be removed from farm animals, such as at the cull plant before the carcass is processed, subcutaneous implants are unlikely.

The addition of GPS to an RFID system would enhance the system's ability to locate individual animals. However, GPS systems require a battery, which makes such devices heavy and expensive for widespread application. In contrast, the ability to track each animal's health status, such as body temperature, heart rate, and number of steps in a given period, will likely be added to RFID systems in the near future.

There is also interest in correlating RFID data with video data. Combining these two technologies would further support herd management. For example, if the RFID system recorded less feed consumption and the video system captured less movement for a particular animal or group of ani-

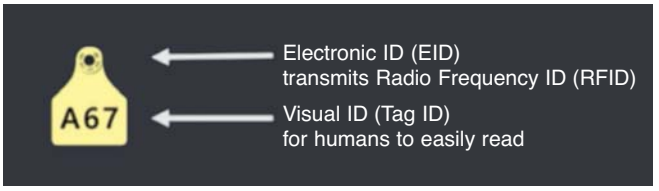

Figure 8. A combined RFID and visual ID tag.

mals, producers would be able to detect health problems earlier than is currently possible.

To eliminate the need for separate visual and RFID ear tags, the RFID microchip and the visual information could be combined on a single tag (fig. 8). In addition, smaller, lighter tags lead to increased tag retention.

RFID technology is a great example of precision agriculture in the livestock sector. With this technology, animal welfare, health monitoring, and informed decision-making will continue to improve.

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Further reading

Bach, M. P., Zoroja, J., & Loupis, M. (2016). RFID usage in European enterprises and its relation to competitiveness: Cluster analysis approach. *J. Eng. Bus. Mgmt.,* 8, online. https://doi.org/10.1177/1847979016685093

Brown-Brandl, T., Adrion, F., Maselyne, J., Kapun, A., Hessel, E., Saeys, W., Van Nuffel, A., & Gallmann, E. (2019). A review of passive radio frequency identification systems for animal monitoring in livestock facilities. *Appl. Eng. Agric., 35*(4), 579-591. https://doi.org/10.13031/aea.12928

Chenbo, S., & Rao, X. (2018). Behavior detection of pregnant sows based on deep learning. ASABE Paper No. 1800321. St. Joseph, MI: ASABE.

Doğan, H., Caglar, M., Yavuz, M., & Gözel, M. (2016). Use of radio frequency identification systems on animal monitoring. SDU Intl. *J. Tech. Sci., 8*(2), 38-53. https://www.researchgate.net/publication/308167938_Use_of_Radio_Frequency_Identification_Systems_on_Animal_Monitoring

Dyche, G. (2017). RFID basics. Glendale, CA: Avery-Dennison. Retrieved from george.dyche@averydennison.com.

Fairbairn, C. A. (2020). RFID tags for use in swine in Pennsylvania. University Park, PA: Penn State University Extension. https://extension.psu.edu/rfid-tags-for-use-in-swine-in-pa

Li, Y., Cui, S., Zhang, H., Johnston, L., & Baidoo, S. (2017). Determining the minimal floor space allowance for gestating sows kept in pens with electronic sow feeders. NPB #14-041. Des Moines, IA: National Pork Board. https://porkcheckoff.org/wp-content/uploads/2021/02/14-041-LI-UofMN.pdf

Manteuffel, C., Schon, P., & Manteuffel, G. (2011). Beyond electronic feeding: The implementation of call feeding for pregnant sows. *Computers and Electronics in Agric., 79*(1), 36-41. https://doi.org/10.1016/j.compag.2011.08.009

Maselyne, J., Adriaens, I., Huybrechts, T., De Ketelaere, B., Millet, S., Vangeyte, J., Van Nuffel, A., & Saeys, W. (2016). Measuring the drinking behavior of individual pigs housed in group using radio frequency identification (RFID). *Animal, 10*(9), 1557-1566. https://doi.org/10.1017/ S1751731115000774

Purdue. (2010). Pork industry handbook. West Lafayette, IN: Purdue University Press. http://www.thepress.purdue.edu/ titles/pork-industry-handbook

Thomas, L., Gonçalves, M., Vier, C., Goodband, R., Tokach, M., Dritz, S., Woodworth, J., & DeRouchey, J. (2018). Lessons learned from managing electronic sow feeders and collecting weights of gestating sows housed on a large commercial farm. *J. Swine Health Prod., 26*(5), 270-275. https://www.aasv.org/shap/issues/v26n5/v26n5p270.html

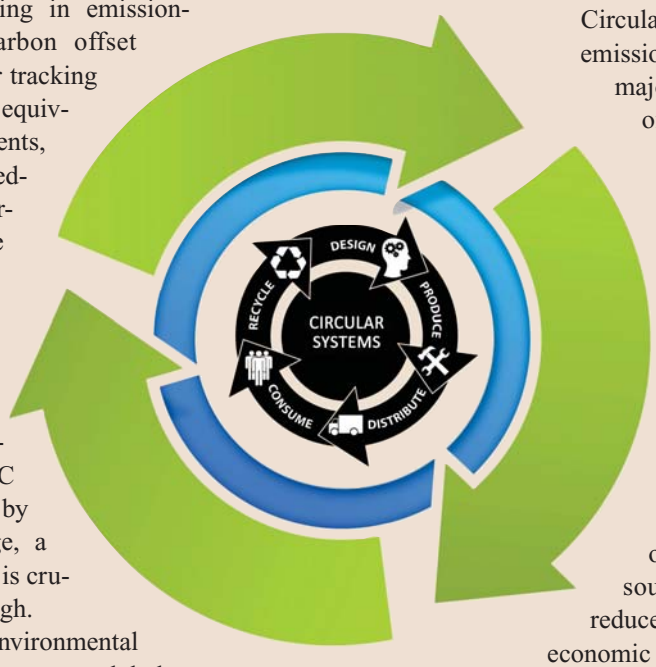
van Barneveld, F. J., Vandepeer, M. E., & Brooke, G. (2007). Manipulation of ad libitum feed intake in sows. *Manipulating Pig Production XI, Proceedings of the Twelfth Biennial Conference.* Perth, Australia: Australian Pig Science Association.

Vargovic, L., Hermesch, S., Athorn, R. Z., & Bunter, K. L. (2021). Feed intake and feeding behavior traits for gestating sows recorded using electronic sow feeders. *J. Animal Sci. 99*(1). https://doi.org/10.1093/jas/skaa395

A circular economy can offset carbon emissions

In the 1990s, growing concern about CO_2 and other greenhouse gas (GHG) emissions led to the start of the so-called carbon market, in which entities could receive credit for investing in emission-reduction strategies. The carbon offset became a quantifiable unit for tracking the reduction in CO_2 and CO_2 equivalents. Corporations, governments, and individuals use carbon credits to track and reduce their carbon footprint and become more carbon-neutral.

Now, in the 21st century, climate change is impacting us all, on a personal, national, and global scale. Despite our best efforts, the global temperature is predicted to rise 2.9°C above pre-industrial levels by 2100. To meet this challenge, a transition to renewable energy is crucial, but that alone is not enough.



In addition to its other environmental benefits, the circular economy model has emerged as an innovative approach to fighting the climate crisis. A circular economy minimizes waste and pollution through smart design, longer product life, and regeneration of natural systems. Because as much as 45% of total GHG emissions are generated by the design, manufacture, and use of products, circularity is key to building a climate-friendly economy.

As an alternative to our current, waste-oriented, linear production systems, circularity can further reduce carbon emissions while increasing production efficiency and improving yields. For example, the construction industry can eliminate up to 61% of the total emissions generated over a building's life by reducing material over-specification, adopting new cement and timber derivatives, optimizing space usage in the building, and recycling and reusing construction waste, such as steel and concrete.

A shining example of the circular economy approach to mitigating carbon emissions is the picturesque city of Turku, Finland. Turku is one of 449 cities that are part of the Race to Zero campaign, aiming to achieve net-zero carbon emissions by 2050. Their most prominent strategy involves a circular approach to major sectors of the economy: food, energy, water, transportation, and construction.

