One of our Society’s goals is to cultivate a diverse, thriving, and engaged membership. The March/April issue of Resource, celebrating “Women of ASABE,” illustrates how we’re working toward this goal. Thanks to guest editor and ASABE member Kati Migliaccio and all the women who told their stories for this distinctive edition. If you haven’t read the issue yet, then you’re missing something special. I suggest that you stop right now, settle in, and start reading (https://www.asabe.org/r2602). I’ll wait for you to come back.

So, what did you think? Pretty inspiring, isn’t it? It certainly helps men better understand the often difficult path that women have taken and the courage that they’ve shown. Men, do you think you could have moved forward if you were in the minority, striving for participation and recognition in an “almost all women” Society? Many of us might not. I honor all our women members. Thank you for helping our Society grow, diversify, and improve the world with better food, fiber, energy systems, products, and processes.

Our women membership has been growing:

<table>
<thead>
<tr>
<th>Year</th>
<th>Overall</th>
<th>Regular</th>
<th>Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>12%</td>
<td>9%</td>
<td>26%</td>
</tr>
<tr>
<td>2013</td>
<td>14%</td>
<td>10%</td>
<td>28%</td>
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<tr>
<td>2018</td>
<td>17%</td>
<td>15%</td>
<td>31%</td>
</tr>
</tbody>
</table>

Those numbers show a nice trend, and I think that the quality of our membership has improved as well.

So, how can we do more, as men and women? How do we increase diversity and engage others who are not like ourselves? The women of ASABE have given us some great examples. But there are still some tough issues to tackle—some that are not in our comfort zone.

One “non-comfort zone topic” is the need to continually protect each other from any form of harassment. Historically, this has not been a significant issue in our Society. But we must remain sensitive, and harassment must have no part in our culture. Harassment is a cancer to any group’s growth, and it’s just unacceptable. Our Society’s mission to benefit others with engineering solutions depends on a fundamental respect for others. We are committed to setting standards of excellence in this area.

Therefore, in March, we took action and joined the Societies Consortium on Sexual Harassment in STEMM (the second M stands for Medicine) as an inaugural member to advance professional and ethical conduct, climate, and culture in our Society. This consortium has expert resources on law, policy, and procedures to help societies like ours. We will use this new relationship and the valuable resources to determine better methods to minimize and manage any potential harassment issues. I’m excited about this initiative, and I ask for your support. To learn more, and to participate, contact me or anyone at headquarters.

In this issue of Resource, you’ll find more examples of working with diverse groups that have helped elevate our Society’s worldwide impact. For example, ASABE Fellow Indrajeeet Chaubey and Indra Mani of the Indian Society of Agricultural Engineers (ISAE) report on the success of the Global Water Security Conference for Agriculture and Natural Resources, which was held in India in October 2018. Our thanks to Indrajeeet and Indra, the 2050/5 Committee, and ISAE for the partnership that brought this conference to life.

As always, if you have new ideas for ASABE, thoughts, or opinions, I really want to hear from you.

Maury Salz
msalz@myasabe.org

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**events calendar**

**ASABE CONFERENCES AND INTERNATIONAL MEETINGS**

To receive more information about ASABE conferences and meetings, call ASABE at 800-371-2723 or e-mail mtgs@asabe.org.

**2019**

July 7-10 **ASABE Annual International Meeting.** Boston, Mass., USA.

**2020**

Feb. 10-12 **Agricultural Equipment Technology Conference (AETC).** Louisville, Ky., USA.

July 12-15 **ASABE Annual International Meeting.** Omaha, Neb., USA.

**2021**

July 11-14 **ASABE Annual International Meeting.** Anaheim, Calif., USA.
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Consumers throughout the world are always seeking high-quality foods that are tasty, nutritious, wholesome, free of chemicals, visually appealing, and long-lasting on the shelf. The food and beverage industry is committed to providing such foods through the development and adoption of innovative technologies and processing methods. Recent advances in nanoscience and nanotechnology have provided a unique opportunity for the industry to meet or even exceed consumer expectations.

In the metric system, “nano” means $10^{-9}$, which is very small. For example, a typical human hair is 80,000 nanometers in diameter. More importantly, the behavior of materials at the nano scale is very different from their behavior at larger scales. Silver in aggregate form is inert, but at the nano scale it has antimicrobial properties. This nano behavior provides opportunities for the food and beverage industry to incorporate nanomaterials, and processes involving nanomaterials, into food processing, pathogen detection, food packaging, water purification, wastewater treatment, and targeted delivery of nutrients and other beneficial compounds. Some examples of the benefits of nanotechnology are outlined below.

Omega-3 fatty acids provide significant health benefits, such as reductions in cardiovascular disease, stroke, and certain cancers. The main sources of omega-3 fatty acids are fish oil and flaxseed oil. Unfortunately, many people don’t like the taste of these oils, and therefore avoid them. However, by nanoencapsulating these oils and then incorporating them into breads or other baked products, these healthful oils can be delivered to the digestive system with no unpleasant flavors or aromas, and consumers will receive the benefits.

Nanopackaging of beneficial compounds can also improve the health benefits of foods and beverages. Packaging materials that incorporate nanoparticles can...
enhance the shelf life of perishable products, and such packaging already exists. For example, Nanox Technology, a nanofabrication company in Brazil, markets milk containers with silver nanoparticles that increase the shelf life of milk; Fonterra Ltd., a dairy cooperative in New Zealand, markets double-layer UV-protected milk containers that incorporate titanium dioxide nanoparticles; and Baby Dreams Ltd., in South Korea, markets feeding bottles with silver nanoparticles. Nanosensors can also be built into packaging to warn consumers of spoilage.

Meat products are a major source of protein for consumers, but fresh meat has a short storage life and can quickly spoil due to microorganisms and pathogens. Packaging film can incorporate nanoparticles to enhance the film’s strength as well as to optimize gas transmission properties to create an environment that promotes longer storage life. Packaging film with built-in nanosensors can also detect pathogenic microorganisms on meat and warn retailers and consumers of the risk. Meat can also be made more beneficial for consumers by incorporating prebiotics and probiotics using nanoemulsions. Because of the large surface-to-volume ratio of nanoparticles, smaller quantities of preservatives or marinades can achieve the same benefit as larger quantities with larger particles.

So far, consumers are willing to accept nanoparticles, as long as the particles are not in direct contact with the foods they consume. However, consumers are not yet ready to accept nanoparticles that are integrated into foods or beverages, and only limited studies have been performed to demonstrate that no negative effects on human health occur from long-term consumption of nanoparticles. Therefore, to build consumer confidence in the use of nanotechnology, the food and beverage industry must support independent research on the long-term effects of nanoparticles using cellular, animal, and human models. If consumers are not convinced, there is a danger that we will lose the benefits of this useful technology.

ASABE Fellow Digvir S. Jayas, Vice-President (Research and International) and Distinguished Professor, Department of Biosystems Engineering, University of Manitoba, Winnipeg, Manitoba, Canada, digvir.jayas@umanitoba.ca.

Further reading
Coffee is the third most consumed beverage in the world, after water and tea. About half of Americans drink coffee every day, but we rarely think about the people half a world away who pick the beans, nor the technology that brings the coffee to market and to our mugs.

In Nicaragua, coffee is the primary driver of economic development. It is by far the country’s most important crop due to its economic, social, and environmental impacts. The coffee sector employs about 332,000 people, which is equivalent to 15% of the labor force and 54% of the agricultural sector. Coffee is the backbone of Nicaragua’s economy. However, despite the global demand for coffee, 50% of Nicaragua’s coffee producers, who are mostly subsistence farmers, live below the poverty line. Nicaragua remains one of the poorest countries in the world and the second poorest country in the Western Hemisphere.

The Puget Sound Professional Chapter of Engineers Without Borders-USA (EWB-USA) recently returned from a monitoring trip to Nicaragua to inspect a coffee processing facility and wastewater treatment system that was designed and built in collaboration with the community of Tierra Nueva and our field partner, Agros International. This is the second season that the system has been functioning.

For the 150 families who reside in the mountainside town of Tierra Nueva, coffee now offers a path out of poverty. These farmers are growing their way to a better future by working as part of a collective armed with technical knowledge and improved facilities that create better quality beans.

