January/February 2022

# RESOURCE

engineering and technology for a sustainable world


**Inside:**
**AE50 Award Winners**
**Ethics Essay Winner**
***VisualChallenge*11**

PUBLISHED BY AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS ASABE

# from the President

## Building a thriving membership

Last fall saw a resurgence of ASABE activities. As a result, I've been invited to many student activities and section meetings, and the invitations keep coming. While I'd love to attend every meeting in person, that's not really possible (I have a day job!), so the ability to attend virtually is still welcome. My virtual visits have included a biosystems engineering class at Virginia Tech, and a virtual presentation by the Texas section. The Texas meeting was well attended in person as well as on-line.

The return of in-person meetings is a hopeful sign. For the first time since February 2020, I climbed aboard an airplane to attend the North Carolina Section meeting. The meeting was held at Weaver Labs, home of NC State's Department of Biological and Agricultural Engineering. To help keep us safe, the meeting was held outside, but we didn't anticipate the cold weather! Regardless of the chill, it was a warm reception with an excellent program. Thanks to Garey Fox for hosting me and to Ed Barnes for giving me a great tour of Cotton, Inc.

As I mentioned in my previous column, this is a good space to share progress on our strategic goals and related activities. As president, I'm focusing on our goal to "cultivate a diverse, thriving, and engaged membership." In past years, I've often heard laments about why we have thousands of members, but our Annual International Meeting only attracts a fraction of the membership. I've come to realize that focusing on the AIM ignores all the other ways in which members can participate. The section meetings are a great example of this broad participation, and we should encourage members to create their own opportunities for getting together, sharing their experiences, and building their networks.

Think of our strategic goals as inward looking and outward looking. The goal of a diverse, thriving, and engaged membership is certainly inward looking. On the other hand, our effort to "raise the prominence of the agricultural and biological engineering profession globally" is outward looking. The two big initiatives that we are leading, Transforming Food and Agriculture to Circular Systems (TFACS) and the Alliance for Modernizing African Agrifood Systems (AMAAS), are telling the world who we are. These important, outward-looking initiatives are driving engagement with other professional societies and organizations.

For example, ASABE was well represented at the recent National Academy of Engineers virtual forum entitled "Complex Food and Agricultural Systems: Engineering for Sustainability and Resilience" held on September 9, which featured **ASABE members Jim Jones, Bruno Basso,** and **Brahm Verma,** with **Paul Singh** and **Sue Nokes** serving as moderators. More than 1000 people attended. Likewise, the AMAAS initiative has been thriving. **ASABE members Margaret Gitau, Senorpe Asem-Hiablie, Klein Ileleji,** and **Ajit Srivastava** put together an extensive article about the AMAAS initiative in the November-December issue of *Resource*. While our headquarters staff provides public relations support (led by Dolores Landeck) for our activities, members—like you and me—create the opportunities that build ASABE's prominence in the world.

Finally, speaking of building a diverse, thriving, and engaged membership, the Board of Trustees supports an amendment to our constitution on the upcoming ballot that will allow all members, including student members, to vote in our general elections. Vote "yes" on this amendment. If we really want all members to have a voice, then our student members should be able to vote.

I wish you safe and happy holidays, and a great new year!

Paul Heinemann
hzh@psu.edu

# events calendar

**ASABE CONFERENCES AND INTERNATIONAL MEETINGS**
*To receive more information about ASABE conferences and meetings, call ASABE at 800-371-2723 or email mtgs@asabe.org.*

**2022**

| | |
|---|---|
| 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**

| | |
|---|---|
| Jan. 8-13 | **Soil Erosion Research under a Changing Climate.** Aguadilla, Puerto Rico. |
| 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:**
**ASABE member Jean Pompeo** inspects lettuce to be measured and logged in at a University of Florida growth chamber, see more *VisualChallenge11* entries on page 22.

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# RESOURCE

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ASABE AE50 outstanding innovations AWARD



## FEATURES



## UPDATE



## DEPARTMENTS

# Let's Celebrate the Winners

*Resource* magazine has once again sponsored the AE50 Award program, celebrating companies for their recent developments in agricultural, food, and biological systems. From the many entries submitted in 2021, an expert panel selected the products, showcased on the following pages, for recognition. The award-winning products are those ranked highest in innovation, significant engineering advancement, and impact on the market served.

The products represent the diversity of agricultural and biological engineering, as well as the variety of companies that continue to bring advanced technology and exciting innovations to the marketplace. This year's AE50 recipients join the ranks of many who have been honored for their ingenuity in product development—saving producers time, costs, and labor, while improving user safety as well.

The AE50 Awards had their beginning in June 1984, in a special issue of ASABE's *Agricultural Engineering* (now *Resource*), in which 25 new techniques, inventions, and innovations were showcased. The featured items were drawn from product information solicited by the Society and screened by a panel of engineers. From this focus on identifying innovative technology, two years later the AE50 Award program was born. As the announcement stated, "Acceptance in the marketplace is the highest accolade any new agricultural product can receive. But for innovative developments in the last 12 months, a singular honor is to be named one of the year's Agricultural Engineering 50 outstanding innovations." Product nominations poured in. An enlisted panel of experts reviewed the entries, and in 1986 the first AE50 Awards were presented.

Interest in new technology and innovative applications of existing technology remains constant. Over the years, many award-winning products were patented and their names trademarked. Some were further improved as technology advanced, and with time, won another AE50. But the most important yearly constant: all winning entrants continually strive for excellence, and we are pleased to honor their work with the highest honor in the only awards program of its kind. Congratulations to the winners!

## 1775NT 24Row30 Planter

**Deere & Company**
**Moline, Illinois, USA**
**deere.com/en/**

The 1775NT 24Row30 Planter Model Year 2022 update increases onboard seed and fertilizer capacity while reducing soil compaction. New commodity tanks include a 30-bushel increase in onboard seed capacity and 150-gallon increase in liquid fertilizer capacity over last year's model, with a main frame tracks option that reduces ground pressure under the center section by 70% compared to tires. The track system provided from the factory includes toe-angle adjustment and load sharing capability, reducing heat generation at high speeds and on uneven surfaces. When the planter is in road-transport configuration with seed and fertilizer tanks half-full, the tracks can travel continuously for up to 2 hours at 20 mph.

## B-Series

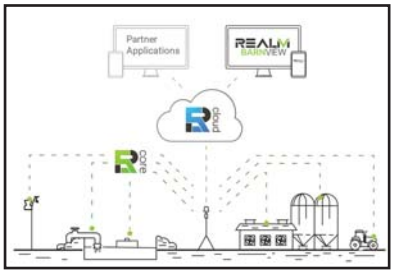
**SCO2, LLC.**
**Little Canada, Minnesota, USA**
**sco2.net**

SCO2's technology combines hybrid cold-press and supercritical $CO_2$ extraction in one step. The patent-pending technology utilizes the chemistry of supercritical $CO_2$ extraction with the mechanics of hydraulic pressure to produce precision botanical extractions in minutes instead of hours. Real-time remote pressure and temperature monitoring, and the internal linear position sensors within the hydraulic rams provide positional feedback and accuracy. Systems are automated to be user-friendly. Operation is simplified and streamlined, requiring minimal pre-processing with no grinding or milling required. The raffinate exits as a compressed puck, saving valuable operator time, space, and material handling steps. Available in five standard models that process between 16 to 500 pounds of raw material per hour, SCO2's technology enables powerful high-volume solvent free extractions for 24-hour industrial production.

## Barn View

**RealmFive, Inc.**
**Lincoln, Nebraska, USA**
**realmfive.com**

RealmFive's Barn View is a livestock-centric product suite including powerful enterprise-level application software, drop-in connectivity, and plug and play wireless monitoring devices that include feed, water, air and effluent components. RealmFive Barn View brings a dashboard view across all types and vintages of livestock barns, often located in rural sites, with robust connectivity and extremely easy device installation. More than 90% of swine barns in North America are not connected to the internet, making it difficult for producers to take advantage of efficiency gains that come from access to standardized data across their enterprise. Barn View is a solution for operations consisting of a mix of barn vintages and controller types. Barn View can seamlessly connect to RealmFive's EcoSystem of connected solutions for agronomy, irrigation, inventory, compliance, and logistics.




## C770 Cotton Harvesters

**Deere & Company**
**Moline, Illinois, USA**
**deere.com/en/**

The C770 Cotton Harvesters provide productivity, technology, and efficiency for cotton growers. The CP770 with the PRO16 HS row units can harvest more than ten acres per hour while reducing cotton losses. The CS770 cotton stripper with the new SH12F 12-row folding stripper header can harvest up to an extra 100 acres per day in dryland cotton. Both machines are equipped with a cotton handling system that reduces wrap and hauling costs up to 8% on the picker and 12% on the stripper. The cab on these harvesters is equipped with the latest technology that automatically shares data with the John Deere Operations Center. These changes, combined with the JD14P engine from John Deere Power Systems and hydraulic system, provide increased productivity while reducing fuel usage by up to 20%.

## Case IH® Fast Riser 6100 3-Section Front-Fold Planter

**Case IH**
**Racine, Wisconsin, USA**
**caseih.com**

The 27-row 45-cm row spacing Case IH® Fast Riser 6100 is a 3-section front-fold corn/soybean/cotton planter designed for use in Brazil for growers and contractors that must transport on public roads. One operator can convert from a 13-m planting width to a 3.2-m regulatory road transport width from the tractor cab in one minute. Two lubrication points save hours of maintenance per planting season. A 5,440-L seed capacity increases productivity. Equipped with a 3-section hydraulic wing down force system and agronomically designed row unit, this planter is designed to help increase yield potential and cover more acres.

## Case IH Patriot® 50-Series Sprayers

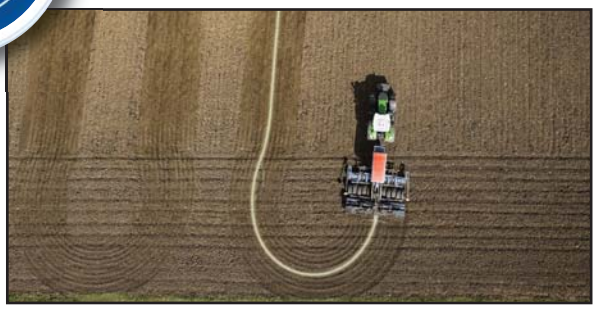
**Case IH Agriculture**
**Racine, Wisconsin, USA**
**caseih.com**

Patriot 50-series sprayers are the first full-line redesign of the Case IH Patriot® sprayer line in 15 years. The entire machine, from tires and suspension, through engine and drivetrain, machine structures, cab, spray system, vehicle electronic and hydraulic architectures, has been redesigned. The common theme with other Case IH flagship equipment is designing around a range of integrated, connected solutions. This allows next steps toward remote management and optimization of machines, data, diagnostics, agronomic inputs, and other valuable resources. It also provides the platform for future integration of evolving chemical application and vehicle control technologies. These technologies will further improve consistency and accuracy of application, reduction of inputs through precision agriculture, and micro-site management. This is accomplished while increasing machine efficiency, autonomy, safety, and operator comfort.