Specific initiatives include producing value-added chemicals from industrial waste streams, increased recycling of lithium-ion batteries for electric vehicles, and CO_2-negative, energy-positive wastewater management. Turku's circular economy is already paying dividends, as the local GHG emissions have dropped by 50% compared to 1990 levels. In fact, Turku is on track to reach carbon neutrality by 2029, way ahead of the 2050 target.

Circularity can also transform the carbon emissions of older industrial systems. A major impediment to global carbon offsets has been the increased industrialization in developing countries that rely on fossil fuels. A life-cycle analysis of 130 coal-powered industrial parks in China showed that circular models for comprehensive use of methane, mining waste, and wastewater treatment could reduce carbon emissions by 21% over 16 years. As developing countries gradually phase out coal and other carbon-intensive energy sources, circularity can ensure reduced GHG emissions while providing economic benefits.

Since the beginning of the industrial revolution, the U.S. has contributed nearly 25% of cumulative global CO_2 emissions. In July 2020, the Climate Action Tracker rated U.S. climate policies as "critically insufficient." If that was the Yelp review for a restaurant, no one would eat there. The transition to renewable energy is long overdue in the U.S.

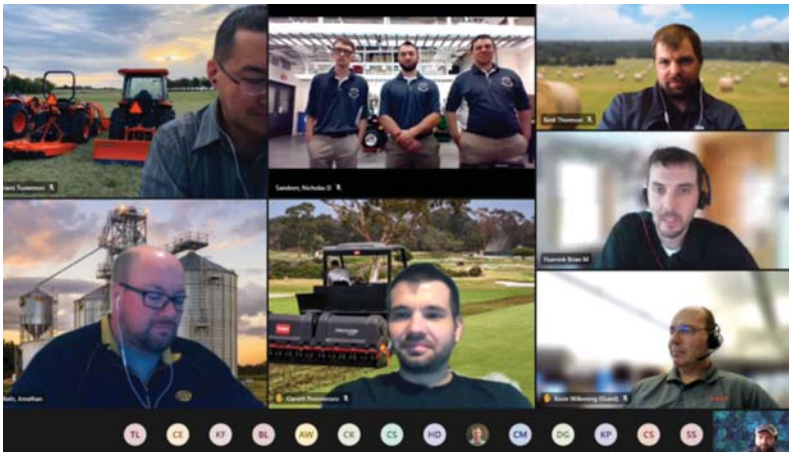
Ultimately, achieving carbon neutrality will require an all-encompassing transformation to sustainable, circular design, production, and use of our everyday consumables. A circular economy is our best chance for reducing our carbon footprint, achieving a carbon-neutral future, and surviving into the 22nd century.

ASABE Member and YPC Member at Large Ekramul Haque Ehite, University of Tennessee, Knoxville, eehite@vols.utk.edu.

ASABE International 1/4-Scale Tractor Student Design Competition

The 24th annual event goes virtual

Amanda Corban



Students from Iowa State University deliver their design presentations to a panel of industry professionals.

Like last year, this year has not been a normal year, but the planning committee for the ASABE International 1/4-Scale Tractor Student Design Competition knew that another year could not pass without hosting an event. Back in March 2020, planning for the 2020 event was just getting started when the IQS committee members were sent home to work, along with similar arrangements at the universities that had signed up to compete in 2020.

That was in the early days of the pandemic, and we thought we would still be able to host the competition in June. However, as 2020 progressed, we had to cancel the competition for the first time in its history. That was a tough decision because the competition is a great experience for the next generation of agricultural engineers.

We also knew that we would need to explore alternatives for the 2021 competition. With different COVID restrictions for the different university teams, we needed to offer an event without requiring travel to Peoria. In the fall of 2020, the committee polled the teams to determine which teams would be able to travel to an in-person event in May of 2021. All the teams were excited to compete, but many were unable to travel, or even meet to build their tractor, due to circumstances beyond their control.

So for 2021, we planned an event that could be presented on a virtual platform. We still wanted to give the teams an opportunity to compete in person, if their school allowed them able to travel. As in previous years, performance events were held in Peoria, and individual winners were determined, but those events did not impact the overall scoring. To allow all the teams to compete as equals, we decided to score only the events that could be completed virtually.

On May 24 and 25, the virtual 2021 competition was held, with 16 teams participating and approximately 50 industry professionals providing feedback from their homes across the country. The virtual competition consisted of design judging, team presentations, and written technical reports. A new event, called defense of design, was added to replace the sound event.

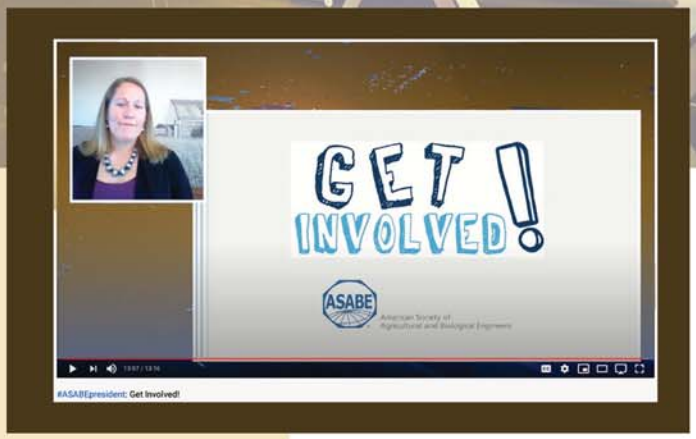
On the first day, the students shared their designs with the industry professionals in the areas of safety, manufacturability, serviceability, testing and development, and ergonomics. The defense of design event allowed the students to explain the reasoning behind their design. On the second day, the students delivered their design presentations, focusing on the target market and cost of their tractor.

The winner of the 2021 ASABE International 1/4-Scale Tractor Student Design Competition was the University of Manitoba, a team that had very limited access to their shop, which prevented them from working together as a team throughout the school year. The University of Nebraska and Iowa State University rounded out the top three.

All the teams did a fantastic job, and we are grateful to our judges, sponsors, and everyone who made this year's competition possible. The virtual event was a big success, and we will probably keep some virtual aspects in future competitions. Most of all, we're all looking forward to returning to Peoria in person and full force in 2022.

ASABE member Amanda Corban, Territory Customer Support Manager, John Deere, Colona, Illinois, CorbanAmandaM@JohnDeere.com.

A Year of Getting Involved . . . Mostly Virtually



If ever there were a year marked by extremes and uncertainty, my presidential year, 2020-2021, was that year. In retrospect, it seems that the only thing we were ever sure of was that we couldn't be sure of much at all.

My term as president of ASABE began at the first-ever virtual annual international meeting, necessitated by the COVID-19 pandemic that emerged at the end of 2019. At the time, we anticipated that it would be our *only*-ever virtual annual meeting. In hindsight this set the tone for the rest of the year: virtual section meetings, virtual student regional rallies, virtual committee and council meetings, and virtual conferences.

As the pandemic evolved, the Board of Trustees cautiously monitored our financial stability and were grateful for the forethought and wisdom of prior leaders in establishing a restricted reserve for the Society. By the time the fall Board meeting convened, we were pleased to learn that the Society had survived 2020 financially, thanks to a reduction in expenses and to income support provided by the federal Paycheck Protection Program. On the horizon, however, was a deficit budget for 2021, the result of continued uncertainty in membership and publishing and of multiple conferences being postponed or pivoting to virtual formats. Then, by January 2021 everything had changed once again, with the announcement of a second round of the Paycheck Protection Program and the fantastic recovery of our investment portfolios.

Despite the financial heaves, we maintained a steady focus on the work of the Society. An excellent metrics report prepared by staff illustrated progress on Society goals and allowed leadership to identify where to focus our efforts next.