Traditional coffee farming
Approximately 95% of the coffee farmers in Nicaragua are micro-scale and small-scale producers. In addition to coffee, most families rent land to grow corn and beans for subsistence. In payment for this land, the landowners can take up to 50% of the harvest, trapping the families in a cycle of poverty.

Families are the primary source of labor on small farms, which forces children to spend their days performing agricultural work instead of attending school. Many of these subsistence farmers also work as day laborers on large plantations because their small, rented parcels are not sufficient to support their families.

Coffee is one of the few crops still harvested by hand. Coffee trees require several years to produce a harvest, and the production process requires a greater commitment of capital, labor, and land than most other crops. Coffee is only harvested once a year, and the harvest is backbreaking work.

After the coffee berries are harvested, they must be de-pulped, fermented, and cleaned. This must be done within 24 hours of harvest or the berries will begin to decompose. A byproduct of the cleaning process is a large amount of wastewater, or aguas mieles (honey water). This highly acidic wastewater is one of the leading contaminants of local water sources in coffee-growing communities, threatening marine life and producing bacteria harmful to people.

Breaking the cycle of poverty
In 2008, EWB-USA partnered with Agros, a nonprofit committed to breaking the cycle of poverty in Mexico and Central America by enabling landless communities to achieve land ownership and economic stability. We do this by providing long-term loans to farmers and by building communities—literally. To date, Agros has established 42 communities in Nicaragua, Honduras, Guatemala, El Salvador, and
Mexico. Our first collaboration was a rainwater harvesting and irrigation system for the Agros community of El Eden.

In 2012, we joined forces again with Agros to propose solutions for processing coffee berries and treating the residual wastewater for Tierra Nueva and other communities in northern Nicaragua. The coffee processing facility, known as a beneficio, was designed with two goals in mind: encourage families to use an environmentally friendly coffee processing method, and empower farmers to move beyond selling coffee berries to selling coffee beans, which command a higher price on the market. The families can also generate income by charging a small fee to other coffee farmers seeking to use the cleaning facility.

The beneficio features a treatment system capable of filtering and treating an entire season’s worth of coffee processing wastewater. Within the system, coffee husks are filtered, and the wastewater is directed to a settlement basin and neutralization ponds. After several months in storage, the water naturally loses its acidity and can be released to the environment.

Benefits of the beneficio

With the new beneficio and wastewater treatment system in place, the people of Tierra Nueva can safely grow, process, and sell coffee beans without causing harm to their health nor to the surrounding land and rivers. The facility also makes it easier for families to efficiently de-pulp, ferment, wash, and dry their own coffee beans. Dried coffee beans can be readily sorted by quality and size, allowing the farmers to sell their best beans for a premium price.

Advances in technology, like this beneficio, leverage community resources to help farmers move from subsistence farming to profitable and dignified agribusiness ownership. As for EWB-USA, our project team member Eset Alemu sums it up well: “It’s great to be part of an organization where I can see the fruits of my labor and put my engineering skills to social good. It’s good to spread the love.”

Christine Broda-Bahm, Communications, Engineers Without Borders USA, Denver, Colorado, Christine.Broda-Bahm@ewb-usa.org. Photos by Eset Alemu.
Ready for the agBOT Challenge?

Rachel Gerrish

With ever-advancing technology, the agriculture industry is on the move. That’s why the Gerrish Farms family in Parke County, Indiana, about an hour south of Purdue University, decided to showcase new agriculture innovations through a friendly competition. The agBOT Challenge pits teams of students and entrepreneurs against each other in robotics competitions that bring together innovators, universities, and investors.

A patriarch with a big idea

A fourth-generation farmer, Steve Gerrish studied plant breeding and genetics in Purdue’s College of Agriculture while working as a commercial corn breeder. He started his first company in 1987, developing and selling seed corn and alfalfa varieties. To test varieties, Steve patented yield monitors that could be retrofitted onto commercial combines and tractors. He formed a second company in 1991 to commercialize his yield monitoring equipment.

Over the last two decades, Steve has focused on technology commercialization and startups at the Wisconsin Alumni Research Foundation, the Purdue Research Foundation, and privately as well. His passion is new business models at the intersection of artificial intelligence, machine learning, robotics, rural broadband, genetic interactions with nutrition and drugs, and disease diagnostics. His farmer-centric solutions are rapidly making it to the market.

In 2015, Steve increased the broadband on his Rockville, Indiana, farm and laid plans to host three years of competitions in agricultural automation. “The agBOT Challenge was designed as a symbolic event to provide a vision of what could be possible if we had high tech and high-speed internet on the farm,” he said. “Competitions are a great way to drive innovation and collaborative efforts in ag tech.”

In each year’s agBOT Challenge, research-focused universities and entrepreneurial teams are required to build machines for a specific task. The competition has encouraged collaboration across multiple disciplines, including ag and bio engineering, robotics, plant science, computer science, microbiology, artificial intelligence, and more.

Like father like daughter

As Steve’s daughter and a fifth-generation farmer (and raising a sixth-generation of farmers!), I came on board to help with the program. With an MA in industrial and organizational psychology, I had a career in management and provided consulting services to a variety of businesses, from large healthcare providers and educational systems to small technology startups. My work focused on evaluating markets and designing business practices through advanced technologies and employee education. Coming on board to help my father, I had to shift my skills to the ag industry, evaluating current practices and identifying areas where new technology could have an impact.

After three years of hosting the agBOT Challenge, we’re excited to partner this year with Purdue University’s College of Agriculture and cosponsors Purdue Foundry and Purdue Polytechnic Institute to continue the successful growth of the program. And after spending the last few years working with ag tech, I’ve found a new path: future plans are to pursue a PhD in ag and bio engineering at Purdue, focusing on autonomous solutions for agriculture.

Onward with the agBOT Challenge

For each year of the agBOT Challenge, we’ve designed specific competitions. In 2016, it was a Seeding Competition. In 2017, the agBOT Challenge included two competitions: a...
Seeding Competition on the first day, and a Weed & Feed Competition on the second day. The Seeding Competition involved planting 1,000-foot rows of different seed varieties while live streaming video of the process, while the Weed and Feed Competition involved the use of technology to identify weeds in cornfields and remove them chemically or mechanically.

The competitions for the 2018 agBOT Challenge focused on autonomous plant identification, harvesting, and weed eradication. The competing teams demonstrated machines that were capable of autonomously moving through the field, identifying plant health, eradicating weeds, harvesting watermelons, and gathering multiple layers of data.

Throughout the last three years of the agBOT Challenge, teams from Purdue, Virginia Tech, Ohio State, Cal Poly, and from as far away as Nova Scotia have competed for $100,000 in prize money.

Each year, prior to the agBOT Challenge, students from local schools attend NextGen Expo, an all-ages interactive exhibit, to learn about the innovative technologies that are changing agriculture and meet the teams competing in the agBOT Challenge. NextGen Expo was originally hosted on the farm, but it has grown steadily, so this year we’ll be moving to the campus of Purdue University.

Rachel Gerrish, Senior Executive Producer, agBOT Challenge, Rockville, Indiana, rlgerrish@odeaulete.com.

This year’s agBOT Challenge is May 16-18, 2019

The mission of this year’s agBOT Challenge is to integrate innovative technologies to improve observation, intervention, analytics, and data storage in agricultural work methods.

NextGen Expo 2019, on May 16, will be held at Purdue University’s Agronomic Center for Research and Education (ACRE) in West Lafayette, Indiana. Attendees will explore ag tech, meet the agBOT Challenge teams, and see cutting-edge innovations in agriculture. Interactive exhibits will showcase robotics, machine learning, artificial intelligence, and drones. Admission is free, and tours will be available of the Indiana Corn and Soybean Innovation Center.

The Weed & Feed Competition, on May 17 at ACRE, challenges teams to create an autonomous machine capable of navigating a cornfield to identify corn plants and weeds. Upon identification of a corn plant, the machine should determine if the plant is healthy or in distress, and if fertilizer is required. Upon identification of a weed, the machine should eradicate the weed chemically and/or mechanically.