## Crop Chaser 1000

**Amity Technology LLC**
**Fargo, North Dakota, USA**
**amitytech.com**

The Crop Chaser 1000 is a multi-crop capable, single-tank dump cart that utilizes hydraulically controlled independent front and rear live floor chains to provide operators with maximum control over the unloading process. Similar to a traditional dump cart, the Crop Chaser 1000 utilizes independent hydraulic remotes to control the lift and tilt functions, while the addition of the front and rear live wall floor chains increases the machine stability while unloading and adds increased control for optimized truck box loading. Whether it is silage, beans, corn, sugar beets, or a variety of other product, the Crop Chaser 1000 will increase harvest logistic efficiency. An automatic unload detection scale system and tracks are standard equipment.



## Fendt TI Headland

**AGCO Corporation**
**Duluth, Georgia, USA**
**agcocorp.com**

Fendt is introducing a reverse turn (Y-turn and K-turn) alongside the existing fully-automatic turn types to allow tractor operators to automatically turn three-point mounted implements on small headlands. The current automated turn types such as keyhole or U-turns require a large headland or the implement cannot finish the row in a straight line. With the Y-turn, on entering the headland, the sequence starts automatically, the tractor brakes and automatically reverses, and at the end of the headland the tractor and implement run seamlessly back into the next wayline. The K-turn is especially suited to turning on slopes, which tractors with rear attachments can climb while reversing. This turn type helps stabilize both the tractor and implement.

## Fendt® 300 Vario®

**AGCO Corporation**
**Duluth, Georgia, USA**
**Fendt.com/us**

The Fendt® 300 Vario® consolidates the innovations and features of Fendt's higher horsepower offerings into an expanded wheeled tractor product line in North America. This latest generation includes four models ranging from 100 to 132 rated horsepower in the three configurations from Power and Profi up to Profi+. The fourth-generation Vario features the smart power-boost concept Fendt DynamicPerformance on the Fendt 314 Vario, which provides up to 10 rated horsepower more power on demand. Superior driving and working comfort were first in mind when designing this platform. The system delivers maximum ride comfort and ease of use with its VisioPlus™ cab, the optional FendtONE™ operator's station, a self-levelling suspended front axle, optional cab suspension, Fendt Cargo loaders, and a variety of Fendt Smart Farming solutions.

## Fendt® Rogator® 900 Series Applicator

**AGCO Corporation**
**Duluth, Georgia, USA**
**agcocorp.com**

The Fendt® Rogator® 900 Series Applicator is a self-propelled, rear-mounted boom applicator with dual-position, adjustable crop clearance for use from pre-plant to tall crops. The machine adjusts between standard (56-60 inches) and high clearance (72-76 inches) in less than 45 seconds with the push of a button. It can be equipped with liquid, dry pneumatic or dry spinner delivery systems, which can be switched in as little as 2 hours. The result is a single, versatile solution for year-round application of liquid or dry crop nutrients, crop protection products, and seeding of cover crops, replacing multiple machines and optimizing equipment investment. This applicator's design and versatility allow better control of timing and method of applying products to help optimize yields and the investment in crop care products.

## Flex Mini

**RealmFive, Inc.**
**Lincoln, Nebraska, USA**
**realmfive.com**

The Flex Mini VTH wireless monitoring device utilizes wireless data acquisition technologies to collect and transfer data into RealmFive's Barn View software suite. Flex Mini monitors for in-barn temperature and humidity, and detection of feed outages. The Flex Mini VTH mounts to livestock barn feed lines within five minutes, continuously measures vibration, and distinguishes between operating conditions such as "full" and "empty". Alerting capabilities allow livestock owners to rest assured that their animals are well-fed and comfortable, regardless of the remoteness and size of their operation. Data from the Flex Mini VTH combined with feed level data enables swine managers to remotely differentiate between feed outage events versus "bridged" feed situations. Flex Mini leverages years of wireless technology that has been developed to handle tough agriculture conditions like those found inside animal barns.

## Flex-Flo XD Ultra Unloader

**AGCO Corporation**
**Assumption, Illinois, USA**
**automatedproduction.com**

The XD Ultra unloader is a new boot and modular unloader system for livestock applications. The XD Ultra's durable design allows for smooth material flow from a feed tank to a multitude of feed conveying options. The 50% bigger XD Ultra boot opening increases feed flow and reduces bridging events. Tests of the XD Ultra show the wear plate last at least four times longer. The XD Ultra can be fitted with remote flow control gates with a bolt change. The configuration options mean farmers will be able to find a great fit for their farm. The XD Ultra unloader increase in useful life, improved flow, configuration offerings, and the option to add automation mean that the XD Ultra unloader is a major improvement from other unloaders.

## Front Cloud Connect Monitoring Device

**RealmFive, Inc.**
**Lincoln, Nebraska, USA**
**realmfive.com**

The Front Cloud Connect utilizes world-class wireless data acquisition technologies to interface with a variety of environmental and field sensors and provides a connection to the RealmFive View data platform. Front provides a highly reliable and cost-effective connection interface for a SDI-12 soil moisture sensor, leaf wetness sensor, and full weather station suite sensor inputs (exact inputs depend on model of Front). The device was designed to require no tools for installation. The solar powered device has three communication options including a wireless connection (requires a separate RealmFive gateway), direct cellular connection, and a cellular gateway option. Over-the-air firmware updates allow Front's communication settings and configurations to be modified after purchase. The cellular gateway option is truly unique, offering users the ability to surround a Front device with up to 50 wireless sensors.

## Hagie™ STS20

**Hagie Manufacturing Company**
**Clarion, Iowa, USA**
**hagie.com**

The Hagie™ STS20 boasts a 2,000-gallon (7570 L) solution tank, packaged into an efficient layout and paired with precision technologies. The STS20 covers 80 additional acres per tank fill compared to a 1,200-gallon (4540 L) sprayer at 10 gallons per acre, increasing productivity and reducing the need to fill the sprayer as often. The STS20 incorporates common intuitive operator controls found in other John Deere equipment and comes standard with Category 4 active carbon filtration. Increased speeds up to 25 mph paired with an STS20 specific suspension design provide increased productivity while maintaining operator comfort. In the factory, the modular machine design reduces labor time up to 35% compared to the previous STS models.

## HDF Hinged Frame Flexible Cutterbar Draper

**Deere & Company**
**Moline, Illinois, USA**
**deere.com/en/**

HDF drapers offer ground following capability for on-and-off-ground harvesting, enabling producers to recover more crop while meeting the high capacity needs of today's combines. HDF supports the harvesting system by combining a flexible cutterbar with a hinged frame and hydraulic suspension. HDF suspension decouples combine dynamics from the header, enabling more consistent cut height in all harvestable terrain. Adjustments needed for both on and off ground harvesting are integrated into the combine cab for easy operator control when paired with a John Deere X or S Series Combine. An optional integrated low-speed transport system aids field-to-field logistics, and a new "wing leveling" feature returns wings to a pre-set "flat" or "smile" position for headland turns. HDF is available in cutting widths of 35, 40, 45, and 50 feet.

## Horizon™ Ultra Tractor Cab

**CNH Industrial**
**New Holland, Pennsylvania, USA**
**agriculture.newholland.com/nar/en-us**

The Horizon Ultra cab has been redesigned from the ground up to meet the customers' most demanding expectations: A new cab frame sets a record as the quietest in the industry with a measurement of just 66 dBA. All-round visibility is aided by enlarged glass areas, front and rear cameras and at night there are 24 LED lights to maintain visibility. The high-capacity climate control includes dual fans and zone control, while multiple storage solutions include a large cooled compartment and a host of electrical power supplies. The driver is more connected than ever, information is displayed on a 12-inch tablet-like monitor and the unique CentreView steering wheel display, while all tractor operations are controlled from the SideWinder Ultra armrest.

## Hydraulically Adjustable Windrow Merger on the KUHN FC 9330 D RA

**Kuhn North America**
**Brodhead, Wisconsin, USA**
**kuhn-usa.com**

The hydraulically adjustable windrow merger on the KUHN FC 9330 D RA is one of the most flexible merger systems in the triple mower conditioner segment. The belt speed and position are set from the cab, allowing customization of the windrow width from a narrow 5 foot 11 inches to a wide 11 foot 10 inches. Each merger conveyor can be individually folded up out of the way to make wide windrows without merging. The self-contained hydraulic system compensates for hilly terrain with the help of an onboard inclinometer to control the belt speed. Operators can manually adjust belt speeds or activate the automatic feature to allow the machine to make the correct adjustments when needed, ideal for less skilled operators.

## Integrated ExactRate™ Liquid Fertilizer System

**Deere & Company**
**Moline, Illinois, USA**
**deere.com/en/**

John Deere's 8RX with ExactRate™ tractor tanks builds on the industry-exclusive 4-track row crop tractor and 1775NT planter capabilities by integrating 1,600 gallons of fertilizer capacity (1,000 gallons on the tractor, 600 gallons on the planter). The ExactRate™ Liquid Fertilizer Transfer System is a John Deere designed, manufactured, and dealer supported solution that allows customers to apply fertilizer during planting—when timing is most critical—while maintaining vehicle width, exceptional visibility, and ease of entry/egress, all with fully integrated system controls. At full capacity, the integrated tank systems provide customers up to 80 acres per fill when applying at 20 gallons per acre. In addition, tracks on both tractor and planter maintain low ground pressure, minimizing soil compaction while precisely placing seed and fertilizer.

## John Deere 9R Series MY22 Tractors

**Deere & Company**
**Moline, Illinois, USA**
**deere.com/en/**

Large acre grain producers start earlier and run later to complete spring seeding/planting work in optimal seeding/planting windows. Their tractors pull wider implements faster and more precisely than ever before. John Deere 9 Series tractors feature an additional 20 engine horsepower and increased max ballast to 67,000 pounds. A clean sheet design JDPS 13.6L engine from 390 to 590 engine horsepower was built for performance, serviceability and reliability. A new cab is designed with industry leading LED lighting and comfort features on par with the finest automobiles. John Deere 9 Series tractors paired with John Deere Precision Ag Technology helps farmers drive farm management changes to improve yields, lower costs, and farm more acres in less time.