We continue to be indebted to ASABE's excellent volunteer leaders and staff, who collaborated within the councils to execute major projects this year. Meeting organizers successfully pivoted the 2020 AIM to a virtual event within barely two months of the meeting and then transitioned the 2021 AETC to virtual, too. The Meetings Council continues to build on the planning process and improve the quality of meetings. The Membership Development Council is advancing efforts of the past two years to increase membership value. A revamped welcome packet for new members, an online registration portal for section meetings, and "Member Hour" virtual networking events will help strengthen the relationship between ASABE and our members around the world. The Publications Council released the freely available *Introduction to Biosystems Engineering* textbook, renamed *Transactions of the ASABE* to the *Journal of the ASABE,* and adopted a new page charge model.

A number of developments over the past year illustrate the global impact of the Society, as well as the imperative to recognize and support diversity among our members beyond their technical interest areas.

- Initiated by an enthusiastic cohort of ASABE members, BIPOC in ASABE was launched, extending a welcome to all interested ASABE members, carrying out social-media campaigns in observance of Black History and Women's History months, and planning sessions at the 2021 annual meeting.
- A new executive-level committee, E-03, will take on the work of addressing issues related to inclusion, diversity, equity, and access (IDEA).
- An exciting initiative, Transforming Food and Agriculture to Circular Systems, has the potential for global impact and is garnering strong support, both within ASABE and the ASABE Foundation and from external partners. A mini-symposium at the

2021 annual meeting is expected to advance the initiative and catalyze engagement among ASABE members.

- The Alliance for Modernizing African Agrifood Systems, within E-2050, aims to lead the Society in taking a holistic approach to accelerating improvements in the food value chain in Sub-Saharan Africa. The keynote address at AETC focused on this effort, and multiple sessions are planned for the 2021 annual meeting to maintain the momentum.
- A new committee within the Standards Council, STC-03, Canadian Standards Oversight, will provide leadership in coordinating alignment between US and Canadian standards.

With an energy on which they've earned their reputation, our Young Professionals Community led a number of online social and educational events, and their enthusiastic use of social media has magnified the reach and visibility of their work. Building on a successful October 2020 social media takeover that focused on standards, they held events on career development, mock interviews, and graduate student trivia, to name a few.

We're also seeing progress on student-focused efforts, such as the conversion of competitions and regional rallies to virtual formats, while the ASABE Foundation has provided financial support to dramatically increase per-student scholarship amounts.

My presidency has certainly been a fascinating one. It began with my urging to #GetInvolved in the Society. And while "getting involved" has mostly been limited to virtual activities, within that limitation has lain an immense opportunity to leverage evolving digital tools, lean more heavily on social media (using the #ASABEpresident thread), and reach members who ordinarily do not or cannot travel to our events.

Because of the virtual events, I ended up getting to "see" many more of our members than I would have in a traditional year, yet I missed having the chance to engage in person and to make closer, personal connections. I adapted, as we all did, and ASABE will be stronger for our having encountered the challenges.

Candice Engler
ASABE President 2020-2021

Membership

Filled equally with challenges and opportunities, the past year presented a unique outlook for ASABE and members alike. With direction from the Board of Trustees, we expanded options within membership profiles, allowing members to voluntarily self-identify in categories related to inclusion, diversity, equity and access. The aggregate demographic information will be used as a guide in accomplishing the Society's goal of cultivating a diverse, thriving, and engaged membership.

Over the past year ASABE members from more than 90 countries have built value and furthered the Society mission by helping advance the agricultural and biological engineering profession, network and engage with individuals in virtual settings, and learn from countless online, virtual, and hybrid events. Membership operations will continue to focus on creating new engagement opportunities and enhancing the value proposition.

2020-2021 at a Glance

- 48% of memberships are held by those in industry, 39% of members work in academia, and 13% are in a public service position
- 37% of all Society members belong to an ASABE membership community
- 30% of members serve on a technical committee
- 121 major-award applications were submitted
- 844 memberships are held by students

Meetings & Conferences

- The 2020 ASABE Annual International Meeting (AIM) was held virtually July 13-15, with the assistance of our meeting planner, HelmsBriscoe. There were over 1,400 registrants and more than 930 presentations.
- The 2021 Agricultural Equipment Technology Conference (AETC) was held virtually, February 8-11, with 238 attendees celebrating the 25th anniversary of AETC. The 2022 event will be held in Louisville, February 14-16.
- The 2021 ASABE Annual International Meeting is being held virtually July 12-16. There are 1,325 abstract submissions, including invited presentations.
- The 6th Decennial National Irrigation Symposium, originally scheduled for 2020, will be held in San Diego, December 6-10.
- The 2022 Soil Erosion Research under a Changing Climate Conference, originally planned for 2021 will be held in Puerto Rico, January 9-14.
- The 2022 Sustainable Energy for Sustainable Future Conference was rescheduled from 2021 and will be held in Costa Rica, May 16-19.
- The 2022 ASABE AIM will be held in Houston, July 17-20.

Standards

Our Standards program continues to thrive, thanks to the efforts of our dedicated committee members and with the longstanding support of our industry partners. The 2020 ASABE Standards CD includes 281 standards, with 47 standards projects in the queue. ASABE has now nationally adopted over 60 ISO standards as American National Standards. In the US, the right to nationally adopt ISO standards is granted to the organization that administers the US position for a specific ISO technical committee or subcommittee. ASABE recently was accredited by ANSI to coordinate our fifteenth distinct ISO committee, Technical Committee 326, which is focused on food machinery.

More than 1,500 members serve on our technical committees, many of them using virtual meeting tools to conduct business, which will allow standards work to progress even when travel to physical meetings is not possible.

Publications

Introduction to Biosystems Engineering is a new, open-access text targeted at first- and second-year university-level students and is available for download as individual chapters or as a whole. Authors are invited to propose a new chapter or contribute to updates. There are currently four new chapters in development. Another open-access textbook is expected to be completed this year, *Irrigation Systems Management*.

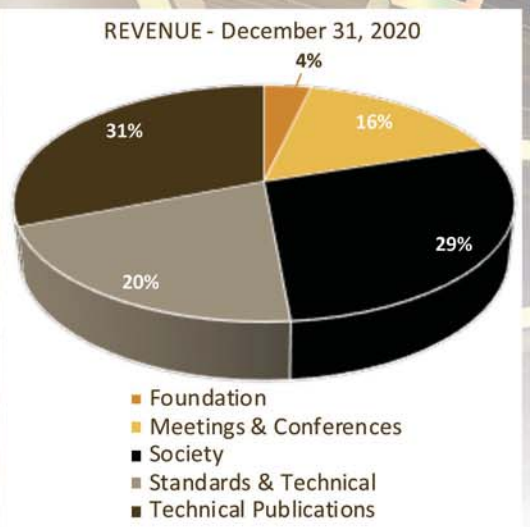
New teaching modules are being added to the technical library for "Case Studies and Modules for Data Science Instruction." Four of the modules are online in the technical library under "Textbooks and Teaching Materials." More are currently undergoing peer review.

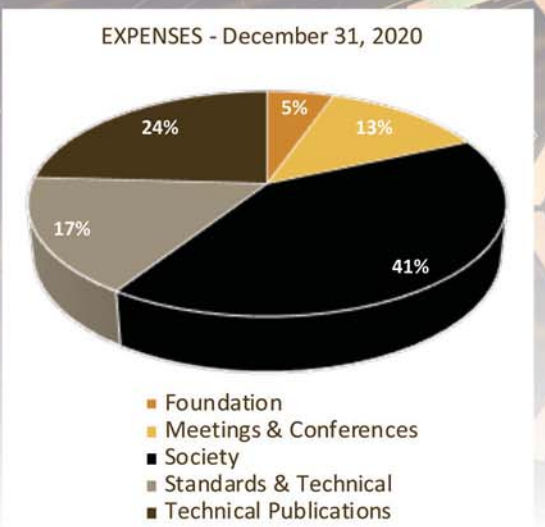
Beginning in 2022 our peer-reviewed journal *Transactions of the ASABE* will be renamed to *Journal of the ASABE*. The Journal Editorial Board considered a number of alternatives and made the selection with the goal of providing a clear reflection of the journal's peer-reviewed content. The new name eliminates any confusion created by the word "transactions," which some interpret as meaning conference proceedings. This change maintains the uniqueness of our Society's primary journal in publishing peer-reviewed engineering and scientific articles of importance to the broad field of agricultural and biological engineering.