The objective is to produce an unmanned, autonomous machine that will: autonomously maneuver along two or four 150 ft rows at a time and turn at the row end, making two 150 ft passes; observe crop plants to assess their health; deliver fertilizer to distressed plants; identify three common weeds (giant ragweed, cocklebur, and foxtail) within and between rows; arrange for the weeds to be destroyed either chemically or mechanically as the machine moves through the field; and provide real-time observation of movement, plant identification, fertilization, and treatment back to the base.

The Mining for Microflora and Microfauna Competition, on May 18 at ACRE, challenges teams to create an autonomous machine capable of navigating a field, collecting soil samples, and preparing and storing the samples for microscopic evaluation of microflora and microfauna. Teams may use a variety of solutions, combine elements of solutions from different markets, and create innovative solutions designed for their machine.

The objective is to produce an unmanned, autonomous machine that will: autonomously and accurately maneuver through a predetermined sampling section of 30 yards and take three soil samples at sites 10 yards apart; collect samples at depths of 0 to 10 inches into the soil; map the sample locations and label the samples; separate microfauna and microflora from the soil, capturing organisms within the 4 to 10 micron size range; prepare the samples for diagnostic evaluation and storage; and provide real-time observation of movement, location, and soil collection.

All devices must have a functional kill switch in case of emergency. There is no limit on age or number of team members. However, all teams are required to have a one-on-one virtual project review session with agBOT producers during checkpoints. For more information, visit www.agbot.ag.
Two years ago in a rural field in Rockville, Indiana, a tractor propelled itself forward, planting corn as it moved along, with no driver in sight. On the sidelines, people watched as autonomous vehicle technology merged with agriculture.

The tractor, designed by a team of students from Cal Poly’s Department of BioResource and Agricultural Engineering, won second place in the 2017 agBOT Challenge, an annual competition that showcases the newest technology in agriculture.

The seven-member Cal Poly team had driven more than 30 hours and 2,171 miles to get to Indiana, and they were determined to succeed. “We spent two quarters transforming a 30-year-old tractor into a state-of-the-art, wirelessly remote-controlled machine,” said ASABE member Caleb Fink, the team’s manager, who has since earned an MS in agriculture with a specialization in bioresource and ag systems. “With a very limited budget, we used a lot of scrap metal and brainstormed innovative ways to make things happen.”

Fink’s team of BRAE students, including Ryan Vyeniolo, Charlie Ross, Dillon Beatty, Austin Della, Nate McCarthy, and Matthew Valentine, created an unmanned robotic device that could move through a field autonomously and plant up to four rows of corn. The Cal Poly tractor planted different corn varieties in a straight line in two rows, turned around, and planted another two rows—and applied fertilizer and live-streamed video from the front and rear while planting.

The Cal Poly team was one of seven teams that competed in the seeding competition, going up against Virginia Tech and Ohio State, as well as industry professionals and farmers. The first-place winner was a farmer who entered a tractor that he had used to plant more than 500 acres of corn the previous spring.

In the end, the resourcefulness of the Cal Poly tractor—using shop vacs to change seed varieties, tractor auxiliary hydraulics for clutch actuation, and even a little duct tape—was a winning strategy. The team used their $15,000 second-place prize to buy materials and equipment for the 2018 competition.

The 2018 watermelon harvester

A new team was formed with the objective to design and build an autonomous machine that could navigate a field, identify ripe watermelons, and harvest them. Months later, the team shipped their watermelon harvester from San Luis Obispo, California, to Parke County, Indiana, for the 2018 agBOT Challenge.

Every team attending was intrigued by the other competitors’ unique designs. The Cal Poly team based their watermelon harvester on a golf cart. That approach allowed them to focus on the harvesting process, rather than building a chassis and drive system from scratch. Using the golf cart as a starting point, the team built a harvesting mechanism, a control system, and a computer vision system for autonomous navigation.

Cal Poly’s watermelon harvester features a scoop, web cameras, a sorting arm, and a holding bin. Using computer vision, the harvester finds a watermelon, drives up to the melon with the scoop down, and then lifts the watermelon for inspection. The vision system determines the ripeness of the watermelon based on color. Depending on the ripeness, a sorting arm pushes the watermelon into the holding bin or off the harvester, back into the field.

Cal Poly: Two-time agBOT Challenge Winners

AnnMarie Cornejo and Megan Caird

The 2017 Cal Poly agBOT team basks in second place with their autonomous tractor.
The control scheme uses a microcontroller, a relay bank, motor controllers, and batteries. The microcontroller controls linear actuators for steering, scooping, and harvesting, as well as the throttle. The linear actuators use relays, while the throttle is controlled with a stepper motor and a motor controller. The linear actuator for steering is equipped with a potentiometer for precise feedback. Acceleration and speed are controlled with a stepper motor that operates a golf-cart speed controller. This allows the vehicle speed to be controlled with about 2400 steps of precision, from 0% to 100% full throttle. For safety, the control scheme includes kill switches on the outside of the harvester as well as a remote kill switch—a requirement for all entries in the agBOT challenge.

In their presentation, the team displayed the harvester’s effective use of color for identification of watermelons. They also demonstrated the harvester in the field, picking up watermelons by remote control. Overall, Cal Poly tied for third place, with Muchowski Farms, in the 2018 agBOT Challenge. Pee Dee Precision took second place, and Virginia Tech took first. Other competitors included Colorado Mesa University, Indiana State University, and Sight, Inc.

The computer vision system

To detect watermelons in the field, the computer vision system uses custom color filters to highlight watermelon objects. Using built-in webcams, the harvester captures image data from the surrounding environment. The harvester then applies a custom filter over every pixel in the captured images. This filter is based on RGB relationships within individual pixels. After filtering, only watermelons are left in the image. Using k-means clustering on the leftover pixels, the location of each watermelon in the image is accurately determined. The harvester then moves toward the nearest watermelon to harvest it.

The harvester uses two webcams to locate and harvest watermelons. When building the harvester, the team chose Logitech c920 HD Pro webcams. These webcams capture 1080p video and 15 MP images. These webcams also have autofocus, and they happened to be on sale at the time!

The two webcams are located on the front of the harvester. One webcam faces forward and allows general navigation around the field. The other webcam faces downward, toward the scoop, and allows local navigation to precisely pick up watermelons. The webcams allow the harvester to navigate the field and collect watermelons autonomously.

The vision system navigates the harvester toward the closest watermelon object using position and distance information based on the object’s location in the image obtained from the forward-facing webcam. After navigating close to the watermelon, the downward-facing webcam precisely navigates the harvester to pick up the watermelon.

The scoop moves around the watermelon and begins to lift it. As the watermelon is lifted, it rotates slightly, and different sides of the watermelon are exposed to the downward-facing webcam. The vision system analyzes the color of the watermelon to determine its ripeness. If the watermelon is ripe enough, the sorting arm pushes the watermelon into the collection bin. If it’s not ripe, the watermelon rolls back off the machine onto the ground.

Lessons learned

In 2017, the first year that Cal Poly fielded a team, it was possible to transport their autonomous tractor all the way to Indiana because the competition was held in the summer instead of during the school year, and the team had plenty of time to travel. In 2018, the competition was moved to the middle of May, during Cal Poly’s midterms, which prevented the team from personally transporting their entry to Indiana. Instead, the team paid to have their watermelon harvester shipped to Indiana. Shipping the harvester was difficult, and rough handling during shipping created a few electromechanical issues. However, while the harvester was not fully functional upon arrival in Indiana, and therefore needed some on-site repairs, the computer vision system worked perfectly.

AnnMarie Cornejo, Public Affairs and Communications Specialist, ancornej@calpoly.edu, and ASABE member Megan Caird, Agricultural Systems Management junior, California Polytechnic State University, San Luis Obispo, mcaird@calpoly.edu.
Agriculture accounts for 70% of all water use globally, and up to 95% in developing countries. The water demand for agriculture is expected to increase by 20% to meet the 70% increase in food production needed to feed 9.6 billion people by 2050. Therefore, effective and efficient management of water resources at various spatial scales is vitally important to enhance and sustain agricultural productivity and to protect natural resources.

In October 2018, ASABE, in partnership with the Indian Society of Agricultural Engineers (ISAE), held an international Global Initiative Conference on Global Water Security for Agriculture and Natural Resources in Hyderabad, India. The purpose of the conference was to bring farmers, researchers, practitioners, entrepreneurs, and policymakers together to discuss current and future water security problems, share research, and discuss creative solutions that can be applicable in different regions. The conference specifically focused on water security for producing food, fiber, and energy crops, as well as maintaining the water quality and quantity needed for ecosystem health and services.