## M1170NT Self-Propelled Windrower

**MacDon® Industries**
**Winnipeg, Manitoba, Canada**
**macdon.com**

The MacDon® M1170NT provides the power and field performance of an M1 windrower, while allowing for a smooth and fast ride of 23 mph (37 km/h) between fields and fitting within road regulations. Transition from the field stance of 150 inches (382 cm) to the narrower road transport of 136 inches (346 cm) is accomplished at the push of an in-cab button. On-screen prompts guide the user through the process. The sliding leg mechanisms used for the front and rear axles have under gone vigorous testing to ensure their durability. The Narrow Transport (NT) option allows for easier trailering for longer hauls. The M1170NT provides the flexibility to get more easily from field to field, while laying some of the widest windrows for optimal dry down.

## MacDon FD2 FlexDraper®

**MacDon® Industries**
**Winnipeg, Manitoba, Canada**
**macdon.com**

The new FD2 FlexDraper® headers (30 to 50 feet) are designed to deliver increased harvesting productivity across a wide variety of crops and conditions. The ClearCut™ high speed cutting system with its patented geometry, 25% more cutting area and new drive system deliver up to 30% faster ground speeds. The header frame accommodates industry-leading 50-inch-deep side drapers to ensure smooth crop flow, increasing combine capacity up to 20%, which is of benefit in bulky crop conditions. The 70% increase in wing flex range enhances ground following capabilities. The optional ContourMax™ system with forward positioned wheels allows ground following to produce a consistent stubble height up to 18 inches. The self-contained EasyMove™ Transport system requires less effort, and converts more quickly from field to transport.

## Massey Ferguson 8S

**AGCO Corporation**
**Duluth, Georgia, USA**
**agcocorp.com**

The Massey Ferguson 8S Series (five models, 210 to 290 rated engine HP) features a new Protect-U™ design, which allows more than nine inches of separation between the cab and engine, provides a freer flow of fresh air to improve cooling performance, offers increased visibility and significantly reduces cab noise and vibration. The new cab frame features a forward-leaning shape similar to vintage Massey Ferguson tractors from several decades ago. The cab interior trim and texture are completely updated with a new multi-function joystick and intuitive control layout. The dual-clutch Dyna E-Power transmission provides stepless shifting with the mechanical efficiency and price of a powershift transmission. Substantial improvements have been made to hydraulic performance and the HVAC system.

## Massey Ferguson DM 367 FQ-RC Front Mower

**AGCO Corporation**
**Duluth, Georgia, USA**
**AGCOCorp.com**

The DM 367 FQ-RC by Massey Ferguson is a front 3-point hitch mounted mower with rubber conditioner rolls. The heavy-duty one-piece welded steel RazorEdge™ cutterbar features a wide disc diameter to ensure high output and reduced power consumption in heavier crops, resulting in a lower cost of ownership. The design of the mower linkage means the mower is pulled instead of pushed. The use of pulled bars, steering rods and cylinders with ball joints ensures exceptional three-dimensional ground adaptation for perfect forage production with minimal loss. Direct attachment to the tractor linkage without an 'A' frame results in a shorter front overhang for better stability and comfort. Foldable protective covers for transport and a wide opening front cover allows easy access to the cutterbar and quick-change blades.

## OMNiDRIVE™

**Raven Industries**
**Sioux Falls, South Dakota, USA**
**ravenprecision.com**

OMNiDRIVE™ is the first Driverless Ag Technology for grain cart harvest operations. It allows users to monitor and operate a driverless tractor from the cab of the harvester. OMNiDRIVE™ is an easy-to-integrate aftermarket system that installs on several current tractor models. With OMNiDRIVE™, users can create a field plan, establish and modify stage locations, adjust speeds, monitor location activity, and command the tractor pulling a grain cart to sync with the harvester as it offloads on the go. OMNiDRIVE™ will then return the tractor to a user-defined unloading area. After unloading, OMNiDRIVE can re-sync and is ready to deploy the next mission. OMNiDRIVE™ is operated via an intuitive, tablet-based user interface.

## OptiWrap® OWR 6000

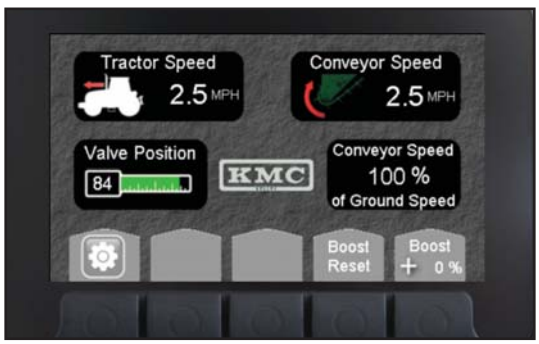
**Kuhn North America**
**Brodhead, Wisconsin, USA**
**kuhn-usa.com**

The KUHN OptiWrap® OWR 6000 inline round bale wrapper offers wrapping productivity with pre-stretchers that have a 70% stretch ratio to minimize film and fuel use. The IntelliWrap™ system controls the process and allows the operator to adjust film layers, seam layers, load delay, and bale dimensions. The OWR 6000's stretch ratio provides more efficient plastic utilization and better bale compression, reducing plastic cost. IntelliWrap controls, combined with the optional FilmSense™ system, can adjust pusher and hoop speed to maintain the target layer count even if a stretcher runs out or tears film during the wrapping cycle. The BaleEye photoelectric sensor detects a bale on the loading platform without using mechanically moving parts. The OWR 6000 features dual industrial-grade polymer non-pneumatic hoop drive wheels for optimal hoop traction in adverse conditions.

## Peanut Inverter Auto Speed Control

**Kelley Manufacturing Company**
**Tifton, Georgia, USA**
**kelleymfg.com**

The KMC Peanut Inverter Auto Speed Control system increases the efficiency of a peanut digger-shaker-inverter by automatically adjusting the speed of the conveyor to match the desired percentage of forward ground speed of the implement as defined by the user, ensuring a smooth transition of the peanut crop from the digging blades onto the shaking conveyor. The KMC Peanut Inverter Auto Speed Control allows the operator to set the ideal conveyor speed based on peanut variety and soil type, reducing crop loss by up to 50%. Operator fatigue is reduced by simplifying, and sometimes eliminating, manual conveyor speed adjustments required by changing field conditions that are typical of peanut digging.



## Permanent Crop Analyzer™

**Smart Guided Systems**
**Indianapolis, Indiana, USA**
**SmartApply.com**

The Permanent Crop Analyzer™ is a Utility Vehicle add-on kit that uses LiDAR to scan permanent crops; inventory tree statistics, tree location, track or section boundary, and density statistics; provide yield estimates; and forecast chemical savings using the Smart-Apply® Intelligent Spray Control System™. The Permanent Crop Analyzer™ uses a wireless Android tablet interface, operated by the grower or as a dealer service. It produces a location-based inventory including tree height, width, and a foliage density index per tree. The chemical savings analyzer compares the grower's current spray usage to a density-based spray system, outlining where and how chemical savings are possible. Using historic density heat maps, the grower identifies growth concerns, making data driven decisions. Comparing density heat maps to harvest yields allows for year-over-year comparisons, and estimations of current year yield.

## Quick Change Blade Feature for ProSeries™ Opener

**Deere & Company**
**Moline, Illinois, USA**
**deere.com/en/**

The Quick Change Blade feature is a product enhancement for the ProSeries™ Opener that dramatically reduces maintenance time and labor costs needed to replace the opener disks. The opener disk can be replaced with minimal tools and part removal through the use of a sculpted gauge wheel arm. ProSeries™ Openers are available on all John Deere no-till air seeding tools and were introduced in 2018 as a major upgrade to the 90 Series Opener. The Quick Change Blade feature builds on the improvements made to serviceability, durability, reliability, and function including the removal of two grease points, improved boot and seed tab, more aggressive closing wheel, thinner and more flexible press wheel and improved seed boot mounting of the ProSeries™ Opener, making it more reliable and easier to service.

## Quicke® QE-Command with Q-Companion

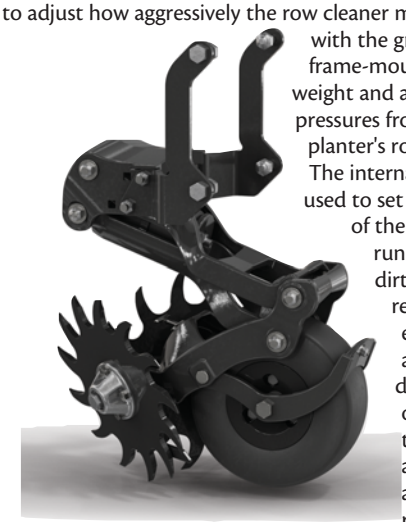
**Ålö USA Inc.**
**Simpsonville, South Carolina, USA**
**quicke.org**

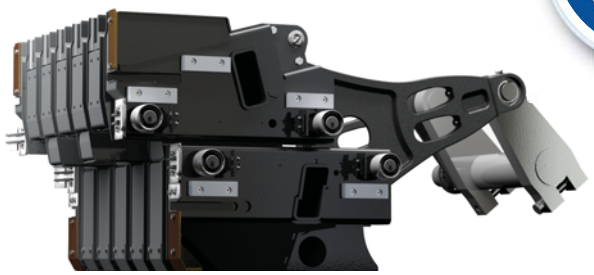
The Quicke® QE-command smart front loader control with Q-companion includes payload weighing, automation of work cycles, end position damping, and the ability to limit implement heights and tilt angles. A color display with on-screen instructions and a built-in product manual makes it simple to use. Settings are stored on individual implements, offering a "set and forget" experience. Although packed with functions, the system is designed to suit non-experienced operators. The loader is fitted with a tilt angle and lift height sensor, two hydraulic pressure sensors and an ECU. The cab is fitted with a color display as well as the joystick. Advanced motion planning is used to allow pre-programmed implement positions, useful during limited visibility. Bluetooth and a free phone app facilitate material weighing data transfer and storage.