The Journal Editorial Board is implementing a new pricing structure for article-processing charges. Under the new structure, members will receive the first three pages at no charge, pages four to seven are $100 each, and pages eight and over are $200 each. For non-members, only the first page has no charge. The *Journal of Agricultural Safety and Health* charges follow the same structure, but at half the per-page charge because of its smaller page size.

Our most recent impact factor for *Transactions of the ASABE* increased for the sixth year in a row to its highest ever, 1.156. The impact factor for *Applied Engineering in Agriculture* increased by 30%, to 0.973.

ASABE now has an archive for supplemental information to host additional files linked to journal articles. Submitting your files to our Figshare-hosted portal is easy. These files include spreadsheets, images, datasets, and many other types of data that support journal articles. Each dataset receives a unique DOI and a corresponding hyperlink.





STATEMENT OF FINANCIAL POSITION

December 31, 2020 and 2019

	2020	2019
Assets		
Cash	$ 2,048,866	$1,811,006
Accounts Receivable	32,395	16,205
Prepaid expenses	0	4,648
Book Inventory	67,702	75,036
Due from (to) inter-fund (special projects)	0	0
Due from (to) inter-fund (other)	(109,573)	(7,117)
Property & Equipment	233,077	254,134
At cost, less $1,231,686 accumulated depreciation in each year		
Total Assets	$2,272,467	$2,153,912
Liabilities and Fund Balance		
Accounts Payable & Accrued Expenses	554,151	470,596
Unearned Revenue: Dues & Sales	961,936	926,936
Fund Balance	756,380	756,380
Total Liabilities and Fund Balance	$2,272,467	$2,153,912
Restricted Reserve Balance	$2,638,940	$2,263,281
REVENUE	3,146,074	3,475,087
EXPENSES	3,036,501	3,467,970
SURPLUS	**$ 109,573**	**$ 7,117**

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Indigenizing ASABE: Why We Should, and How We Can

Qualla Jo Ketchum

One of the biggest pushbacks I've received during my work with Indigenous engineering students is that they are not a big enough population to make an impact. In the words of my father, known for his dry Cherokee humor and lack of couth, "that's like saying we shouldn't protect endangered species because there aren't enough of them." While I don't particularly like being compared to an endangered species, he makes an important point.

Just take a look at the numbers. According to the most recent ASEE Engineering by the Numbers factsheet, 422 (just 0.3%) of engineering bachelor's degrees were awarded to Native Americans in 2018. That same factsheet reported that only 1,787 Native Americans were enrolled in undergraduate engineering programs out of over 600,000 total undergraduates, 98 were in master's programs out of over 90,000 total, and 78 out of almost 80,000 were in doctoral programs. Outside of engineering degree programs, Native Americans make up 1.2% of the U.S. population, but only 0.3% of the engineering workforce and 0.1% of all engineering faculty.

I see ASABE and our field as holding a unique opportunity within engineering to better include the perspectives of those traditionally left out of engineering due to our orientation on systems. This understanding does not make us immune to how the structures and practices of engineering are grounded in the dominant White culture. Instead, this understanding puts us in a better position to connect with the more eco-centric, rather than anthropocentric, worldviews of BIPOC communities, particularly Indigenous populations. This understanding can ease the connections between community, culture, and engineering for Native American students. Many of the issues that plague tribal communities, such as energy, water, and food security, can be addressed through agricultural and biological engineering.

Indigenizing the BSE classroom: A personal example

To "indigenize" means to bring Indigenous ways of knowing, being, and doing into spaces where that perspective has historically been excluded. Indigenizing the academy is a recognized need in Canadian universities, particularly since the release of the Truth and Reconciliation Commission's final report in 2015. Canadian universities have made a conscious effort to bring Indigenous voices, worldviews, and cultures into their strategic plans, governance, academics, research, and recruitment. Universities in the U.S. have not seen the same systematic changes, but grassroots efforts at institutions such as Virginia Tech have made substantial progress in recent years.

During the Spring 2018 semester, I worked to indigenize my instruction of Virginia Tech's Introduction to Biological Systems Engineering (BSE) course. BSE students take this introductory course during their sophomore year. In design-

ing the course, one of my priorities was to establish a sense of community for the students, both in the department and in the BSE profession. I used Virginia Tech's Principles of Community as well as my own Cherokee community values to guide the classroom activities.

In 2005, Virginia Tech endorsed the Principles of Community to affirm the university's commitment to diversity and inclusion, and the Principles of Community are now required on all course syllabi. For example, one of the Principles of Community states: "We affirm the inherent dignity and value of every person and strive to maintain a climate for work and learning based on mutual respect and understanding."

The fundamental value of the Cherokee community is ga-du-gi, which translates as "people coming together as one and working to help one another."

To establish their importance, the Principles of Community were the first item on my syllabus, with my Cherokee community values right alongside. Three examples of my Cherokee community values, as manifested in the classroom, are discussed in the following sections.

> "To "indigenize" means to bring Indigenous ways of knowing, being, and doing into spaces where that perspective has historically been excluded."

ᎦᏚᎩ
(Ga-Du-Gi)

The most fundamental value is ga-du-gi, which translates as "people coming together as one and working to help one another." In an academic context, it means that the classroom is a learning environment in which all present can create and share knowledge as a community. In my Intro to BSE class, a great example of this value was when the students extended their co-created community beyond the classroom and formed a March Madness bracket for the class, completely independent of me. I'm proud to have inspired that, and I'm proud of the class for doing it.

I also demonstrated this value in my lectures. It was important for me to create a dialog with the students, instead of standing in front of them lecturing for long periods of time. In practice, this looks like breaking the lecture material into mini "lecturettes" and presenting these while sitting at the same height as the students whenever possible. This approach breaks down the divides between the instructor and the students and facilitates open discussion.

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(NuDaNtiYu DeTsaDaNvWiDiSGesSDi)

This second value translates as "encourage and instruct one another in a gentle and thoughtful way." In practice, this involves encouraging students toward their goals and instructing them in a way that values each student as a whole person. My pursuit of this value was confirmed by the students. In their course evaluations, 100% of the students either agreed or strongly agreed that an atmosphere of mutual respect was fostered in the classroom. This value also showed up in their written comments, with one student commenting that the instructor "explained everything really well, [was] passionate

about what she was teaching, and genuinely wanted us to understand. I really enjoyed this class."

ᏚᏳᎪᏛ ᎢᏗᏢ ᏕᏣᏓᏎᎮᏍᏕᏍᏗ (DuYuGTv iDiTlv DaTsaDaSeHeSDeSDi)

This third value translates as "direct one another in the right way, without confining or pushing." This is similar to the previous value, but it differs by focusing on being both resourceful and knowledgeable, as well as thoughtful and caring. In the course evaluations, 100% of the students either agreed or strongly agreed that my teaching was effective. The evaluations also included this comment, "Qualla was always easy to speak to and get feedback from, and overall created a comfortable classroom setting." This demonstrates the value of providing proper and useful feedback while maintaining a productive environment.

Overall, my Intro to BSE class was an amazing experience that demonstrated how all students can respond and thrive in an indigenized classroom. Indigenizing our classrooms, and our profession, can benefit everyone, regardless of cultural background. None of my students that semester identified themselves as coming from an Indigenous community, and every student passed the course, with a B+ average overall, including those who struggled in the class in previous semesters.

How can we indigenize our instruction?

My example of indigenizing a classroom was authentic to my cultural values, but many of my colleagues have asked me, "How do I, as a non-Indigenous person, achieve the same thing?" To answer that question, I've pulled together the following tips for how we can indigenize as individuals, as members of academic departments, and as a professional society.