Thanks to the attendees and presenters
The conference welcomed guests from around the globe to share knowledge and develop strategies for addressing this complex problem. Those who participated included 21 invited keynote speakers representing universities, the UN Food and Agriculture Organization (FAO), the World Bank, the International Commission on Irrigation and Drainage (ICID), the Indian Council of Agricultural Research (ICAR), the Indian Government’s Department of Agricultural Research and Education, the International Water Management Institute (IWMI), industry, other government agencies (including the USDA), and other national and international organizations. A large number of Indian students funded by ICAR also attended. Presentations were made by 245 speakers in various sessions organized under three themes:

- Agricultural water scarcity and security: Weathering water resource extremes.
- Irrigation and drainage, conservation, and water management for sustainable agricultural growth.
- Identifying, managing, and treating conventional and alternative agricultural water supplies.

A panel discussion included farmers from the U.S. and India, irrigation industry experts, and policymakers, who discussed the water security challenges faced by farmers and the innovative solutions and policy interventions needed to address the current and future challenges. In addition, ten students from the U.S. and Canada, funded by the USDA National Institute of Food and Agriculture (NIFA), and an equal number of students from India, funded by ISAE, actively participated and made presentations at the conference. More than 320 registered participants representing 19 countries attended the conference.

A pre-conference symposium to share innovations in agricultural engineering curricula was organized on the first day and was attended by more than 50 academic leaders from the U.S. and India. Several potential collaborations among academic institutions were discussed at this symposium. Post-conference technical tours were organized for partici-
pants to visit the Kaleshwaram Lift Irrigation Project of the Government of Telangana, under construction to supply irrigation water for over 1.8 million acres, and the Infosys Digital Agriculture Show Farm.

Indrajit Chaubey and Indra Mani served as conference co-chairs, and Daren Harmel is serving as the Chair of the Publication Committee. The co-chairs for various sub-committees included Gajendra Singh and Mary Leigh Wolfe (Advisory Committee), Dharmendra Saraswat and Suat Irmak (Development Committee), Srinivasulu Ale and Srinivas Reddy Konda (Local Arrangements Committee), Lalit Verma and Mary Leigh Wolfe (Partners Committee), Garey Fox and Dorota Haman (Program Committee), and Sreekala Bajwa and Indra Mani (Publicity Committee).

Manuscripts are currently being solicited from the conference attendees and invited experts for publication in the Global Water Security Special Collection, a peer-reviewed collection to be published in ASABE journals. Daren Harmel, Pouyan Nejadhashemi, and Srinivasulu Ale are serving as guest editors for this special collection.

**Recommendations from the conference**

A number of recommendations emerged from the conference to address global water security:

1. Strategies to address water security for agricultural production must consider regional water availability, production of suitable agricultural crops given water availability, climate change impacts, and expected increases in global food and nutrition demand due to projected population increase.

2. Coordinate data collection among various agencies, and make GIS-driven data and models publicly available so that water availability problems can be evaluated and new or improved models, methods, and decision support tools can be developed for sustainable water management.

3. Develop methodologies for sustainable water conservation that address water stress, water use efficiency and rainfall harvesting, and supply-driven strategies with on-site water management.

4. Develop new regional plans and enhance existing plans to improve data collection and research that will lead to optimal water application methods. Similarly, develop programs to educate all stakeholders on current and future challenges and strategies for efficient water conservation and use. The strategies should include behavioral, production, policy, economic, and technological solutions. For example, providing free electricity to irrigate agricultural fields is resulting in rapid depletion of groundwater and poses a serious threat to the long-term viability of agricultural production.

5. Use emerging crop models to simulate and optimize efficient irrigation systems considering deficit irrigation and termination periods, and improve water use efficiency for irrigation.

6. Assess trends in water use considering urban and irrigation needs, evolve methods for diversification of water sources (e.g., use of blue, green, and gray water for agricultural production), and adopt state-of-the-art conservation practices and water pricing policies.

7. Develop simple yet practical decision support systems (DSS) using geo-spatial data to assess the health of riparian corridors with concepts that are transferable to the evaluation of water stress and the health of irrigated agricultural systems.

8. Adopt enabling technologies such as GPS, GIS, DSS based precision irrigation, and incentivize and encourage sustainable farming systems that increase resource use efficiency and manage water scarcity.

9. Agricultural trade, including the concept of virtual water trade, can be an option for management of water scarcity, thereby improving water productivity.

10. To develop sustainable water security, there is a need for investment and innovation in information, infrastructure, and institutions.

11. Water and food security for marginal farmers under a changing climate is essential for the eastern Gangetic Plain. A transdisciplinary research approach has to be adopted, especially in India, Nepal, and other neighboring countries.

12. Revive the natural spring water resources and their proper utilization in the Himalayan region for sustainable crop production. This can be done in collaboration with different organizations and institutions, such as ICAR, DRDO, IIT, SAU, GBPHIED, and NGOs.
13. Optimization and integration of techniques will be useful to develop suitable solutions for global water security.

14. There are different entry points for improving water productivity at different scales, e.g., field-scale interventions are different from basin-scale interventions. Therefore, scale-specific strategies to improve water management must be developed.

15. Crop diversification, such as introducing pulses in cereal rotations, is a climate-smart agricultural practice for improving economic, physical, and nutritional productivity.

16. Increasing agricultural productivity with less water is the major challenge in dry regions. Among the different strategies, such as increasing yields, managing the demand or pricing of water, and increasing irrigation efficiency, enhancing water productivity is most relevant for dry regions. Supplemental irrigation, deficit irrigation, and suitable crop diversification are important best-bet practices for enhancing water productivity and sustainable agriculture in dry regions.

17. Low-cost, farmer-friendly tools and techniques for measuring water flow, monitoring soil moisture, and irrigation scheduling suited to given hydro-climatic and socio-economic conditions are necessary for improving water productivity.

18. Government support for large-scale physical interventions, enabling policies along with local participation, is a prerequisite for implementation of the technologies developed for improving water productivity.

19. Due to changes in rainfall patterns, the water available for crop production has decreased substantially. Globally, more than 70% of available water is used for agriculture. Rainfall harvesting and storage strategies to meet water demand during dry periods should be a priority. There is a need to identify suitable locations for water harvesting structures, installation and maintenance of these structures, and decision support tools for efficient use of harvested water for irrigation and other purposes.

20. With irrigated agriculture providing about 40% of the world’s food supply, global food security depends on global water security. If food security depends on global water security, then global security itself is inexorably linked to global water and its sustainable use. Scientific collaboration on agriculture and water is not only important to the U.S. and India, but to the world. Efforts must continue to bring together farmers, researchers, educators, practitioners, and internationally recognized experts to find creative, sustainable solutions to provide water for agriculture.

The venue was also a learning experience

All conference activities took place at the Taj Krishna hotel. Situated in Hyderabad’s Banjara Hills, the hotel offered a panoramic view of the city and Hussain Sagar Lake. Hyderabad is a multicultural city of nearly 7 million people, where Indian languages, traditions, and ancient religions mingle and thrive. Conference attendees had time to absorb some of the rich history of the city, including museums, parks, monuments, and a diverse array of restaurants offering local and international cuisines.

Dating to 1591, Hyderabad is one of India’s major metropolitan areas and serves as the capital of two states, Telangana and Andhra Pradesh. Home to the historic Golconda Fort and the iconic, 400-year-old monument known as the Charminar, Hyderabad has been a center of commerce for centuries. Long known as “The City of Pearls,” it enjoyed a prominent role in pearl and diamond trading, and several traditional bazaars are still in operation. Today, Hyderabad is equally known for its booming IT, biopharmaceutical, and film industries. With the growth of the biotechnology industry, the area has acquired a new name: Genome Valley.

ASABE Fellow Indrajeet Chaubey, Dean, College of Agriculture, Health, and Natural Resources, University of Connecticut, Storrs, cahrdean@uconn.edu, and Indra Mani, Professor and Head, Department of Agricultural Engineering, Indian Agricultural Research Institute, New Delhi, India, head_engg@iari.res.in.
Thirteen new ASABE Fellows were recognized at the 2018 Annual International Meeting last summer in Detroit. Starting with the November/December 2018 issue of Resource and continuing in this issue, we shine the spotlight on these most recent honorees.