## Reveal

**Precision Planting™**
**Tremont, Illinois, USA**
**precisionplanting.com**

Reveal™ is a frame-mounted, floating residue management system for row crop planters that uses a trailing, internal gauge wheel to control the depth of the cleaning tines and two airbags to adjust how aggressively the row cleaner maintains contact with the ground. Reveal is frame-mounted to isolate its weight and adjustment pressures from affecting the planter's row unit dynamics. The internal gauge wheel is used to set a consistent depth of the cleaning tines by running on the cleaned dirt, not on top of the residue. Reveal is equipped with two air bags, one for down pressure, and one for lift pressure to make necessary adjustments to the aggressiveness of the row cleaner wheels.





## SB 1290 iD TwinPact

**Kuhn North America**
**Brodhead, Wisconsin, USA**
**kuhn-usa.com**

The KUHN SB 1290 iD TwinPact plunger offers higher bale densities without the need for a dramatically heavier baler and substantial increase in horsepower required to operate the baler. The split plunger design intelligently applies the force of a standard 3x4 square baler to half the area, twice. Combined with the longer bale chamber and nine hydraulic cylinders on the iD baler, this system increases bale density. The baler runs smoother with a smaller flywheel and overall baler structure compared to competitive units, decreasing the horsepower needed to run the baler while making higher density bales. The combination of fewer, denser bales with lower fuel consumption offers a lower cost of operation for making heavy, high-quality bales that get more weight on a truck, decreasing transport costs.

## See & Spray™ Select

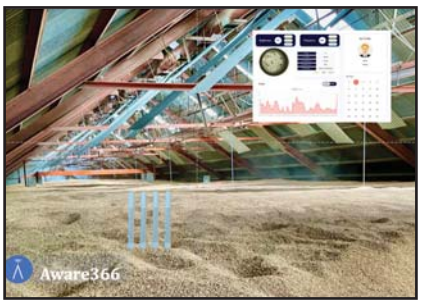
**Deere & Company**
**Moline, Illinois, USA**
**deere.com/en/**

See & Spray™ Select enables spot spraying of weeds on fallow ground and is John Deere's first offering using this technology provides a factory-installed and machine-integrated solution for farmers. See & Spray Select uses camera and control technology to differentiate color on fallow ground, detect weeds and spot spray them. This targeted spray application has similar hit rates as broadcast spraying while applying 77% less herbicide on average. Farmers can reduce input costs or utilize more expensive, complex tank mixes to manage weeds. Built upon the John Deere ExactApply™ foundation, See & Spray Select provides a single machine with seamless switching between target spray and broadcast applications while providing optimal performance, diagnostics, and data management through Operations Center.

## Smart Insect Early Detection and Notification System

**Aware366 LLC**
**El Macero, California, USA**
**aware366.com**

The Smart Insect Detection System achieves early detection of insects and monitors environmental conditions in agricultural and food products, such as cereal grains and nuts, during storage and transportation. It captures insects through novel insect traps as they emerge, remotely monitors their activities, and sends notifications to facility managers for appropriate action. Data on the environmental conditions of the products are used for prediction of insect occurrences and better management. Information can be stored locally and on the cloud, and accessed through apps. This technology provides an innovative solution to problems caused by insect infestation, including product and quality losses, chemical use, food safety concerns, and high management cost.





## Smart Soil Technology™

**Kuhn Krause, Inc.**
**Hutchinson, Kansas, USA**
**kuhn-usa.com**

KUHN Krause Smart Soil Technology™ uses AEF certified ISOBUS electronic control to bring complete, on-the-go adjustment and multiple function fine tuning on the Excelerator® XT into the tractor cab for the first time. Smart Soil Technology™ provides "preset only mode" with up to eight user-defined presets, which can be saved, allowing the operator to make multiple adjustments simultaneously with a simple touch of a button. Preset only mode can be activated to limit adjustment selections only to the saved presets when the machine is operated by a less skilled operator. The AEF certified ISOBUS software provides true plug and play compatibility with other certified displays and provides a truly compatible system from one brands of tractor to another without the need for additional equipment.

## SmartDepth™

**Precision Planting**
**Tremont, Illinois, USA**
**precisionplanting.com**

SmartDepth™ is a depth calibration and control system for row crop planter row units that can function as an automatic depth control system when paired with SmartFirmer for moisture-based automatic depth adjustment. SmartDepth replaces the factory standard T-handle depth adjustment with an electronic actuator that connects to the depth adjustment mechanism in the row unit. Smart Depth gives growers the ability to ensure that every row unit is accurate in its depth setting through a pre-plant calibration process. The grower can adjust depth on the go from the cab manually, or set SmartFirmer in-furrow moisture targets on the 20|20 display to control the depth automatically.

## T-Series Ag-Baggers

**RCI Engineering, LLC**
**Mayville, Wisconsin, USA**
**ag-bag.com**

The T-Series Ag-Baggers feature increased capacity while improving serviceability and transportability. The T7170 and T7060 replace a legacy line of Ag-Baggers and are the first production Ag-Bag® machines to be manufactured by RCI Engineering since the acquisition by RCI of Ag-Bag from CNH Industrial America in November 2019. Major advances include a rotor with more than double the number of teeth and a new pattern to improve capacity and bag density. A single, 12-inch wider conveyor allows delivery of more crop to match the improved capacity of the rotor. A forage distributor, longer tunnel, sweeping tunnel cleanout, longer cables, reversed transport system, integrated hydraulic lift, and streamlined operator control system contribute to making a machine for producers to grow their operations through increased capacity, serviceability, and transportability.

## TEROS 21 Gen 2

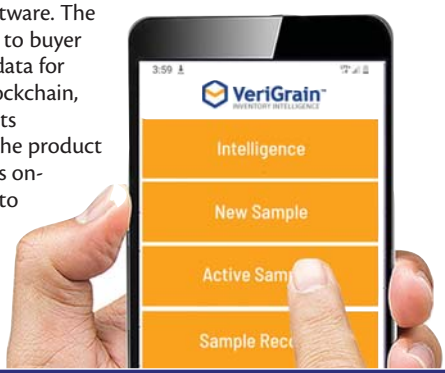
**METER Group, Inc.**
**Pullman, Washington, USA**
**metergroup.com**

TEROS 21 is the first full-range, maintenance-free water potential sensor. It takes a critical parameter that was once difficult to measure and makes it easy and affordable. Water potential is crucial in understanding water availability to plants, slope stability in soil, and potential for landslides. Developing an accurate easy-to-deploy sensor is vital to improving the ability to measure and understand important soil properties. The TEROS 21 Gen 2 boasts an improved circuit, a more robust microprocessor, and an improved measurement range. These improvements now allow the TEROS 21 Gen 2 to measure all the way from near saturation to air dry, finally making it a true full-range water potential sensor.

## VeriGrain Automated Sampling and Data Management System

**VeriGrain Sampling Inc.**
**Saskatoon, Saskatchewan, Canada**
**verigrain.com**

VeriGrain is an automated sampling and data management system. Grain samples are collected using two connected hardware components: a Sample Extraction Module located in the grain flow and a ground level Sample Management Module. Accurate cross-cut samples are pneumatically conveyed to the storage receptacle, collected, and stored in bar-coded containers. The sample data are entered into an app, which determines the optimal sampling interval, tracks grain quality and quantity, interacts with labs to obtain sample analysis, analyzes grain inventory to assist with marketing decisions, and allows the data to be shared with buyers and other farm management software. The app provides bin to buyer traceability and data for sustainability, blockchain, and carbon credits determination. The product platform includes on-board capability to determine grain characteristics in real time.



## VX240 Harvester

**Flory Industries**
**Salida, California, USA**
**Goflory.com**

The Flory VX240 is a new tractor powered nut harvesting machine that incorporates a waterless, filterless, dust suppression system to reduce the dust emissions generated by the harvesting process. This machine uses a three-stage dust suppression system that is compact enough to fit in an orchard and is capable of moving over 12,000 CFM of air while continuously removing debris and dust on the order of thousands of pounds per hour. While typical mobile dust suppression systems rely on water sprayers to reduce dust from air, this machine eliminates the need for a substantial amount of labor and logistics involved in operating water trucks and filling tanks.

## W200 Series Self-Propelled Windrowers and Platforms

**Deere & Company**
**Moline, Illinois, USA**
**deere.com/en/**

The new W200 Series M & R self-propelled windrowers offer producers a variety of horsepower options and new features, like TouchSet™ in cab controls. TouchSet provides operators with the ability to adjust swath flap and forming shields from the cab with the press of a button. The TouchSet pre-set library suggests settings based on crop type and allows for custom settings. The four new SPW models build on the success of the previous W200 series from John Deere with an increased model lineup and new functionality. R Spec models offer higher transport speeds and increase windrow width options. The M, R, R400, R500, and D600 options provide producers with operator environment, horsepower, speed, cut, and conditioning options. The new W200 Series self-propelled windrowers offer a solution to meet any hay producer's needs.

## WD5 Series Self-Propelled Windrower

**Case IH Agriculture**
**Racine, Wisconsin, USA**
**caseih.com**

WD5 Series Windrowers allow producers to get to the field faster and muscle through the tough spots, all without sacrificing harvest quality or operator comfort. Transport speeds up to 30 mph and cutting speeds up to 20 mph together with simplified operations and innovations such as Field Cruise and the Triple Windrower Attachment bring peak efficiency to the operation. These windrowers also feature integrated Advanced Farming Systems (AFS) technology, including the AFS Pro 700 display, to manage auto-guidance, control key machine functions and monitor windrower performance. WD5 Series Windrowers set the bar for innovation, technology and comfort, delivering high-efficiency hay production cutting after cutting. The all-new drive-by wire ground propulsion and steering system makes road transport and field work effortless for a more relaxed operator experience.

## Will your company introduce a new product in 2022?

If you have a new product, we might be celebrating you here next year! If your company will bring a new product to market for 2022, consider nominating it for an AE50 award. ASABE is proud to sponsor AE50, the only awards program of its kind, celebrating product innovations in the areas of agricultural, food, and biological systems. Our online nomination process begins in August, check our website (www.asabe.org/AE50).