Land acknowledgements

The simplest place to start is with land acknowledgements. These statements are often made at the beginning of public events, such as dedication ceremonies. They are also becoming prominent at professional conferences, on organizational websites, in physical spaces, on university course syllabi, and even in e-mail signatures.

A land acknowledgement is a way to recognize the history of colonialism that brought non-Indigenous people to this land. By recognizing this history, land acknowledgements can be transformative acts that work to undo Indigenous erasure and re-center Indigenous perspectives and the enduring relationships that exist between Indigenous people and their traditional territories.

Land acknowledgements are typically concise statements that simply acknowledge the people on whose territory (traditional and modern-day if applicable) the event is taking place. A good resource for finding this information is native-land.ca.

Indigenizing our classrooms, and our profession, can benefit everyone, regardless of cultural background.

Note that land acknowledgements are not written in the past tense. Colonialism is an ongoing process in which we all participate, and the Indigenous people who are acknowledged still hold connections to the land. As an example of a land acknowledgement created through collaboration with the Indigenous community, Virginia Tech's land acknowledgement states:

> *"We acknowledge the Tutelo/Monacan people, who are the traditional custodians of the land on which we work and live, and recognize their continuing connection to the land, water, and air that Virginia Tech consumes. We pay respect to the Tutelo/ Monacan nations, and to their elders past, present, and emerging."*

This is a call for ASABE to include a land acknowledgement at the Annual International Meeting each year, as well as for universities and departments at events. As individuals, we can add these statements to our course syllabi, e-mail signatures, and personal websites.

Support Indigenous communities on campus

Land acknowledgements are an important but small step in indigenizing, and they should be followed by larger actions. Find out if your campus has an Indigenous student center, student organization, faculty caucus, or community of any kind. Many of these groups hold regular events geared toward educating other populations. Attend their events, educate yourself on the issues, listen, and build relationships. These campus communities tend to be small in numbers, and they gladly welcome allies and advocates. Building relationships is imperative when working with Indigenous communities, and campus organizations are a good starting place.

Research local tribal communities

There are 573 sovereign tribal nations within the borders of the U.S., so research the Indigenous communities and nations within your area or state. Many BSE departments are housed at land-grant institutions, where Indigenous groups should be part of the mission. While the history of land-grant institutions has been dubious with regard to Indigenous populations, the land-grant mission of making higher education accessible to all cannot be fulfilled if Indigenous communities are neglected. As universities work to create global partnerships, remember that sovereign nations don't have to be on the other side of the world. International collaborations can occur within state boundaries as well.

Bring Indigenous voices into the classroom

Representation is an important factor in broadening participation. We can increase representation by bringing diverse voices into the classroom. A simple way is by starting classes with quotations from important people in engineering who come from diverse backgrounds. Highlighting both the historical and contemporary contributions of Indigenous engineers is an easy way to increase representation. For example, Mary G. Ross, the first Native American woman engineer, was a founding member of Lockheed's top-secret "Skunk Works" in 1954. She worked on defense systems and space exploration, and much of her work is still classified.

Another way to bring diverse voices into the classroom is through the required readings. Assigned readings subtly inform students about what is important. If only one perspective is presented, then only that perspective is seen as valuable.

ASABE member Qualla Jo Ketchum is a part of the BIPOC community within ASABE and is a citizen of the Cherokee Nation.

Conclusion

The goal of this article was to present my personal perspective as an Indigenous ASABE member and demonstrate some of the opportunities that we have to raise awareness of Indigenous perspectives within our profession. Indigenizing ASABE has potential to encourage Indigenous participation in our profession, and greater diversity benefits everyone. I'm excited about the development of the BIPOC community within ASABE, and I'm proud to be part of it. I hope this article can move that effort forward, so we can all improve, as a professional society, as engineers and educators, and as people who must share the Earth.

ASABE member Qualla Jo Ketchum, Doctoral Student, Department of Engineering Education, Virginia Tech, Blacksburg, qualla@vt.edu. This article is inspired by her presentation at the 2019 ASABE International Meeting entitled "Indigenizing the BSE Classroom."

The 2021 Davidson Prize Winners

Since 2018, ASABE has partnered with the Association of Equipment Manufacturers (AEM) to award the Davidson Prize, recognizing outstanding innovations in agricultural, food, and biological systems engineering. The prize-winning products represent the diversity of our profession, as well as the variety of companies that bring advanced technology to the agriculture industry.

Named for Jay Brownlee Davidson (1880-1957), the father of modern agricultural engineering and the founding president of ASABE (then known as ASAE), the Davidson Prize pays homage to engineers, like Davidson, who aspire to find a better way.

"ASABE and AEM came together to bring additional recognition to those who embody the spirit of J. B. Davidson," said Darrin Drollinger, executive director of ASABE, "Professor Davidson would be amazed to see how advanced farm equipment has become!"

To be eligible for the Davidson Prize, a product must first have received an AE50 Award. A panel of industry experts then examines the highest-scoring AE50 Award winners. The submission material used for the AE50 Awards is the basis for selecting the Davidson Prize winners.

The judges select up to three products that they consider the most innovative and most likely to have a significant impact on agricultural production, efficiency, and safety. "These products deliver solutions that represent J. B. Davidson's legacy of innovation," said Curt Blades, senior vice-president of agriculture at AEM. "I continue to be amazed by the advances in ag engineering and the positive impact these advances have on producers' ability to work more efficiently."

Many strong candidates made selecting the Davidson Prize winners a difficult task. The three Davidson Prize winners for 2021 were announced on March 2 at the virtual special-edition Commodity Classic:

- LeafSpec from Purdue University and LeafSpec LLC.
- DRI-Stack System from Haber Technologies, Inc.
- Fendt 9350 DynaFlex® Draper Header with AutoDock™ from AGCO Corporation.

Find out more about these three products on the following pages. Congratulations to this year's winners, and thanks to all the candidates for their innovation and inspiration!

> **Professor Davidson would be amazed to see how advanced farm equipment has become!**
>
> **Darrin Drollinger**
> **executive director of ASABE**

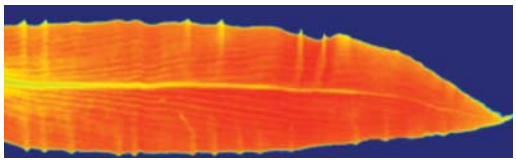
About the AE50 Awards

The Davidson Prize winners are selected from the recipients of ASABE's AE50 Award, an annual award that celebrates breakthroughs in the areas of agricultural, food, and biological systems engineering. For more information on the AE50 Awards, visit www.asabe.org/AE50.

LeafSpec from Purdue University and LeafSpec LLC

With hundreds of wavelengths in each pixel, hyperspectral imaging (HSI) far surpasses human vision. In precision agriculture, HSI has been well established for measuring plant physiological features such as nutrient levels, drought stress, and disease symptoms. During the crop growing season, HSI cameras can be carried by airborne systems to acquire images of the crop from above. While these aerial systems have demonstrated their effectiveness in numerous applications, the quality of remote sensing has been limited by the image resolution and by noise issues, such as varying ambient light conditions and leaf angles.

Jian Jin holding the LeafSpec handheld hyperspectral imager.



Chlorophyll distribution on a corn leaf generated from LeafSpec's hyperspectral image.

Meanwhile, indoor HSI facilities for plant phenotyping have been constructed in recent years. However, only large companies and research institutes can afford such expensive facilities, which can only serve a small group of users. It would be ideal if HSI could be implemented in a handheld device so that more users could benefit from this advanced technology.

To meet this need, in 2018, LeafSpec was developed by Dr. Jian Jin's Plant Phenotyping Sensor Lab at the Department of Agricultural and Biological Engineering of Purdue University. LeafSpec is an accurate, affordable, and portable hyperspectral leaf imager. LeafSpec needs just 5 to 10 seconds to scan a leaf non-destructively and generate a high-quality hyperspectral image of the leaf with <0.5 mm resolution.