ASABE Fellows all 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 in upcoming issues.

Dirk Maier, P.E., Professor and Postharvest Engineer, Department of Agricultural and Biosystems Engineering, Iowa State University, is honored for the development and delivery of engineered technologies to protect stored bio-products worldwide.

Maier is an exceptional academic administrator, as proven by his ability to obtain grant support for university programs. Maier’s research and outreach programs have received $10 million, $10.5 million, and more than $1 million (to date) in grant support at Purdue, Kansas State, and Iowa State, respectively. Under his leadership, the U.S. grain industry initiated a continuing education program of more than 26 courses that has reached more than 5,000 participants in 36 countries.

Maier’s research has largely focusing on grain storage, especially the development of non-chemical and other alternative protection technologies, including chilling, ozonation, heat, modified atmosphere, and hermetic storage. These techniques have resulted in increased use of commercial grain chillers and ozone generators to improve storage conditions for cereal grains, oilseeds, and processed products. His research has extended to modeling stored grain ecosystems and the effects of fumigation, hermetic, and environmental conditions on stored-product pest management. As a result, producers and the grain industry have adopted moisture and carbon dioxide monitoring for early spoilage detection.

Pictured above, Dirk at the start of another RAGBRAI, the Register’s Annual Great Bicycle Ride Across Iowa, a non-competitive 500-mile ride organized by The Des Moines Register that draws recreational cyclists from across the U.S. and other countries.

Larry Gaultney, P.E., Senior Engineering Associate, E.I. duPont de Nemours and Co., Wilmington, Delaware, is honored for the development of innovative agricultural chemical applicators and dispensing systems, other machinery systems, and for outstanding support of preprofessionals.

With a team of graduate students, Gaultney developed a real-time organic matter sensor, one of the first compact soil property sensors. It demonstrated the value of collecting many data points to prepare accurate soil property maps. A direct-injection system for granular crop protection products allowed use of previously unavailable products for spraying without needing to tank-mix the products, making sprayer cleanout easier and reducing the environmental impact.

Gaultney has also developed electronic dispensing systems that have improved the convenience and accuracy of applying crop protection products. The systems can prepare customized product mixes for each field or sprayer load, improving performance and minimizing environmental impact. Through his research career, Gaultney has created an application technology program that increases agricultural production, protects the environment, and improves conditions for agricultural workers.

Pictured above, Larry with his daughter Cecilia at her graduation.

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Meet the Fellows

Ronaldo Maghirang, Associate Dean for Research and Graduate Programs and Professor of Biological and Agricultural Engineering, College of Engineering, Kansas State University, is honored for his outstanding global leadership and contributions to the advancement of animal and facility systems through teaching, research, and service.

Maghirang’s research has focused on low-cost air pollution measurement; measurement, monitoring, modeling, and control of air emissions from agricultural operations and off-road activities; measurement, control, and modeling of indoor air quality in agricultural buildings; environmental applications of nanotechnology; and improved grain handling and storage.

Much of Maghirang’s research has involved extensive collaboration with scientists and engineers from Kansas State University, other educational institutions, the USDA Agricultural Research Service, and industry. Major accomplishments of his research group include the characterization and measurement of air emissions from open-lot cattle feedlots, development and evaluation of best management practices for controlling dust emissions from open-lot cattle feedlots, and development of packing factors for various types of grain.

Pictured above, Ronaldo (left) with his major professor, ASABE Fellow Harvey Manbeck, and daughter Kayla.

Steve Mickelson, Chair and Chuck R. and Jane F. Olsen Professor of Engineering, Department of Agricultural and Biosystems Engineering, Iowa State University, is honored for sustained exemplary performance in teaching and learning, university administration, and resource conservation research.

Mickelson led the agricultural and biological systems engineering department at Iowa State University to the top-ranked position in undergraduate education in the U.S. His leadership and expertise in the classroom have had a positive, lasting impact on the new generation of scientists and engineers. During his tenure as chair, Mickelson has seen enrollment in agricultural and biological engineering at Iowa State grow to more than 900 students, making it the largest such program in the country.

Mickelson spearheaded a strong partnership with the Georgian Technical University (GTU) in Tbilisi, Georgia, supported by grants from the Engineering Information Foundation, the North American Trade Organization, and GTU. This partnership established a community college program in Gori, Georgia, and a new College of Agriculture in Tbilisi. This program now offers three new degrees in agricultural engineering: land and water resources engineering, animal science, and agronomy.

Pictured above, Steve proudly shares Iowa State’s #1 ranking.

Are you aiming to form new professional connections, learn about the most recent research, and help formulate standards in your field? The 2019 AIM will give you the perfect opportunity to pursue those goals. Much of the meeting is devoted to presenting research results, and you will get a chance to present your dissertation work—but don’t miss other opportunities to give back to the community and network with colleagues.

The AIM is where ASABE’s committees meet. You can sit in on any of the committee meetings—just search the schedule for topics of interest (www.asabemmeetings.org/agenda.html). After you attend and listen this year, maybe next year you’ll feel comfortable about becoming a voting member, or even an officer, for a committee in your field.

What does committee attendance bring you? First of all, it’s a way to give back to your professional community, because ASABE’s committees are deeply involved in industrial applications and affect the way people work at other institutions. Attending committee meetings also allows you to interact with a close-knit community of industry and academic representatives whom you might not have a chance to meet otherwise (and yes, possibly get a job).

The AIM also provides many other ways to network. You can attend a breakfast with department chairs, meet industry leaders in a new speed-networking event, or find a mentor among the other members. If you’re still in grad school and unsure of which path to take—academia, industry, or elsewhere—the YPC is organizing several events tailored to your professional development, including a professional choice panel to help you select your path forward.

Plan to arrive early. On Saturday, July 6, the YPC is hosting an outing at Fenway, followed by the 5K run on Sunday morning. Take a professional development course as a fun way to learn and network—How about a crash course in Python? Or explore Boston on an agriculture-focused excursion. Or add to your professional contacts with the new speed-networking event! These hands-on activities will make your AIM experience more rewarding.

Do you have ideas on how to engage young members in ASABE? Be sure to share your thoughts at the graduate students’ committee meeting or the YPC business meeting. See you in Boston!

ASABE member and YPC grad student representative
Veronika Vazhnik, Doctoral Student in BioRenewable Systems, Department of Agricultural and Biological Engineering, Pennsylvania State University, and Graduate Fellow, Idaho National Laboratory, vzv6@psu.edu.
The ASABE Foundation serves as the charitable arm of ASABE, generating and awarding resources to aid the Society and its members in building a stronger future for the agricultural and biological engineering profession. Funds administered by the Foundation are used for scholarships, competitions, special projects, and to support ASABE programs and awards.

The KEYS initiative focuses on student development and humanitarian outreach in four vital areas: K-12 education, Encouraging humanitarian outreach, Youth career development, and Student chapter support. All proceeds from AIM fundraising activities grow the KEYS fund, and your participation matters. Last year, AIM activities raised $15,000 for KEYS. This amount, along with your additional generous donations, brought us to 30% of our $500,000 goal for 2020.

The 2019 AIM in Boston—a uniquely American city with beautiful amenities and opportunities for sophisticated experiences—will give members and guests an opportunity to network and have fun while supporting the Foundation in the following activities:

**Gale Holloway Memorial Golf Outing**
**Sunday, July 7, tee times begin at 8:00 a.m.**
$120 includes green fees, cart rental, and lunch
Enjoy a sporting morning with colleagues on the William J. Devine Golf Course at Franklin Park. The course was established in 1896 and is the second oldest public golf course in the nation behind Van Cortlandt Park in the Bronx. From tee to green, you will find a variety of challenges and discover why over the years *Golf Digest* has rated this course as one of the best places to play. Meet at the conference hotel registration desk at 7:15 a.m. to ride-share to the course in Dorchester (www.cityofbostongolf.com/course/william-j-devine-golf-course; phone 617-265-4084).

**ASABE Foundation Raffle**
Purchase your raffle tickets from Foundation members at the Foundation booth near the registration area. Increase your chances of winning by purchasing several tickets!