# INDEX OF WINNERS BY COMPANY

**AGCO Corporation**
- Fendt® 300 Vario®
- Fendt TI Headland
- Fendt® Rogator® 900 Series Applicator
- Flex-Flo XD Ultra Unloader
- Massey Ferguson 8S
- Massey Ferguson DM 367 FQ-RC Front Mower

**Ålö USA Inc.**
- Quicke® QE-Command with Q-Companion

**Amity Technology LLC**
- Crop Chaser 1000

**Aware366 LLC**
- Smart Insect Early Detection and Notification System

**Case IH**
- Case IH® Fast Riser 6100 3-Section Front-Fold Planter
- Case IH Patriot® 50-Series Sprayers
- WD5 Series Self-Propelled Windrower

**CNH Industrial**
- Horizon™ Ultra Tractor Cab

**Deere & Company**
- 1775NT 24Row30 Planter
- C770 Cotton Harvesters
- HDF Hinged Frame Flexible Cutterbar Draper
- Integrated ExactRate™ Liquid Fertilizer System
- John Deere 9R Series MY22 Tractors
- Quick Change Blade Feature for ProSeries™ Opener
- See & Spray™ Select
- W200 Series Self-Propelled Windrowers and Platforms

**Flory Industries**
- VX240 Harvester

**Hagie Manufacturing Company**
- Hagie™ STS20

**Kelley Manufacturing Company**
- Peanut Inverter Auto Speed Control Permanent Crop Analyzer™

**Kuhn Krause, Inc.**
- Smart Soil Technology™

**Kuhn North America**
- Hydraulically Adjustable Windrow Merger on the KUHN FC 9330 D RA
- OptiWrap® OWR 6000
- SB 1290 iD TwinPact

**MacDon® Industries**
- M1170NT Self-Propelled Windrower
- MacDon FD2 FlexDraper

**METER Group, Inc.**
- TEROS 21 Gen 2

**Precision Planting™**
- Reveal
- SmartDepth™

**Raven Industries**
- OMNiDRIVE™

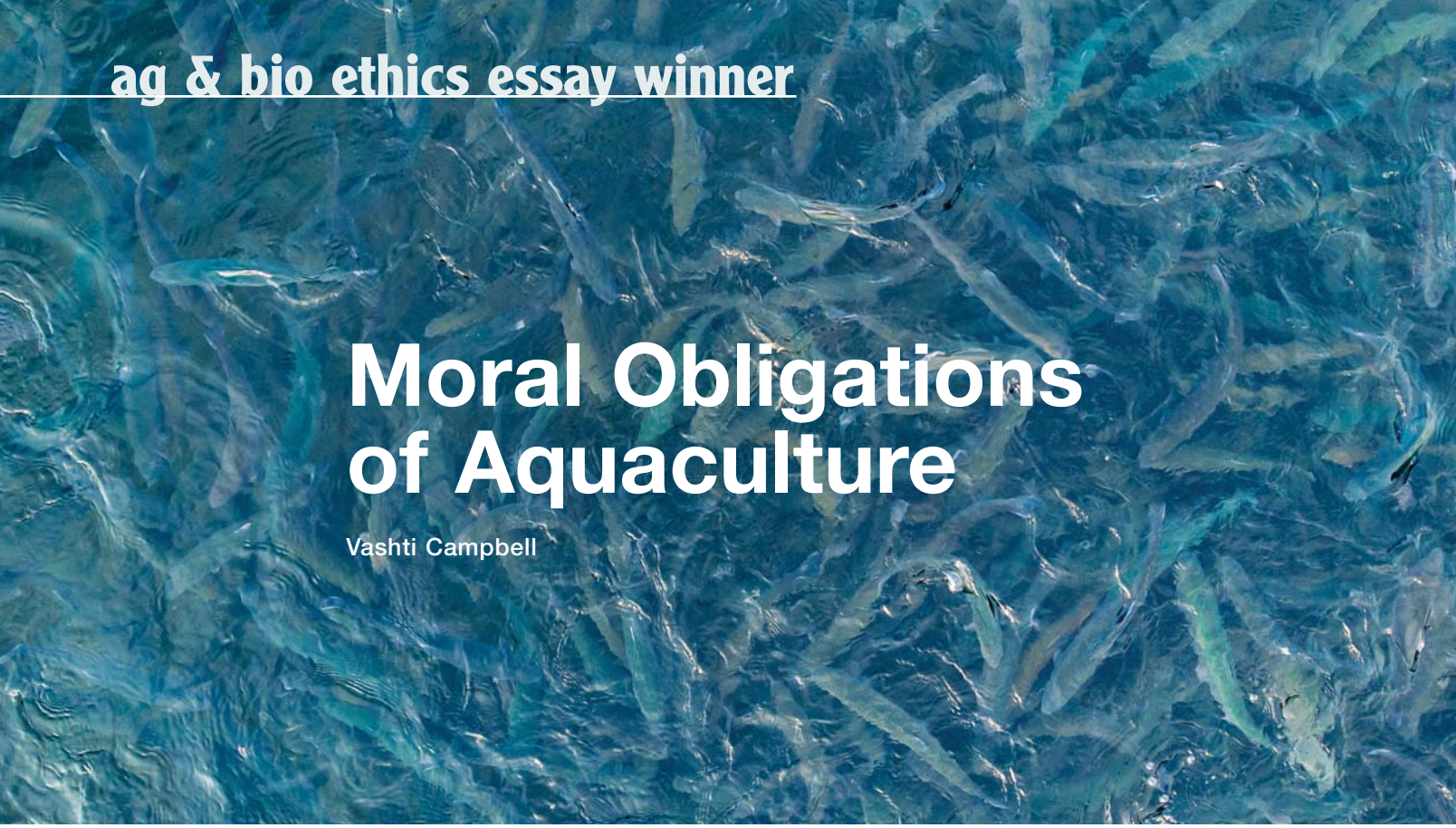
**RCI Engineering, LLC**
- T-Series Ag-Baggers

**RealmFive, Inc.**
- Barn View
- Flex Mini
- Front Cloud Connect Monitoring Device

**SCO2, LLC.**
- B-Series

**Smart Guided System**
- Permanent Crop Analyzer™

**VeriGrain Sampling Inc.**
- VeriGrain Automated Sampling and Data Management System



# Moral Obligations of Aquaculture

Vashti Campbell

**Editor's note:** **ASABE member Vashti Campbell,** a student at North Carolina State University, took first place in the 2021 Ag and Bio Ethics Essay Competition by submitting "an original work of up to 1,500 words on an ethics topic impacting the practice of professions related to agricultural and biological engineering, systems, or technology." Open to undergraduate and graduate student members of ASABE and IBE, second place went to **ASABE member Grace Phung** of Auburn University for "The Right to Clean, Healthy Living: The Correlation between Raw Sewage Exposure and Socioeconomic Disparity" and third place was awarded to **ASABE member Ryan Ackett** of North Carolina State University for "Labor Outcomes and Ethics of Agricultural Automation." Congratulations to our 2021 finalists, who presented their essays at the 2021 virtual Annual International Meeting. These winning essays can be found at asabe.org/Awards-and-Competitions/Student-Awards-Competitions-Scholarships/Ethics-Essay-Competition.

As a student conducting aquacultural research, I now find myself pondering the "story" of my purchase when I shop for fresh seafood. After a few inquiries of my fishmonger, I have found that most of my favorite seafoods are local aquacultured product, grown in North Carolina. This fact is a pleasant surprise; however, it is no secret that aquacultured seafood is quickly becoming one of the world's largest animal production industries (Bostock et al., 2010). Nevertheless, along with aquaculture's steady ascent comes specific challenges regarding the moral obligations of the industry to local communities, the environment and aquatic systems, and concerning the handling of live aquacultured product.

Aquaculture is the cultivation of aquatic life. The National Oceanic and Atmospheric Administration further defines aquaculture as "breeding, raising, and harvesting fish, shellfish, and aquatic plants" (National Oceanic and Atmospheric Administration, 2021). The most recent data shows that aquacultured "fish, crustaceans, molluscs, and other aquatic animals excluding aquatic mammals, reptiles, seaweeds, and other aquatic plants" represents 52% of all seafood production globally (FAO, 2020). While the burgeoning industry has greatly profited large food manufacturing industries, investors, non-profit organizations, and other groups, small-scale fisheries, and seafood businesses, especially those in developing countries, have not fared so well. Many small-scale seafood and fishing operations have complained that their livelihoods are being threatened by the

aquacultural industry due to the involvement of larger groups in wholesale seafood purchasing, industrialization of marine and coastal waters, and regulations preventing fishing for conservation purposes (Bavinck et al., 2017; Said et al., 2017; Cohen et al., 2019). One way larger aquacultural entities can abate the financial woes of small-scale operations is through collaboration. Through education and investment in innovative farming techniques and useful technology, extensive operations can support modest aquacultural industries. In addition, larger groups may even help develop small-scale aquaculture hubs in a particular location. It has been noted that while wild-caught fishing may yield greater gains at times, aquaculture provides more predictability in both time and economic value (Slater, 2017). This also provides job opportunities for the local community and creates an industry that is close to home for fishermen and other workers. Since every human has the right to nutritious foods, like lean and protein-rich seafoods, cooperation amongst larger operations is paramount for the progression of aquaculture worldwide. In addition, aquaculture businesses have a duty to protect aquatic resources.

The damaging effects of overfishing of the world's ocean have been vast. Coastal and marine ecosystems have suffered such impacts like extinction of marine vertebrates, reductions in aquatic plants, and eutrophication (Jackson et al., 2001).

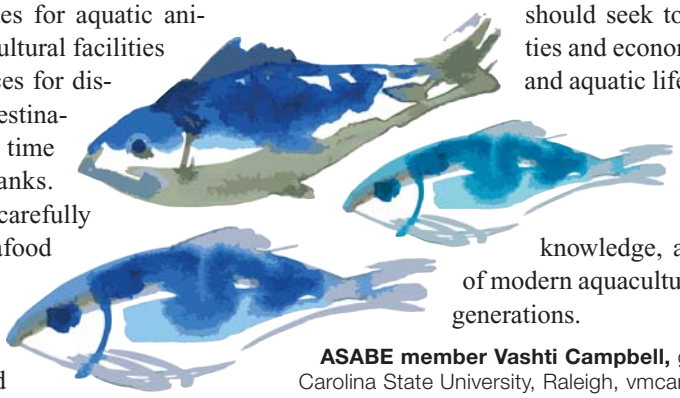
> "Thorough planning and execution of environmentally favorable aquaculture facilities and systems are currently needed to reap potential gains in the future."

Jackson et al. (2001) explains the ecological cycles of aquatic environments have not only been disturbed by large operations but also smaller native groups that utilize these water systems. Aquaculture combats overfishing by giving aquatic organisms time to naturally reproduce and replenish, subsequently restoring the natural balance of life in water ecosystems. The aquaculture industry also allows for some extent of management of aquatic life unlike products of the wild-caught industry. Since aquacultured product is often maintained in man-made systems (e.g. tanks, upweller systems, and caged systems), we can use these operations to "work for us." For example, oysters are filter-feeding creatures that are known to pump in surrounding water. If oyster aquaculture systems are grown in water negatively affected by eutrophication, they can help clean the water and feed human consumers. Aquacultured products like oyster reefs and kelp forests provide habitats, food, and coastal protection which contributes to a healthy biodiversity in the earth's oceans (Theuerkauf et al., 2019). Another advantage of aquaculture for the environment is that the practice can help ease stress on terrestrial land systems. Aquaculture facilities require less land than livestock and agricultural farming because aquatic creatures are "extremely efficient at converting feed to biomass for human consumption" (University of California-Santa Barbara, 2018). Thorough planning and execution of environmentally favorable aquaculture facilities and systems are currently needed to reap potential gains in the future.