The image is then immediately processed with LeafSpec's onboard microprocessor, which generates predictions such as the leaf moisture content, chlorophyll content, nitrogen content, pests and diseases, and stresses from chemicals. The images and measurement results can be viewed in real-time with a smartphone app, and the full dataset can be downloaded to a computer for further analysis.

LeafSpec also removes many types of noise that occur in other HSI systems. Imaging in an enclosed chamber with stable artificial light blocks the effect of ambient light. Inside the chamber, the leaf is imaged at a fixed distance, facing the camera and light source, which ensures uniform imaging, and the LeafSpec camera is much closer to the leaf for high-resolution imaging. Even the leaf veins are clearly visible. Compared with conventional image processing methods that analyze the average color of a whole leaf, LeafSpec allows researchers to analyze the distribution of nutrients and stresses across the leaf surface and develop new software for earlier stress detection and more precise phenotyping..

As a handheld device, LeafSpec can be operated by a single person at any location. Each measurement is geo-referenced and automatically uploaded to a geographic information system (GIS), which allows viewing the data with no delay. The GIS functions simplify the data reporting, so that the LeafSpec user can focus on leaf selection and scanning. Very little manual effort or special expertise in data management are required. These automated functions also make LeafSpec easy to adopt for digital agriculture.

LeafSpec has already been adopted in large research projects sponsored by the NSF and DOE. It has also been used by major agricultural companies in different countries. Multiple trials have clearly demonstrated that LeafSpec can achieve higher signal-over-noise for leaf measurement and can detect plant nutrients and chemical stresses several days before experienced farmers or researchers can visually see the signs.

LeafSpec LLC was founded by Dr. Jin in 2018 for commercialization of the LeafSpec technology. The company started sales in 2020 and plans the first mass production by summer 2021 to meet the growing demand. In addition to the original version of LeafSpec for corn and sorghum, Dr. Jin's lab has developed new versions of LeafSpec for dicots, such as soybean, and plants with smaller and narrower leaves, such as wheat and rice. Dr. Jin's lab also successfully developed a robotic system to automatically operate LeafSpec in the field, which can be attached to most ground-based vehicles. Dr. Jin is working with Purdue's Office of Technology Commercialization on licenses for LeafSpec LLC to commercialize these new versions by the end of 2021. Dr. Jin welcomes potential investors and collaborators to help accelerate the commercialization process.

A short demonstration of LeafSpec can be viewed at: https://www.youtube.com/watch?v=6BwCvSCNih8

DRI-Stack System from Haber Technologies, Inc.

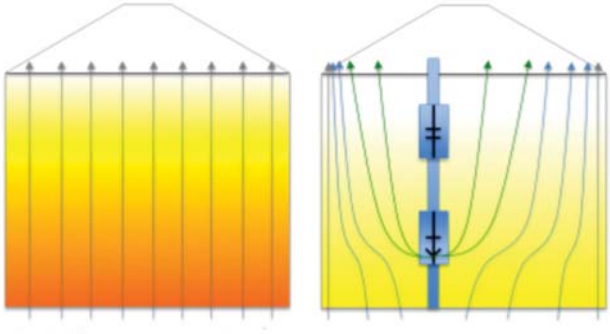
Ambient air and heated air are often used for drying agricultural products, and they are the most common methods used for the preservation of cereal grains and oilseeds. Historically, these drying methods have involved various stand-alone systems as well as in-bin systems. Many designs exist for these systems, and they are widely used on farms and at commercial facilities.

Unfortunately, conventional drying methods can create problems with the stored product, such as heat damage, fissuring, and cracking, due to variations in the heat application and airflow. Additional challenges include over-drying of grain in the bottom layers of the bin, a potentially wide range of final moisture contents from the bottom to the top of the bin, and moisture migration during hot or cold weather, which can lead to spoilage due to mold.

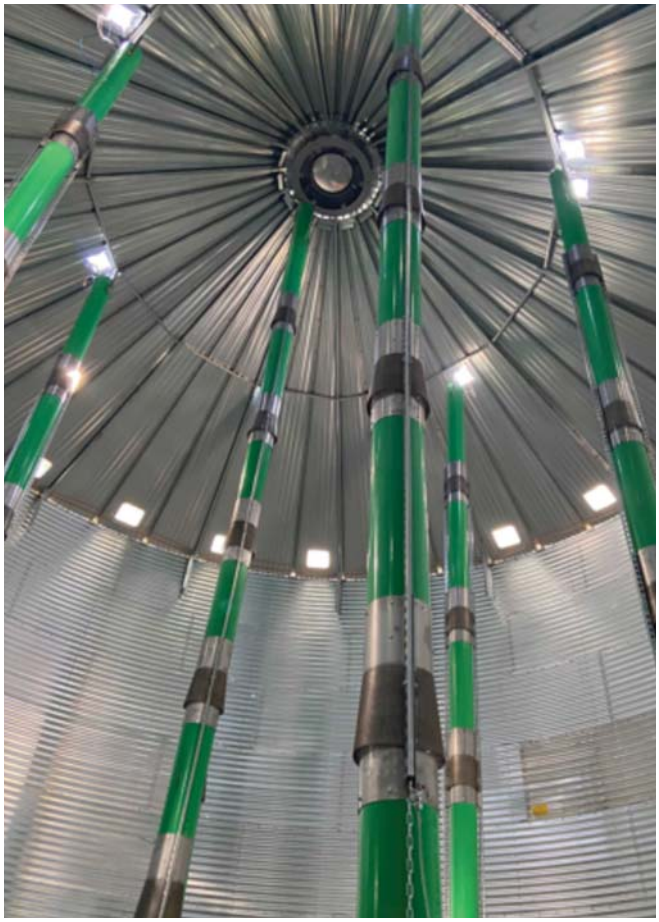
To address these challenges and improve stored product quality, Haber Technologies has developed a novel approach to drying and aeration of stored grain. The DRI-Stack system consists a series of vertical stacks that are evenly spaced inside a grain bin, as well as sensors and control software. Each stack contains multiple air inlet/outlet valves, which are controlled individually to direct the airflow and target specific locations within the bin.

As in conventional aeration, the air still flows up from a plenum in the bin floor. However, DRI-Stack allows specific routing of the air within the grain mass at specific locations. For example, air can be directed from valve to valve within a single stack, or from valve to valve between different stacks. Multiple stacks can function simultaneously, or air can be directed through a single stack alone.

A computer algorithm controls the drying and aeration in the bin, and the drying process is sequenced to prevent over-drying of the bottom layers. This operational sequence has been optimized to remove moisture uniformly from the grain. Additionally, sensors within the stacks continuously monitor the status of the grain throughout the bin. If a hot spot occurs, the adjacent valves direct air to that spot to remove moisture and prevent spoilage.



Comparison of in-bin grain drying and aeration: (left) uneven performance of conventional systems and (right) uniform performance of DRI-Stack.



DRI-Stack installed in a grain bin.

Field-testing of prototypes during 2019 and in commercial installations during 2020 demonstrated the gain in efficiency, as well the cost reduction, that can be achieved with this technology. Using ambient air, the DRI-Stack system was able to dry entire bins in one or two weeks, depending on the air conditions, using only 50% of the energy that a conventional drying and aeration system would require.

Videos of the DRI-Stack can be found at https://youtu.be/FXtvovdFZ4s and https://www.drycorn.com/photo-videos. More information about Haber Technologies can be found at www.drycorn.com.

Fendt 9350 DynaFlex® Draper Header with AutoDock™

The Fendt 9350 DynaFlex® draper header with AutoDock™ docking is a 50-foot flexible header with the industry's first automatic system for attaching all mechanical, electrical, and hydraulic connections of the header to a Fendt IDEAL combine. AutoDock allows operators to connect and disconnect the header without leaving the cab, a necessary first step toward total automation of the harvesting process.