**ASABE Foundation Dinner**
**Tuesday, July 9, 7:00 to 10:00 p.m.**
$150 per plate; $125 for students
Join us for a truly Boston dining experience—from lobster to Boston cream pie—in the elegant Staffordshire Room of the Westin Copley Place overlooking historical Copley Square, a three-minute walk from the Marriott. After dinner, enjoy an engaging presentation by ASABE Fellow Chandra Madramootoo, who will share his deep insights on “How to feed nine billion people in a resource-constrained world” (see more information below). The Foundation dinner is the pinnacle AIM event for good conversation, food, drink, and entertainment—the single best opportunity to mingle outside of your usual circles, network with fellow members, and enjoy the sights.

As you complete your AIM registration, consider including the golf outing and the Foundation dinner to enhance your meeting experience while advancing the good work of the Foundation. To find out more about how you can contribute to the Foundation, contact Mark Crossley, ASABE Director of Advancement, at crossley@asabe.org.

**ASABE member and Foundation Trustee Mark Riley, Associate Dean for Research, Professor of Biological Systems Engineering, University of Nebraska-Lincoln, mriley3@unl.edu.**

This is one in a series of articles from the Foundation Development Committee.

**ASABE Fellow Sylvia Schonauer, P.E., Foundation Trustee and Development Committee Chair, Principal Engineer (retired), W.K. Kellogg Institute, Bellaire, Michigan, sylvias@valkyrie.net.**

**How to feed nine billion people in a resource-constrained world**
Under current growth scenarios, the world’s population is expected to reach nine billion by 2050, leading to increased energy, water, food, and nutrition demands. Meeting these demands through the untamed exploitation of non-renewable resources will certainly contribute to increased atmospheric temperatures and greenhouse gas emissions. Food production systems will consequently face new stresses. Dr. Madramootoo’s presentation will illustrate some of the key priorities for the ASABE community to consider in shaping the global change agenda to address these significant threats to agriculture and the world’s food systems.
Saturated buffers reduce nitrogen in agricultural drainage

In Brief: Every summer, a “dead zone” forms in the Gulf of Mexico. Plumes of oxygen-robbing algae, fed by excess nitrogen from the Mississippi River, kill off marine life and threaten the livelihoods of those who fish the Gulf. States bordering the Mississippi River are putting strategies in place to limit nitrogen from wastewater treatment plants, surface runoff, and agricultural fields. In a new study, University of Illinois scientists have estimated that a new conservation practice, known as saturated buffers, could reduce nitrogen in agricultural drainage by 5% to 10%.

It might not sound like much, given that agricultural drainage represents only a portion of the nitrogen entering the Mississippi River. However, the 5% to 10% reduction would result from inexpensive, passive systems that farmers can put in and forget about, said ASABE member Reid Christianson, research assistant professor in the University of Illinois’ Department of Crop Sciences and co-author of the study.

Saturated buffers are vegetated strips of land, as narrow as 30 feet, between tile-drained agricultural fields and waterways. Ordinarily, the tiles carry drainage water from the fields directly into ditches or streams. With a saturated buffer, the water is rerouted to a perforated pipe installed below the soil surface and parallel to the stream. From the perforated pipe, drainage water flows through the soil of the saturated buffer and into the stream. Along the way, soil microbes remove up to 44% of the nitrogen.

Saturated buffers don’t take a lot of land out of production, and they are fairly inexpensive to install, at $3,000 to $4,000 to treat the drainage water from a field-sized area, roughly 30 to 80 acres. “Farmers have to avoid farming right up to the creek, but as an edge-of-field conservation practice, saturated buffers fit easily with farming and provide additional benefits, like wildlife and pollinator habitat,” said ASABE member Laura Christianson, assistant professor at U of I and co-author of the study.

To arrive at their nitrogen reduction estimate, the Christiansons and ASABE member Janith Chandrasoma, a doctoral student at U of I, looked at publicly available digital maps of crop, soil, and stream types to estimate the total number of saturated buffers that could be installed across the Midwest. They estimated that 248,000 to 360,000 buffers could treat up to 9.5 million acres of drained land. With other studies showing average nitrogen removal rates between 23% and 44%, their estimated number of saturated buffers would reduce the total nitrogen load in agricultural drainage by 5% to 10%.

The estimation required several assumptions. For example, there are no satellite images or maps for tile drainage systems across the entire Midwest, so the researchers assumed that corn and soybean fields characterized as poorly drained were most likely tiled. However, Reid noted that tile drainage
systems are installed under many corn and soybean fields in the Midwest, and not just poorly drained fields. “Overall, our assumptions were conservative,” he said, “We probably underestimated our figures as a result.”

Saturated buffers are a new conservation practice, and the first USDA standard was published in 2016. So far, they have not been adopted at anywhere near the scale shown in the Christiansons’ study. For example, Laura estimates that fewer than 50 saturated buffers are currently installed across the entire Midwest region. “Adoption at the scale we estimated is likely a long way off,” she said. “But anything we can do to reduce nitrogen flowing to the Gulf, especially if it fits easily with current farm management, warrants attention.”

For more information, contact Lauren Quinn, ACES news writer and media specialist, lduquinn@illinois.edu; Reid Christianson, reiddc@illinois.edu; or Laura Christianson, lechris@illinois.edu.

“Saturated buffers: What is their potential impact across the U.S. Midwest?” by Janith Chandrasoma, Reid Christianson, and Laura Christianson, was published in Agricultural and Environmental Letters (doi: 10.2134/ael2018.11.0059). The work was funded through the USDA Farm Service Agency.
Digvir Jayas appointed to the Order of Canada

In Brief: ASABE Fellow Digvir Jayas was recently named one of 103 appointees to the Order of Canada by Governor General Julie Payette. He will enter the order as an officer.

From humble beginnings as a student and farmhand working outside of New Delhi, India, to serving as a distinguished professor and vice-president at the University of Manitoba, Digvir Jayas’ career is proof that we reap what we sow. “When I received the call, I was overwhelmed, and it took me a few seconds to absorb the news,” Jayas said. “I certainly was deeply honored and felt quite humbled, but the most important thing that came to my mind when I heard the news was the help and assistance that I have received from so many people over the years.”

The Order of Canada is one of the country’s highest civilian honors and recognizes individuals for their service, innovation, and compassion, according to a statement issued by the Governor General’s office. Jayas is being invested for his advancements to agricultural practices worldwide and for his promotion of academic and scientific research in Canada.

Jayas is currently the University of Manitoba’s vice-president of research and international, a role he took on in 2011, as well as interim president of the Natural Sciences and Engineering Research Council of Canada, and a former Canada Research Chair in stored-grain ecosystems. His research over the past 30 years has focused on engineering models that can improve the storage and transportation of grain and addressing the challenges of grain spoilage and pest infestation. Jayas has authored or co-authored approximately 900 technical articles. In 2017, he received the Sukup Global Food Security Award from ASABE.

Jayas said his investiture into the Order of Canada will allow him to continue producing and disseminating research for the benefit of society. “Producing food is a very resource-intensive process, and we as a society have to minimize the losses,” he said. “We should pay close attention to how our food is produced and stored, and we should not waste food.”

For more information, contact Danielle Da Silva, community journalist, The Sou’wester, danielle.dasilva@canstarnews.com.

National Academy of Inventors honors Susan Sun

In Brief: The National Academy of Inventors (NAI) has honored ASABE Fellow Xiuzhi (Susan) Sun, university distinguished professor of grain science and industry and ancillary faculty of biological and agricultural engineering at Kansas State University, for her prolific spirit of innovation and the impact of her work.

Sun is one of 148 renowned NAI academic innovators named as the newest fellows. The academy’s more than 1,000 fellows represent more than 250 research universities and government and nonprofit research institutes. The 2018 fellows are named as inventors on nearly 4,000 issued U.S. patents.

“I am honored to be named a fellow, and I thank my collaborators and students through the years for their contributions to my efforts,” Sun said. “I feel so blessed to have the opportunities to discover something useful to humanity.” Sun brought her research expertise in bio-based materials engineering and discovery to Kansas State University in 1996. She is named on 15 U.S. patents that have generated more than $385,000 in licensing revenue via the Kansas State University Research Foundation.