Likewise, ethical aquaculture establishments should also consider the welfare of aquatic animals. Animal welfare is centered on "the animal's condition, on its subjective experience of that condition and/or whether it can lead a natural life" (Huntingford et al., 2006). This topic has been well debated and there have been concerns about whether or not fish can feel pain (Ashley, 2007). For some time, there has been concern on the stock density of live fish, for example. When fish are overloaded in transport tanks, the fish sometimes exhibit defensive behavior toward one another and can even spread disease amongst the group. While some distributors may be fully aware of overstocked tanks, some will proceed because more product transported results in more money gained. This malpractice is even evident in the final seafood product. Stresses experienced in the muscles of the fish due to transportation, capture, and management precede rigor mortis and contribute to the final product's quality (Nathanailides et al., 2011).

Live, aquatic animals should be provided enough space for the creature to move around freely as if in its natural environment because confined animals are also more likely to spread disease. A previous study showed that water-borne pathogens can spread amongst aquatic creatures at a faster rate than pathogens in terrestrial systems if not properly managed (Leung and Bates, 2012). Finally, the type of species of aquatic life should also be considered before containment and transportation. It has been previously suggested that aggressive aquatic species should not be held with docile species due to the possibility of violence toward the weaker animals. A previous study noted that aggressive aquatic species fared better in larger holding tanks with complex habitats (Oldfield, 2011). Aquaculture operation hubs, not just limited to the coasts but inland as well,

could also reduce transportation times for aquatic animals. Increasing the amount of aquacultural facilities would provide more harvesting sources for distributors closer to the product's end destination, thus reducing the amount of time creatures are kept in storage tanks. Overall, aquaculture, if considered carefully could offer many benefits for the seafood industry and society at large.



Though there are no clearly defined rules regarding ethical practices in aquaculture, we should strive to enhance humanity and steward the earth's resources in a responsible manner. All beneficiaries, employees, and contributors to the aquacultural industry should seek to benefit local communities and economies, aquatic ecosystems, and aquatic life. The aquacultural industry is steadily growing, so new challenges lie ahead; however, with good intent, growing knowledge, and hard work, the fruits of modern aquaculture can be assets for future generations.

**ASABE member Vashti Campbell,** graduate student, North Carolina State University, Raleigh, vmcampbe@ncsu.edu.

## References


Ashley, P. J. (2007). Fish welfare: Current issues in aquaculture. *Applied Animal Behaviour Sci., 104*(3-4), 199-235. https://doi.org/10.1016/J.APPLANIM.2006.09.001

Bavinck, M., Berkes, F., Charles, A., Dias, A. C. E., Doubleday, N., Nayak, P., & Sowman, M. (2017). The impact of coastal grabbing on community conservation—A global reconnaissance. *Maritime Studies, 16*(1), 1-17.

Bostock, J., McAndrew, B., Richards, R., Jauncey, K., Telfer, T., Lorenzen, K., Little, D., Ross, L., Handisyde, N., Gatward, I., & Corner, R. (2010). Aquaculture: Global status and trends. *Philosophical Trans. of the Royal Society B: Biological Sci., 365*(1554), 2897 LP-2912. http://rstb.royalsocietypublishing.org/content/365/1554/2897.abstract

Cohen, P. J., Allison, E. H., Andrew, N. L., Cinner, J., Evans, L. S., Fabinyi, M., Garces, L. R., Hall, S. J., Hicks, C. C., Hughes, T. P., Jentoft, S., Mills, D. J., Masu, R., Mbaru, E. K., & Ratner, B. D. (2019). Securing a just space for small-scale fisheries in the blue economy . In *Frontiers in Marine Sci.* (Vol. 6, p. 171). www.frontiersin.org/article/10.3389/fmars.2019.00171

FAO. (2020). The State of World Fisheries and Aquaculture 2020. In Sustainability in Action.

Huntingford, F. A., Adams, C., Braithwaite, V. A., Kadri, S., Pottinger, T. G., Sandøe, P., & Turnbull, J. F. (2006). Current issues in fish welfare. *J. of Fish Biology, 68*(2), 332-372. https://doi.org/10.1111/j.0022-1112.2006.001046.x

Jackson, J. B. C., Kirby, M. X., Berger, W. H., Bjorndal, K. A., Botsford, L. W., Bourque, B. J., Bradbury, R. H., Cooke, R., Erlandson, J., Estes, J. A., Hughes, T. P., Kidwell, S., Lange, C. B., Lenihan, H. S., Pandolfi, J. M., Peterson, C. H., Steneck, R. S., Tegner, M. J., & Warner, R. R. (2001). Historical overfishing and the recent collapse of coastal ecosystems. *Science, 293*(5530), 629-638. www.jstor.org.prox.lib.ncsu.edu/stable/3084305

Leung, T. L. F., & Bates, A. E. (2012). More rapid and severe disease outbreaks for aquaculture at the tropics: implications for food security. *J. of Applied Ecology, 50*(1), 215-222. https://doi.org/10.1111/1365-2644.12017

Nathanailides, C., Panopoulos, S., Kakali, F., Karipoglou, C., & Lenas, D. (2011). Antemortem and postmortem biochemistry, drip loss and lipid oxidation of European sea bass muscle tissue. *Procedia Food Science, 1,* 10991104. https://doi.org/10.1016/J.PROFOO.2011.09.164

National Oceanic and Atmospheric Administration. (2021). What is aquaculture? National Ocean Service Website. https://oceanservice.noaa.gov/facts/aquaculture.html

Oldfield, R. G. (2011). Aggression and Welfare in a Common Aquarium Fish, the Midas Cichlid. *J. of Applied Animal Welfare Sci., 14*(4), 340-360. https://doi.org/10.1080/10888705.2011.600664

Said, A., MacMillan, D., Schembri, M., & Tzanopoulos, J. (2017). Fishing in a congested sea: What do marine protected areas imply for the future of the Maltese artisanal fleet? *Applied Geography, 87,* 245-255.

Slater, M. J. (2017). Societal and Economic Impacts of Aquaculture. *J. of the World Aquaculture Society, 48*(4), 539-541. https://doi.org/https://doi.org/10.1111/jwas.12445

Theuerkauf, S. J., Morris Jr, J. A., Waters, T. J., Wickliffe, L. C., Alleway, H. K., & Jones, R. C. (2019). A global spatial analysis reveals where marine aquaculture can benefit nature and people. *PLoS One, 14*(10), e0222282.

University of California - Santa Barbara. (2018). Farming fish saves land: Team conducts the first land-use analysis of future food systems focusing on aquatic farming. *ScienceDaily,* April 30. www.sciencedaily.com/releases/2018/04/180430160434.htm

# YPC News & Notes

## Career Fair and Résumé Tips

*Especially if the job posting doesn't mention agricultural or biosystems engineers*

### Create a résumé with relevant coursework

Most recruiters won't recognize agricultural or biosystems engineering as a degree or understand the coursework involved. Help them by listing courses in your degree program that are similar to courses in the degrees they are looking for or that have relevance for the position you are applying for. Include the course number and full title (such as, ABE 404: Instrumentation for Agricultural and Biosystems Engineering). For example, if I were applying for a water resources engineer position, I might list my civil engineering hydrology and hydraulics course as well as my soil and water conservation engineering course in the agricultural engineering department.


### Keep your elevator pitch short and snappy

Try to keep it to only a few sentences about why you are excited for the position and what you will bring to the company. Start with your name and your expected graduation date, or the type of position (internship or full-time) that you are applying for.

It helps if you can relate something currently on your résumé to why you are interested in the position. This is a good place to loop that in. For example: "I currently maintain and operate data collection equipment for strength testing in my research assistant position. It would be very rewarding to learn more how those skills relate to the test engineer position at your company."

Ask the recruiter a question to close the pitch. This opens the conversation and takes the pressure off you feeling like you're reading from a script. Remember, the people you talk to at a career fair are looking for their next new co-workers, especially if they are early-career engineers. Friendliness and likeability count in your favor. It may also be a good idea to ask about their role at the company, if they don't tell you when introducing themselves. That will help you tailor your questions to be more HR- or engineering-related.

### Close the conversation with your "why"

Before you step through the doors of the career fair, consider what your end goal will be for each interaction. Begin with that end goal in mind when you are preparing to speak to recruiters. Do you want to get an interview? To learn more about how to apply? Maybe you want to learn more about what the person you are talking to does at the company. Your end goal will shape what you say and the story you tell about yourself.

If possible, ask a direct question related to your goal for the career fair. Examples include, "I've applied online to this position, what is the timeline for the next steps?" or, "How soon will someone from your company be in touch about this position?" It might also be possible to ask for an on-campus interview, if the prospective employers are scheduling interviews at your school.

Remember to thank the recruiters for their time after they've responded to your questions.

Above all, apply for the positions that you are interested in, even if the job posting doesn't specifically mention agricultural or biosystems engineers. Make sure you clearly connect your degree, interests, and activities to the position through your résumé. Preparing for the career fair isn't just what you do in the week prior, it's part of the purpose of everything you do, inside and outside the classroom, during your college experience. But that's not to say you can't join a club just for fun!

**ASABE member and YPC Executive Committee Member at Large Abby Schaefer,** graduate student, Iowa State University, Ames, ae.schaef@outlook.com.

## VisualChallenge11

# IN PLAIN SIGHT

## IMAGES OF AGRICULTURAL AND BIOLOGICAL ENGINEERING

Each year, *Resource* asks ASABE members and their colleagues to communicate with images—statements without words—to celebrate the visual aspects of agricultural and biological engineering. After the call went out for submissions for *VisualChallenge*11, we were eager to see what our members would submit. We are pleased to showcase a handful of the entries that we received for our eleventh year.

We thank our many contributors who focused in on the profession—finding beauty and meaning. Their work comes to life in these images, showing to those outside the field: "This is what we do."

While the selection process was inevitably subjective, we hope these photos provide a glimpse into the variety of activities, workplaces, and surprises that an ABE career can offer. As your view clears in 2022, remember to pull out your camera or phone and take a shot for next year's visual challenge!