"An operator pulls up to the header, lifts it from the ground or trailer, and pushes a button in the combine cab. AutoDock then uses guide pins and hydraulic actuators to connect the drives on both sides of the header and connect all systems with a single-point coupler while mechanically latching the header, all in five seconds," said Kevin Forth, Senior Marketing Manager for IDEAL in North America. With its width and ground-hugging flexibility, the 9350 DynaFlex draper header improves harvest productivity in a number of crops.

In the cab, the joystick is positioned on a new left armrest and is ergonomically designed with haptic feedback for smooth, confident operation. "Let's say a farmer is attaching or detaching an average of four times a day, requiring about three minutes each time, which is probably on the conservative side," said Forth. "For a harvest that lasts 45 days, AutoDock will save nine hours of hookup time. That's an entire extra day!"

The system also recognizes the specifications of the header and can automatically configure the combine settings, such as the header dimensions and sensitivity settings for header height control. Safety features provided by the system's autonomous capabilities mean that operators can configure the header without leaving the cab, docking and undocking can be performed without assistance, and the driveline and hydraulics are connected automatically. In addition to improving safety, these features save time, eliminate errors, and improve harvesting performance.

The DynaFlex header with AutoDock is a perfect example of AGCO's development of smart solutions that are designed from the ground up with farmers' needs in mind. AutoDock was inspired by customer surveys and interviews designed to uncover specific customer needs and develop solutions. AutoDock was developed to reduce the time that farmers had to spend hooking up and disconnecting their headers.

AutoDock can be ordered as an option on all Fendt IDEAL combines for delivery in 2022. It is available for DynaFlex 9300 Series draper headers and for 3300 Command Series corn heads equipped with AutoDock drivelines and adapters for the multi-coupler attachment. DynaFlex 9300 Series draper headers come in five cutting widths from 30 to 50 feet. The 3300 Command Series corn heads are available in chopping and non-chopping versions with 30-inch row spacing in 8-row, 12-row, and 16-row configurations.

Although AutoDock is currently available only for AGCO headers, Forth said that AutoDock will be available for third-party headers in the future. During 2021, a Fendt IDEAL combine equipped with AutoDock will be in fields for demonstrations, including at the Farm Progress Show on August 31 to September 2 in Decatur, Illinois.

A video animation of AutoDock in operation is available at https://s3.amazonaws.com/cms.ipressroom.com/304/files/20211/AGCO-NA-Fendt-IDEAL-9350-DynaFlex-Draper-Header-Animation.mp4

To learn more about the complete product line from Fendt, visit www.fendt.com.

Honoring the Newly Elected

Twelve new ASABE Fellows were recognized at the virtual Annual International Meeting in July 2020. *Resource* is proud to highlight these Fellows. In this issue, we finish highlighting this incredible group of 2020 Fellows.

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, and *Resource* looks forward to acquainting you with more of ASABE's best and brightest.

Patricia K. Smith, Professor and Associate Department Head for Academic Programs, Texas A&M University, College Station, is recognized for her excellence in engineering instruction and her development of techniques for evaluating uncertainty in hydrologic modeling.

Smith's career has been devoted to the education of young engineers and the development of a comprehensive water quality research program. She has taught a variety of undergraduate and graduate classes and has consistently been rated very highly in student evaluations. Smith employs a flipped classroom model, which structures her classes in a way that provides students with tools to actively engage in their own current and lifelong learning. Throughout her career in education, Smith has made significant efforts to reduce the hurdles that discourage students and faculty from non-traditional backgrounds from pursuing STEM careers. In addition to her teaching, Smith has made significant impacts in hydrologic and water quality research. Her research programs have used stochastic techniques in conjunction with simulation models to address a variety of hydrological and water quality problems in Texas. Smith and her colleagues have also used stochastic techniques to quantify the uncertainty in both measured and predicted hydrologic and water quality variabilities.

Pictured above, Patti and her husband Jason.

Alvin R. Womac, P.E., Professor of Biosystems Engineering, University of Tennessee, Knoxville, is honored for his discoveries and developments in equipment systems for spray application technology and biomass logistics systems.

Womac is a world-recognized leader in agricultural spraying and biomass logistics. He has made significant contributions to research in sprayer droplet sizing, nozzle classification, boom sprayer field performance, and aerial spray applications. Womac led a research team in spray equipment technology, developing novel equipment and monitoring techniques, and resulting in the development of a unique variable-orifice nozzle. Womac was also part of research teams that investigated the safe application of pesticide sprays for minimal environmental impact and maximum targeting of product. Womac has conducted research in biomass, looking for efficient biomass processing and logistics systems. In his current role as a professor of biosystems engineering, Womac teaches courses in mechanical systems engineering, agricultural and construction equipment, and has team-taught a unique biosystems engineering practicum course. Womac is also involved in coordinating ABET self-assessment processes.

Pictured above, Womac Tennessee Thanksgiving—Al and Eleanore Womac (seated on trailer fender) join with immediate family and Eleanore's family to continue their Thanksgiving get-together tradition.

Meet the Fellows

Yibin Ying, President, Zhejiang A&F University, and Qiushi Distinguished Professor, Zhejiang University, Hangzhou, China, is honored for his outstanding contributions and leadership in advancing agricultural sensing technology and equipment, enhancing biosystems engineering education, and promoting international collaboration.

Ying's career has been devoted to improving and extending agricultural engineering access and education in China. Ying led a team that established the first undergraduate program in biosystems engineering in China in 2001. Later, he led a team that established the first doctoral program in biosystems engineering in China in 2002 and developed a model for the multidisciplinary and comprehensive training of graduate students. Ying's team developed a course in robotics for bioproduction systems in order to systematically introduce the developments of bioproduction robotics in China and around the world. Ying has a number of technological research accomplishments, including developing technology and equipment for real-time inspection and grading of fruits based on computer vision. His research team also developed a series of technologies and equipment for the detection, classification, and packing of eggs with high throughput capacity.

Pictured above, Yibin vacationing with his wife and daughter.

ASABE Foundation Work in Focus

A student competition challenge is coming

The ASABE Foundation believes that opportunities to create and compete are essential to the growth of our profession. We believe that the rigor and rewards of our student competitions support this growth, and that our complex world needs creative ABE thinkers, innovators, and dreamers. Our student competitions foster collaboration and teach future ABEs that problems have solutions. Through our competitions, ABE students learn to find solutions, evaluate risks, and understand how to deal with different ideas.

Because of the generosity of donors like you, most of our student competitions are fully endowed. But two competitions remain underfunded: the Ethics Essay Competition and the ASABE Robotics Student Design Competition.

This fall, the ASABE Foundation is launching a matching challenge to fully endow these two remaining competitions. Our goal is to raise $327,500 to ensure that these two competitions will continue to inspire ABE students in perpetuity.

For every $1 you donate, the student competitions will get $2! The challenge is coming this fall. What will YOU do?

For more information, contact **Susan Lane,** ASABE Development Specialist, lane@asabe.org.

Give a gift with lasting impact, and your donation will be doubled!

Your personal/company consultant business card could appear here.

For information on rates ($95 and up), visit www.asabe.org/Advertise or contact Sandy Rutter, 269-932-7004, GuideToConsultants@asabe.org.

Dam! Why Should You Care?

Sherry Hunt

Oklahoma, where the wind comes sweepin' down the plain, and the wavin' wheat can sure smell sweet when the wind comes right behind the rain." Those lyrics from the Rodgers and Hammerstein musical Oklahoma still ring true in Oklahoma, just as they did when the show premiered in 1943. How poignant that song must have been, as Oklahoma was coming out of the Dust Bowl era! Did Rodgers and Hammerstein have a vision of what was in store for Oklahoma when they mentioned rain?

Growing up in Oklahoma, I heard stories about the great floods in the American Midwest from the 1930s to the 1960s. I didn't witness those floods, but my parents and grandparents could sure tell stories, like how my great-grandfather couldn't plant his crops due to water standing in the fields for months on end, and how my father had to ride a tractor down a flooded road to get to his own wedding. Torrential rains, and the ensuing floods, carved away thousands of acres of soil and disrupted transportation as roads and bridges were washed out. Worst of all was the lives lost when floodwaters swept people away.