Two of her most significant patents are for adhesives and coatings made from modified soy proteins and for novel hydrogels for biomedical applications. In 2015, the U.S. Patent Office selected Sun’s hydrogel invention, called PepGel, for the Innovation Festival at the Smithsonian National Museum of American History. PepGel offers a medium in which researchers can grow cells in 3D or deliver drugs into the body. Its unique properties allow it to become a liquid under certain conditions and then turn back into a gel.

Sun is currently working at the Wake Forest Institute for Regenerative Medicine during her sabbatical. She is hosted by Anthony Atala, professor and institute director, to explore the feasibility of using PepGel in 3D bioprinting for organs.

For more information, contact Sarah Caldwell Hancock, communications coordinator, Kansas State University, sarhan@k-state.edu.
Detroit Zoo turns animal waste into clean energy

In Brief: Michigan State University has created a green solution for the problem of what to do with animal and food waste at the Detroit Zoo.

A SABE member Dana Kirk and his research team have worked with the Detroit Zoo to build the first anaerobic digester at a zoo in North America, creating clean energy capable of powering some of the zoo’s operations.

An anaerobic digester is a sealed tank, deprived of oxygen, in which organic waste is degraded at high temperature. These conditions allow the waste to decompose quickly and produce methane gas, which can be captured and converted to electricity. The Detroit Zoo’s digester powers its animal hospital, which requires 100 to 150 kWh of electricity. For reference, a typical U.S. household uses about 900 kWh per month. In addition to reducing electricity costs, other benefits of the anaerobic digester include repurposing animal and food waste and reducing greenhouse gases.

MSU has been recognized internationally for its expertise in anaerobic digester research and development. Kirk, an assistant professor of biosystems and agricultural engineering and manager of MSU’s Anaerobic Digestion Research and Education Center, served as the technical lead on a digester in Costa Rica, as well as the digester that powers part of MSU’s south campus. In addition, he has provided training for professionals from a number of African and Asian countries.

“Over more than eight years, we’ve worked with hundreds of clients around the U.S. to understand how much energy can be produced from organic wastes,” said Kirk. “We’ve also helped stakeholders evaluate technologies, troubleshoot underperforming systems, design and construct pilot digester platforms, and conduct feasibility studies.”

While an estimated 40 to 60 million anaerobic digesters are operating worldwide, just over 1,500 are located in the U.S. That number is expected to grow as digesters, like the one at the Detroit Zoo, come online. With more than 1.5 million visitors annually, the zoo is helping more people learn about the value of aerobic digesters in creating clean energy from a readily available resource.

For more information, contact Lisa Mulcrone, senior communications manager, MSUToday, lisa.mulcrone@cabs.msu.edu.

For an overview of Dana Kirk’s work, visit https://research.msu.edu/overview-of-msu-anaerobic-digestion-research/.


An animated video was created to show audiences of all ages how energy is created inside the anaerobic digester: https://www.youtube.com/watch?v=ovjrL5cOk58.

Zoo animal waste is placed in an anaerobic digester, where heat and moisture are added. Anaerobic microbes grow by eating the waste, producing methane gas as a byproduct. The gas is collected in bladder, filtered for impurities, and then used to power an engine that drives a generator to produce electricity. Art by Deon Foster, Interactive Designer, MSU Communications, Deon.Foster@cabs.msu.edu.
Modeling “what if” scenarios in food manufacturing

In Brief: ASABE member Ashim Datta, professor of biological and environmental engineering at Cornell University, is developing three complementary food-specific, user-friendly computing technologies that can be used to simulate “what if” scenarios in food manufacturing more efficiently than trial and error.

Every industry seeks less resource-intensive new products and process development, faster time-to-market performance, and high-quality innovation. These fundamental goals particularly apply to food manufacturing, with its material complexity and global competition.

Datta has developed three tools to help others in the field of food manufacturing. The first tool, an extensive knowledge base, will provide access to the widest possible range of food properties through a web-based interface. Users will be able to search the database for the property they need for a given food material. The second tool is a set of high-level apps that can quickly simulate food processes, such as drying or frying, to guide food manufacturers toward the best strategy for ensuring product quality. The third tool is a visualization library for the most complex food processes, such as microwave drying and puffing. These simulations will help food manufacturers find ways to improve food production processes.

These tools will make front-end work cheaper, faster, and better for a range of industry sizes, and will therefore make food manufacturing more agile, efficient, and competitive.

Drying, frying, baking, and puffing are just a few of the processes used in the world of industrial food production. Although the foods they alter are highly varied, these processes share a set of universal physical principles. “If you know the underlying physics,” Datta said, “You can move between products and processes, translating from one to another.”

Developing a framework for understanding the physics of food processing and designing simulation models that can pinpoint optimal methods for cooking, preserving, and packaging is how Datta has spent his career. In 1985, when Datta presented his doctoral dissertation on mathematical modeling of natural convection heating of foods, it was met with skepticism. He claims that an audience member, a professor in the discipline from an elite university, told him: “We wouldn’t give you a PhD for that.” Datta earned his doctorate in agricultural engineering that year from the University of Florida, and one year later he began his career as an assistant professor at Cornell.

Fast-forward 30 years, and the world seems to have caught up with Datta’s work on the physics of food preparation. “I have heard from three companies who are trying to work with me on these models,” he said.

In 2014, Datta led a multi-university project that received a $683,000 grant from the USDA with the goal of integrating computer simulation with teaching of food safety principles. In 2018, Datta received a major funding boost for his research: a $905,000 grant from the USDA National Institute of Food and Agriculture. This project, titled “Enabling computer-aided food product and process design for everyone,” has several co-PIs from Cornell as well as other national and international institutions.

“This is not new,” Datta said of his use of computer modeling to improve manufacturing. “It started in the aeronautical industry in the 1970s, the automotive industry in the 1980s, and is now gaining significant interest in the food industry.”

It’s an unconventional way for a food engineer to go about his business, Datta said. Researchers working with food are often chemists or microbiologists who apply their disciplines to food quality or processing, or they approach the understanding experimentally. But the physics of food, and mathematical modeling of food processes? Not so much.

Much research and development in the food industry is based on trial and error, Datta said, “It’s sometimes called
'cook and look.' Resources are wasted in trying one process after another until it’s optimized, such as the exact time and temperature needed to deep-fry partially frozen French fries.

For one project, Datta analyzed the process of baking using a first-principles approach, seeking an optimization strategy for the exact mechanism by which a potato gets crisper during baking. The physical principles are general enough to apply to frying as well. “Universal physical laws apply to processes as varied as cooking meat on a grill and puffing rice in a microwave oven,” Datta said. “But a universal physics framework had not been developed for food, and that has been our contribution to the field.”

Much of the motivation for developing this framework is to enhance quality prediction for food. “French fries have been around for a long time, so why would we make a model for French fries?” he asked. “If you’re doing it by cook and look, by trial and error, and you scale up to thousands of pounds an hour, then you really have to control the process, and you have to get it right. A little problem can mean a big cost and a lot of waste. By knowing the details up front, you can get closer to doing it right the first time, in an automated, efficient way.”

For more information, contact Tom Fleischman, interim managing editor, Cornell Chronicle, tjf85@cornell.edu, or Ashim Datta, akd1@cornell.edu.

KSU researchers apply computer vision to reduce chemical use

In Brief: Agricultural producers annually spray nearly $15 billion worth of chemicals yet still lose 37% of crop yield to pest damage. As the industry moves to sustainably intensify production to feed a growing population, the top priority for ASABE member Ajay Sharda is to reduce farmers’ costs by allowing them to make fewer, more efficient chemical applications, and at the same time limiting impact on the environment.

Sharda, an assistant professor of biological and agricultural engineering, and Brian McCormick, an associate professor of entomology and interim head of KSU’s entomology department.

Funded by the USDA Robotics Initiative, the goal of the project is to develop a vision system to sense and identify the presence of insects in order to conduct site-specific targeted chemical applications using autonomous robotic systems. “This research will create a paradigm shift in sustainable crop production and provide new opportunities for using intelligent operating systems to improve pest control applications and reduce yield gaps,” Sharda said.