**ASABE member Gabriel Abdulai,** ***Ph.D. Candidate, University of Kentucky, Lexington, USA.***

### STARING HEIFER

***A heifer gazes into the distance while we finish our work unmounting heart rate sensors and collars from heifers used in our study.***

**ASABE member A.J. Both,**
*Professor, Rutgers University, Department of Environmental Sciences, New Brunswick, New Jersey, USA.*

## OUTSMARTING MOTHER NATURE

***Crop irrigation: Because Mother Nature doesn't always cooperate.***

**ASABE member Humayun Kabir,**
*General Manager, Alim Industries, Ltd., Dhaka, Bangladesh.*

## MAN VS. MACHINE

***Transplanting rice seedlings by machine rather than by hand reduces cost, time, and labor and increases yield.***

**Matthew Robert, P.E.,** *State Conservation Engineer, USDA-NRCS, Champaign, Illinois, USA.*

## BIRDS OF A FEATHER FLOCKING TOGETHER

***This wetland restoration was designed and constructed about 10 years ago by Illinois NRCS Ag Engineers Manny Wei and* ASABE member Tom Book *(both retired). Since its first restoration, the wetland has been improved upon by Agricultural Engineer Matt Dasenbrock.***

**ASABE member Santosh K. Pitla,** *Associate Professor, Advanced Machinery Systems, Department of Biological Systems Engineering, University of Nebraska, Lincoln, USA.*

## HIGH-TECH FARMHAND

***The University of Nebraska-Lincoln's Flex-Ro robot shown sensing a soybean crop. This multi-purpose platform was developed in UNL's Machine Automation and Agricultural Robotics (MAARS) laboratory for use in phenotyping, spraying, planting, soil sampling, and nitrogen management. This 4-wheel drive, 4-wheel steer robotic vehicle can be thought of as a high-tech farm hand that will assist crop producers and scientists.***

**Jasper Cunningham,** *Director of Membership, ASABE, St. Joseph, Michigan, USA.*

## POUR SOME SUGAR (BEETS) ON ME

***A snapshot taken at the Michigan Section Fall Membership Tour of the Michigan Sugar Company. Growing, storing, and processing sugar beets encompasses a diverse range of agricultural and biological engineering disciplines—machinery and facility systems, ventilation and storage, and bioprocessing.***

**ASABE member Jean Pompeo,** ***Graduate Assistant, Department of Agricultural and Biological Engineering, University of Florida, Gainesville, USA.***

## LETTUCE SHOW YOU OUR RESEARCH

***The 9 x 9 foot growth chamber at the University of Florida houses 96 heads of lettuce grown in NFT hydroponic systems (left). The lettuce leaves are spread for ImageJ leaf area measurements (top).***

**ASABE Past President and Fellow Jim Dooley, P.E.,** ***Chief Technology Officer, Forest Concepts, Auburn, Washington, USA.***

## WE WILL BALE YOU OUT

***One might think of baling hay, corn stover, etc., but we just completed a field trial with PG&E Power Company in California to bale powerline trimmings as an alternative to chipping them. This method is safer, quieter, and enables low-cost transport to users.***

## THE BIG FIVE

***While most tourists visit Kenya to get pictures of "The Big Five" safari animals, here we have a photo of "The Big Five" in hydrology: A river, a streamgage, a bridge, an irrigation pipe, and a hydrologist in waders. In this photo, ASABE member Lory Willard unlocks the cap of the streamgage to download continuous flow monitoring data that will be used to analyze impacts of sustainable agricultural intensification practices on streamflow in Laikipia, Kenya. (*Photo credit: John Gitonga)**

**ASABE member Lory Willard,**
***Ph.D. candidate, University of Florida, Gainesville, USA.***

## TEACHING MOMENT

***Upper Ewaso Ng'iro Water Resources Authority staff teach interns and researchers how to use a dumpy level for stream surveys during a field campaign with University of Florida researchers in Laikipia, Kenya. The surveys will be used to make rating curves for a hydrologic model to assess impacts of sustainable agricultural intensification management on river flow in the region.***
**(Photo credit: Lory Willard)**

## HARNESSING THE SUN

***The St. Joseph Solar Farm was completed in spring of 2021. Indiana Michigan Power (I&M) owns and operates the solar farm. It is their fifth and largest solar farm and is located in St. Joseph County, Indiana. Nearly 58,000 solar panels generate emission-free power by harnessing the sun. The farm generates up to 20 megawatts of energy, enough to power approximately 2,700 homes. This farm also avoids more than 13,000 tons of carbon—the equivalent of taking 2,600 cars off the road or planting 200,000 trees.***

**ASABE member Brian McLaughlin,** ***2015 AE50 Winner, Safety Psychographics LLC, Notre Dame, Indiana, USA.***

## AMISH HAYING OPERATION

***While rotary rakes are now standard equipment for gathering hay in the field, many small Amish farmers still rely on simple rakes drawn by horses. This method doesn't have the speed or efficiency of "English" equipment or practices, but it provides a cost-effective way of gathering up the hay with no fuel cost but oats. This photo was taken in Marshall County, Indiana, near Rentown, within the general bounds of the 3rd-largest Amish settlement in the U.S.***

# Honoring the Newly Elected

Eleven new ASABE Fellows were recognized at the virtual Annual International Meeting in July 2021. *Resource* is proud to highlight these recent honorees. In this issue we recognize **Terry Howell, Jr., P.E.**, and **Rodney Huffman, P.E.**

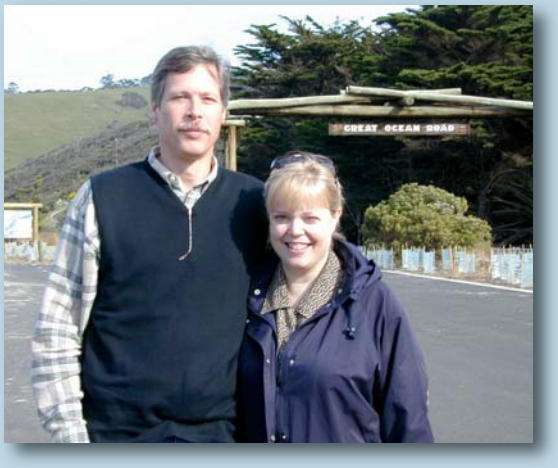
Fellows must have a minimum of 20 years of active practice in, or related to, the profession of engineering, the teaching of engineering, or the teaching of an engineering-related curriculum. The designation Fellow has honorary status, to which members may be elected but may not apply.

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.

**Terry A. Howell, Jr., P.E.,** executive director of the Food Processing Center at the University of Nebraska-Lincoln, is honored for his research and leadership in the agri-food industry and for his committed leadership in ASABE.

At the Food Processing Center, Howell leads a multi-disciplinary team of food scientists and engineers that provides consulting, laboratory and pilot plant testing, and training in the agri-food industry. His role is pivotal in leveraging the people, equipment, and resources that improve the impact of the Food Processing Center on food and agriculture in Nebraska, in the Great Plains region, and beyond. Prior to joining the University of Nebraska, Howell was a senior manager in product development at McKee Foods and supervised the launch of more than 300 new products.

*Pictured above,* Terry and his family vacationing in Texas.




**Rodney L. Huffman, P.E.,** part-time project engineer at Agri-Waste Technology, Inc., in Apex, North Carolina, is recognized for his leadership in providing teaching resources for agricultural engineering and for his service to ASABE.

Huffman is a co-author of multiple editions of the seminal textbook *Soil and Water Conservation Engineering*, which is considered the foundational reference for the natural resources and ecological aspects of agricultural and biological engineering. The book continues to be widely used by faculty at many universities in the U.S. and internationally. For many years, the ASABE subcommittee for development of the professional licensure exam (EOPD 414) has relied on this book as a resource for the agricultural and biological engineering exam. Producing resources to improve teaching in agricultural engineering has always been Huffman's passion.

*Pictured above,* about 20 years ago, Rod and his late wife, Lois, were at the start of the Great Ocean Road, a scenic stretch along the southern coast of Australia (west of Melbourne). It is noted for numerous sea stacks, coves, and beaches, as well as old-growth eucalyptus forests.

**The team isolated living immortalized cells in multi-well plates to study them with Doppler (*Photo courtesy of Purdue University /Rebecca McElhoe*).**

## Doppler radar peers inside cells for faster diagnosis and treatment of infection

**In brief:** Doppler radar can look inside air masses to predict the weather. On a smaller scale, a Purdue University team is using similar technology to look inside living cells, creating a new method to detect pathogens and treat infections.

In research at Purdue University, Doppler radar is being used to peek inside living cells and track their metabolic activity in real-time, without waiting for cultures to grow. Using this method, the researchers can test microbes found in food, water, and other environments to determine if they are pathogens, and identify the right medicine to treat antibiotic-resistant bacteria.

David Nolte, Purdue's Edward M. Purcell distinguished professor of physics and astronomy; John Turek, professor of basic medical sciences; Eduardo Ximenes, research scientist in the Department of Agricultural and Biological Engineering; and **ASABE member Michael Ladisch,** distinguished professor in the Department of Agricultural and Biological Engineering, adapted this technique from their previous study on cancer cells, which was published in *Communications Biology*.

Using funding from the National Science Foundation as well as Purdue's Discovery Park Big Idea Challenge, the team worked with immortalized cell lines, that is, cells that live forever unless they are killed. They exposed the cells to different known pathogens, including Salmonella and *E. coli*. They then used the Doppler method to monitor how the cells reacted. These living cells are called sentinels, and observing their reactions is called a biodynamic assay.

"First we did biodynamic imaging of cancer cells, and now we're applying it to other kinds of cells," Nolte said. "This research is unique. No one else is doing anything like it. That's why it's so intriguing." The method is broadly applicable whenever scientists have isolated an unknown microbe and want to know if it is pathogenic. Such cells may show up in the food supply, water sources, and even in melting glaciers.

"This method directly determines if cells are pathogenic," Ladisch said. "If the cells are not pathogenic, the Doppler signal doesn't change. If they are, the Doppler signal changes significantly. We can then use other methods to identify the pathogen. This is a quick way to tell friend from foe."

Being able to quickly discern harmful cells is helpful in situations where people encounter an unknown microorganism, allowing doctors to know what precautions to take. Once a microbe is known to be harmful, doctors can begin established protocols to identify the microbe and select an effective antibiotic.