While those stories were passed down to me, I rarely saw such disasters. My relative safety was due, in large part, to the USDA Small Watershed Program, a program administered by the USDA Natural Resources Conservation Service (NRCS). The USDA Small Watershed Program provides technical and financial assistance for the design and construction of dams on the upper tributaries of small watersheds across the U.S. The construction of these dams dates back to the 1940s. By the 1960s, the USDA was at the forefront of national dam construction.

Did you know that the USDA is the engineer of record for nearly one-third of the more than 95,000 dams on the National Inventory of Dams (NID)? Of that one-third, nearly 12,000 dams were constructed under the USDA Small Watershed Program. Of course, I'm not talking about famous projects like Hoover Dam or Grand Coulee Dam. I'm talking about small earthen dams, with a height generally between 8 and 25 m (25 and 80 ft), that are meant to provide flood protection for agricultural land. My home state of Oklahoma leads the nation in this effort. With over 2,100 USDA-assisted dams, 90% of Oklahoma's residents live within 20 miles of one of these dams.

These dams were built with the scientific research and engineering know-how provided by my predecessors at the USDA Agricultural Research Service (ARS) Hydraulic Engineering Research Unit (HERU) in Stillwater, Oklahoma. Their dedication and partnerships with the NRCS and local sponsors, including conservation districts, state and local governments, and private land owners, made the dam program successful. These dams are all based on a fairly standard design, mostly developed by HERU scientists, with improvements made over the years as ARS and NRCS engineers learned more about dam performance. For the most part, a flood-control dam in Oklahoma looks very similar to a flood-control dam in New York or California.

Dam! Why should you care? You likely never thought about these dams or even knew of their existence. Why? Because they are silent sentinels, protecting you and your livelihood. Did you know that more than 50% of these dams have surpassed their planned 50-year service life? And many changes have occurred since their construction. Consider, for example, Dam Site 4 in the East Fork Above Lavon watershed, in Collin County, Texas. This dam was constructed in 1959 when the county population was less than 14,000. Today, the county population has surpassed one million. As a result, instead of protecting agricultural land, this dam, and others like it, are now protecting tens of thousands of downstream lives.

In addition to changes in land use, some of these aging dams are experiencing structural deterioration, and their reservoirs are beginning to fill with sediment. Climate change is also creating stresses on these dams like never before, with extreme cyclic conditions between droughts and floods.

Dam! Why should you care? Did you know these dams provide more than flood control? These dams are multi-purpose structures because they also provide rural and municipal water supplies that support economic growth, healthy ecosystems, water for crop and livestock production, recreation, and tourism. In 1957, Oklahoma built the first multi-purpose dam in the nation under the USDA Small Watershed Program.

Why is this dam, known as Wildhorse Creek Watershed Dam No. 22, of significance? At the time, a growing energy company in Duncan, Oklahoma, needed water for industrial use. This dam provided the water. Today, the company that needed water has grown to more than $20 billion in assets. Across the U.S., the USDA Small Watershed Program is estimated to provide an average of $2.4 billion in benefits each year. The actual benefits are likely much greater, as the estimated benefits are projected from the original, pre-development watersheds.

Now that you know that more than 50% of these dams have reached the end of their planned service life, and that they provide a plethora of benefits to you, your family, and your community, what do we do about them? How do we address the challenges they face, so that they can continue to provide the benefits that we've become accustomed to? In 2000, recognizing the critical role these dams play in our national economy, Congress passed legislation for the rehabilitation of dams constructed under the USDA Small Watershed Program to upgrade them to current safety standards.

Fast forward 20 years, and the NRCS reported completion of 161 dam rehabilitation projects last year, which is a far cry from the 6,000+ dams that have reached the end of their planned service life. The continuation of this rehabilitation program depends on annual appropriations and funds authorized through the Farm Bill. Those funds are already stretched as far as they can be to ensure that the dams still provide flood management, water supplies, erosion control, agricultural productivity, recreation, and wildlife habitat.

We all know that there is ever-increasing competition for funding. We see it in the news every day. However, funding this program does more than repair aging dams; it also creates jobs, and it protects homes, infrastructure, commercial property, interstate commerce, and lives.

Meanwhile, HERU scientists continue to build on nearly 80 years of research support for this program by developing innovative, economical solutions for addressing the challenges that the dams are facing. For example, HERU scientists have developed standardized design criteria for roller compacted concrete (RCC) stepped spillways applied to embankment dams as a rehabilitation solution. In addition, in collaboration with the NRCS, Kansas State University, and ARS and NRCS engineers, HERU scientists have developed the Windows Dam Analysis Modules (WinDAM), a software program for predicting earthen dam failure due to overtopping or internal erosion.

New tools are still needed to sustain the benefits of the USDA Small Watershed Program. To meet the challenges we face, we need to be better stewards of the land and more efficient in our use of natural resources. This requires us to develop new technology and new uses for these dams, and their reservoirs, that have previously gone untapped.

For example, wouldn't it be great if we could monitor reservoir levels using modern technology to better meet the needs of farmers in times of drought or flood? Or if we could view the sediments stored in reservoirs as a valuable resource for maintaining a proper balance from uplands to river outlets, rather than as an environmental problem? These are the challenges that my colleagues and I are addressing. These are also the challenges that I ask you to help address.

Dam! Why do I care? I care because my family and friends depend on these dams for their agricultural livelihood. I care because my two daughters enjoy recreation with their grandfather at a dam close to where I grew up. I care because my family has enjoyed watching the diverse wildlife these dams support. I care because these dams supported the construction of a highway through my hometown, so commerce could continue and the town could survive and prosper. I care because these dams saved my community when it was threatened by wildfire. The Air National Guard used water from a reservoir to douse the flames. You bet I care!

The next time you fly over the American Midwest, look out the window at the landscape below. You will see the subtle colors of wheat and corn and freshly plowed ground, the paintbrush strokes of grass-lined waterways, and the stair steps of terraced fields that help keep sediment out of the reservoirs. You will also see water, water everywhere, in the tens of thousands of artificial lakes and reservoirs that speckle the land.

Now think about who is responsible for this masterpiece of sustainable engineering. You don't have to think very hard. You can thank your fellow agricultural and biological engineers, your federal, state, and local governments, and private landowners, because they all came together for the greater good. Just as the creation of the USDA Small Watershed Program was a collective effort among these entities, the future of the program will depend on a collective effort.

As Rodgers and Hammerstein put it, "We know we belong to the land, and the land we belong to is grand." Dam! I will continue to tell this story, because it has a strong past and a great future. Do you care to be part of that future?

ASABE member Sherry Hunt, Research Leader and Acting Location Coordinator, USDA-ARS Hydraulic Engineering Research Unit, Stillwater, Oklahoma, Sherry.Hunt@usda.gov.

AE50 Awards

Nominate your new products

Do you have an innovative product first made available for purchase or ordering during the 2021 calendar year? Maybe multiple products? The AE50 Awards Program could be just for you!

AE50 winners typically include machines, systems, components, software, and services ranked highest in innovation, significant engineering advancement and impact for the markets they serve.

The 2021 AE50 Awards will be presented at ASABE's annual Agricultural Equipment Technology Conference (AETC) in February. The award-winning products are also highlighted in the January/February issue of ASABE's *Resource* magazine. The top ten winners are eligible for the prestigious Davidson Prize, an elite award presented to "the best of the best" among AE50 winners.

All nominations must be submitted through our online nomination web-site (www.asabe.org/AE50). The online nomination website will be opened for new nominations August 1 through September 25.

If you have questions about the AE50 Awards program or the Davidson Prize, contact AE50@asabe.org or visit www.asabe.org/AE50

Submit nominations Aug. 1–Sept. 25, www.asabe.org/AE50