Another benefit is the ability to quickly determine which bacteria respond to which antibiotics. Antibiotic resistance is a serious problem in hospitals and other environments where individuals with compromised immune systems are exposed to antibiotic-resistant bacteria. This exposure can result in fatal bacterial sepsis, or septicemia. Bacterial sepsis is different from the viral sepsis that has been discussed in connection with COVID-19, although the researchers' next steps will include investigating viral sepsis.

Treating sepsis is challenging. Giving the patient broad-spectrum antibiotics sounds like a good idea, but it might not help, and it could even make the situation worse. Exposing bacteria to antibiotics that do not kill them only makes them

**ASABE member Michael Ladisch works with the Doppler apparatus to observe living cells in real time (*Photo courtesy of Purdue University/Rebecca McElhoe*).**

more resistant, and more difficult to fight. However, culturing tissues and homing in on the correct antibiotic can take time that the patient doesn't have.

The new Doppler method will allow scientists to combine bacterial samples with tissue sentinels and treat each sample with a different antibiotic. Using the Doppler signal, they can quickly notice which samples show dramatic metabolic changes. Those changes indicate that the bacteria are dying due to the antibiotic.

"When we treat bacterial infections with antibiotics, the bacteria don't have to multiply much before they start to affect the tissue sentinels," Nolte explained. "There are too few bacteria to measure directly, but they affect how the tissues behave, and we can detect that change with Doppler." In less than half the time required for traditional culture and diagnosis methods, doctors could tell which antibiotic to administer, bolstering the patient's chances for recovery.

The researchers have worked closely with the Purdue Research Foundation's Office of Technology Commercialization to patent and license the technology. They plan to further explore whether the Doppler method will work with tissue samples that have been exposed to nonliving pathogenic cells or dried spores, and test the method for detecting and treating viral sepsis.

For more information, contact Brittany Steff, bsteff@purdue.edu.



## ASABE members honored

**In brief:** Two ASABE members where honored at the Annual Convention of the Indian Society of Agricultural Engineers (ISAE) at Patna, India, on November 23, 2021.

**ASABE Fellow Gajendra Singh** was awarded the ISAE Mason Vaugh Agricultural Engineering Pioneer Award for 2020. This is the highest award given by ISAE. Mason Vaugh is considered the father of agricultural engineering in India. He started the first degree program in agricultural engineering at the Allahabad Agriculture Institute in 1942. The first recipient of the award, in 2012, was Professor Ralph C. Hay of the University of Illinois at Urbana-Champaign.

Gajendra Singh is recipient of ASABE's Kishida International and Massey-Ferguson Education Gold Medal awards. He has served as Professor, Dean, and Vice President at the Asian Institute of Technology, Thailand; Deputy Director General (Engineering) of the Indian Council of Agricultural Research, New Delhi, India; and Founding Vice Chancellor (President) of the Doon University, Dehradun, India.

**ASABE member Vijay Pal Singh, P.E.,** Distinguished Professor at Texas A&M University, received the Professor Gajendra Singh Education Gold Medal Award for 2020 for his service as a leading educator in hydrology, hydraulics, irrigation, and water resources. This award was established by the ISAE to recognize the contributions of Professor Gajendra Singh in the field of agricultural engineering in general and education in particular. Professor Vijay P. Singh is the first recipient of this award.


## ASABEtheChange 2021 is a success

**In brief:** On November 30, 2021, ASABE members came together to show their generosity, share their kindness, and make an impact on Giving Tuesday 2021.

Thank You! Because of you, we were able to raise an incredible $34,884, which was doubled by a generous match from the ASABE Foundation for a total of nearly $70,000 to support student competitions, scholarships, and many other ASABE programs and initiatives.

The passion of people like you keeps us going, and we hope we make you proud with how we pay these funds forward to benefit our members and our profession.

Keep an eye out for updates on the impact of your Giving Tuesday donation in the coming months, along with other ways to get involved. Thank you again for your generous support!

# Inspiring Young Students to Pursue Engineering

Tami Brown-Brandl and Brian Steward, P.E.

Imagine elementary school students understanding inputs and outputs, choosing appropriate sensors, and programming an autonomous robot. Imagine middle school students learning about PID control and creating advanced programs for sensor-based decision making. Imagine high school students using CAD to design drive trains, manufacturing parts with CNC machine tools, using finite element analysis to adjust the design, ordering custom components from a machine shop, using image processing for target recognition, and applying path planning and motion control. We have witnessed all of these skills. They happened outside of traditional classrooms, and they were all student-driven.

Yes, it's true, and it's amazing.

These examples are just some of the skills that we've seen in students who are involved in FIRST programs. FIRST stands for "For the Inspiration and Recognition of Science and Technology." It's an international non-profit organization with a mission to involve students in age-appropriate robotics and STEM-related competitions. FIRST engages more than 650,000 students and about 320,000 mentors and coaches worldwide in five levels of competition (three levels of FIRST Lego League, K-8; FIRST Tech Challenge, 7-12; and FIRST Robotic Competition, 9-12).


**Drive Caption from FRC team Neutrino during an intense robotic match. Thousands of spectators look on as six 185-lb robots move approximately 10 feet/s during each 2:30 min match.**

## Competition and gracious professionalism

When students compete, they compete to win. While FIRST harnesses that competitive spirit, it also inspires "gracious professionalism"—a term coined by the late Woody Flowers, a professor of mechanical engineering at MIT and one of the founders of FIRST. Gracious professionalism is defined as "competition not for the sake of destroying each other, but for the sake of bettering and improving both competitors as a result of the competition." You may need to read that definition again to appreciate its meaning. Gracious professionalism is an ingenious way to inspire students to help each other learn.

FIRST competitions are designed to promote gracious professionalism, and FIRST students take that message to heart. Before and even during the competitions, the student teams reach out to other teams to ask for help and to provide assistance. All the students and their mentors are committed to sharing their knowledge and helping others. As a result, everyone gains new skills—soft skills as well as hard skills. As a lifelong educator, nothing is more inspiring to me than seeing students eagerly helping other students.

## FIRST's motto is "more than a robot"

FIRST programs involve students in many more challenges than designing and building a robot. Younger students learn presentation skills, and they learn about global problems by participating in innovative projects that are based on specific topics. The programs also introduce students to careers that are relevant to the topic. In previous programs, students have learned about ensuring food safety, helping elderly people remain in their homes, and inspiring sedentary people to become more active. Given the current concerns about global supply chains, this year's topic is the transportation of goods. Students are rewarded for their creativity in describing the problem, and for their proposed solutions, in a fun and engaging way.

Older students document their design and development work, and they develop their ability to teach STEM skills to younger students through outreach events. In addition, they submit essays for the awards competition, produce videos to promote their team image and team accomplishments, and work with experts from around the world on new products. These older students also create business plans, raise money by working with sponsors, and much more. Their most important task is learning the different strengths and weaknesses among their team members and then capitalizing on those differences. In other words, they learn to work together.

## A measurable impact

Studies have shown that students involved in FIRST are 1.4 times more likely to become STEM majors in college and 2.3 times more likely to major in engineering or computer science. The numbers are even stronger for female students. Girls who participate in FIRST are 3.1 times more likely to major in computer science or engineering. Other studies have shown that female FIRST students are four times more likely, and minority FIRST students are two times more likely, to pursue technology and engineering in college than non-FIRST students.

We have seen these benefits first hand. In Aurora, Nebraska, Tami volunteers with a FIRST group that has been helping students for 12 years. During that time, the group has mentored about 85 kids. Of the students who graduated from high school, more than 70% were in the top 10% of their class, about 85% majored in STEM-related fields, and 70% majored in engineering.

**A'ROR'N Bots running their robot at Nebraska State Competition. In addition to STEM skills, FIRST teaches teamwork, cooperation, and the art of "gracious professionalism".**

In Ames, Iowa, Brian volunteers with a FIRST group that has mentored 128 high school students over the past ten years. His group has also mentored more than 600 students in elementary and middle school programs, serving as a pipeline to the programs in the upper grades and to STEM majors in college. Of the group's student alumni, at least 64% have pursued STEM majors. The impact of these programs on the students' lives has been profound.

## Partners of FIRST

FIRST is supported by important strategic partners, including John Deere, Caterpillar, Rockwell Automation, Disney, Amazon, Apple, Bosch, the Department of Defense, NASA, and others. A complete list is available at www.firstinspires.org/about/our-supporters/founding-and-strategic-sponsors. These organizations see the value of FIRST.

Professional societies have also supported FIRST by providing scholarships and serving as partners. The American Society of Mechanical Engineers (ASME) provides a $5,000 scholarship for high school seniors involved in FIRST who are planning to major in mechanical engineering. The National Fluid Power Association offers an annual $40,000 robotics scholarship to one lucky graduating senior. Many colleges also offer scholarships for FIRST students. To extend its outreach, FIRST has formed alliances with the American Society of Engineering Education (ASEE), the Society for Women Engineers (SWE), the Society for Hispanic Engineers, and other professional organizations.

Agricultural applications of automation and robotics are developing rapidly. There's a great need for engineers in this area, and our discipline can provide that expertise. Developing a talent pipeline starts early, with primary and secondary students. Today's young people are idealistic and highly motivated. They are inspired to take on big challenges, and early experience with engineering design, team building, and business skills can give them a head start on a useful career.

The continued success of FIRST depends on the involvement of real-world mentors. Take a look around your area, think back on your own career path, and then get involved in helping tomorrow's engineers.

**ASABE Fellow Tami Brown-Brandl,** Professor and Dr. William E. and Eleanor L. Splinter Chair, Department of Biological Systems Engineering, University of Nebraska, Lincoln, USA, tami.brownbrandl@unl.edu; and **ASABE member Brian Steward, P.E.,** Professor, Agricultural and Biosystems Engineering Department, Iowa State University, Ames, USA.

## Further Reading

Burack, C., Melchior, A., & Hoover, M. (2019). Do after-school robotics programs expand the pipeline into STEM majors in college? *J. of Pre-College Engineering Education Research (J-PEER), 9*(2), article 7. https://doi.org/10.7771/2157-9288.1244

FIRST. (2020). Together we rise: 2020 annual impact report. Manchester, NH: FIRST. Retrieved from https://www.firstinspires.org/resource-library/annual-reports

Melchior, A., Cohen, F., Cutter, T., & Leavitt, T. (2005). More than robots: An evaluation of the first robotics competition participant and institutional impacts. Waltham, MA: Brandeis University. Retrieved from http://www.techfire225.com/uploads/6/3/7/1/6371896/first_study.pdf

# 2022 AETC

## Agricultural Equipment Technology Conference

*February 14-16, 2022*
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