The proposed computer vision approach to locate insect incidence and severity, as well as the use of a decision tool for directed spraying with an autonomous robotic system will be a fundamental change from existing techniques of agricultural chemical spray applications. “Involving both graduate and undergraduate students in creating this platform to advance crop protection helps make Kansas State University one of the top institutions engaged in the development of smart autonomous systems for agriculture,” Sharda said.

For more information, contact Mary Rankin, editor, College of Engineering, Kansas State University, mrankin@k-state.edu, or Ajay Sharda, ashard@k-state.edu.
OSU researchers create innovative medical gloves

In Brief: ASABE member Katrina Cornish and her team at The Ohio State University have created the first natural latex medical glove that can block radiation while meeting federal guidelines and not triggering allergic reactions. This glove will eliminate the need for medical professionals to double-glove when working with radiation in order to meet federal requirements for protection against both bloodborne pathogens and radiation.

"Wearing two gloves on each hand is like doing surgery in boxing gloves," said Cornish, Ohio Research Scholar and holder of the endowed chair in bio-based emergent materials in OSU’s College of Food, Agricultural, and Environmental Sciences (CFAES). The awkwardness of wearing two layers of gloves leads some medical professionals to use only one set of gloves. “And then they’re putting themselves at risk,” Cornish said.

Radiation attenuation (RA) gloves are required for medical professionals who perform procedures such as x-rays or radiation treatments. While several types of RA gloves are currently on the market, the glove that Cornish and her team have developed uses rubber from guayule, a shrub native to the southwestern U.S. and northern Mexico that does not cause allergic reactions, according to extensive testing by Cornish and her team.

This is significant because medical professionals typically prefer gloves made from natural rubber, rather than synthetic polymers, because they are stronger, provide better protection against pathogens, and cause less hand fatigue. Synthetic RA gloves are available, but they are allowed to meet a lower performance standard than natural rubber gloves.

Historically, natural rubber gloves have been problematic for people with latex allergies. Type IV latex allergy, the more common type, can cause a rash and skin cracking, while a Type 1 latex allergy can be life-threatening. Gloves made from synthetic rubber typically don’t cause allergic reactions, but they are thicker, less stretchy, and may not offer as much protection against diseases. “With our glove, you get all the required protection with a single product, and no allergies,” Cornish said.

In addition to its non-allergenic properties, guayule rubber is soft, stretchy, and strong. Using guayule rubber, Cornish and her team were able to produce a glove thick enough to block radiation and strong enough to block pathogens, yet thin enough to be flexible and stretchy, making it comfortable to wear while performing precision work.

“Gloves could be made very thick, and they would meet the federal specifications, but you wouldn’t be able to move your hand while wearing them,” she said. As an added benefit, guayule is grown in the U.S., while the bulk of natural rubber currently used nationwide is imported from Asia.

The glove was developed in partnership with EnergyEne Inc., a startup led by Cornish and based in Wooster, Ohio. Cornish will be pursuing FDA approval of the glove, and then a licensing agreement to commercialize it. It will likely be on the market within three years, she said.

Along with making medical gloves, Cornish and her team are creating other products from guayule rubber, including condoms and weather balloons. They also are working on products that can be made from the rubber produced by a specific kind of dandelion, a cousin of the common garden dandelion.

For more information, contact Alayna DeMartini, technical editor, OSU Department of Food, Agricultural, and Environmental Sciences, demartini.3@osu.edu, or Katrina Cornish, Ohio Agricultural Research and Development Center (OARDC), cornish.19@osu.edu.
New bioprocessing pilot plant at University of Illinois

In Brief: New technologies in sustainable fuels, chemicals, and ingredients continue to be developed by researchers across the U.S. Many of these technologies could reduce fossil fuel consumption and greenhouse gas emissions, but new technologies often struggle to make the transition from benchtop research to commercial implementation.

The struggle from the benchtop to commercial application of new technologies was one of the primary motivators behind the Integrated Bioprocessing Research Laboratory (IBRL) at the University of Illinois. The IBRL is a brand new, state-of-the-art, pilot-scale processing facility.

Housed in the Department of Agricultural and Biological Engineering, the IBRL is a resource that allows academia and industry to test technologies at the pilot scale. The 10,000 square foot facility contains private spaces for individual projects as well as quick-connect utilities and electrical access, making it easy to move equipment and start projects quickly. The facility will be home to over $10 million in processing and laboratory equipment.

“The types of project requests that we’ve received is really varied,” said Brian Jacobson, assistant director of pilot plant operations. “We have capabilities ranging from traditional corn processing to advanced biofuel technologies, and the capabilities are continually expanding.”

The IBRL is not alone in its attempt to promote commercialization of bioprocessing ideas at the University of Illinois. Located close to other biotech facilities, such as the Institute for Genomic Biology, the Food Science Pilot Processing Plant, and the Energy Farm, the IBRL is in a position to create a regional hub for research and development of bioprocessing technology.

Because the IBRL is located on a university campus, education is also an important component. Quickly evolving technology requires a highly trained workforce to meet the changing demands of industry. The IBRL offers traditional MS and PhD programs, an MS in bioprocessing and bioenergy, and undergraduate internships for hands-on learning with industrial equipment.

“The IBRL has a unique ability to bring together all of the resources that are necessary to move technologies to commercialization and help develop the bioeconomy in Illinois and beyond,” said ASABE member Vijay Singh, director of the IBRL and professor of food and bioprocess engineering. “The facility is an excellent resource for student education, grant funding opportunities for our faculty, and industry engagement in the university’s mission.”

For more information, contact Beth Conerty, business development manager, IBRL, bconerty@illinois.edu, or Vijay Singh, vsingh@illinois.edu. Visit the IBRL website at ibrl.aces.illinois.edu.
Garey Fox named editor in chief of ASABE journals

In Brief: ASABE member Garey Fox has been named editor in chief of ASABE’s journals. This newly established position is aimed at advancing the Society’s longstanding record as a leader in technical publications for engineering and technology in agriculture, food, and biological systems.

As editor in chief, Fox will provide strategic guidance for the Society’s journals, working with the Editorial Board to establish a vision and goals for strengthening the quality and impact of ASABE’s peer-reviewed publications.

“Now is the time for the Society to be visionary in how we move forward with our journals,” said Fox. “My goal as editor in chief will be to work closely with the community editors and associate editors to identify ways that we can improve the quality of our journals and encourage existing and future members to publish their most outstanding research in ASABE publications.” See his introductory note, www.asabe.org/IntroductoryNote.

Fox joined North Carolina State University’s Department of Biological and Agricultural Engineering in 2017, overseeing and directing the department’s research, extension, and teaching programs. He currently serves as professor and head of the department and conducts research in stream/aquifer interaction, streambank erosion and failure, seepage erosion, subsurface nutrient transport, and vegetative filter strips.

NCSU solving grand challenges with NSF support

In Brief: From harmful algal blooms to protecting infrastructure with mussels, North Carolina State University is leading the way in critical environmental issues. With recently announced funding from the National Science Foundation, several NCSU Biological and Agricultural Engineering faculty members will conduct research to better understand and address these critical problems. With an annual budget of $7.5 billion, the NSF is the funding source for approximately 24% of all federally supported basic research conducted at U.S. colleges and universities.

Changing oxygen levels in freshwater ecosystems

The amount of oxygen is changing in many lakes and reservoirs around the world. These changes may threaten ecosystem services provided by the lakes. In addition to degrading drinking water and fisheries, changes in oxygen can also change how much carbon is stored in lake bottoms. Because human-made reservoirs store more carbon annually than the oceans, these changes may have a major impact on global carbon cycling. The magnitude of the changes in oxygen, and the consequences for water quality, are unknown. ASABE member François Birgand, associate professor at NCSU, has an unprecedented opportunity to switch an entire reservoir from low to high oxygen.

The study includes several experiments that involve changing oxygen levels and examining the impacts on carbon cycling. This research will improve predictions of how environmental changes affect carbon burial in lakes, and the results will help managers meet goals to improve reservoir water quality. The research will also contribute to understanding of the long-term effects of management practices on carbon burial in lakes. This project will produce educational tools and lesson plans for undergraduate courses on reservoir ecology. Project scientists will work with water utilities and the broader research community to share the knowledge and improve management policies.

Addressing “red tide” algal blooms

Since October 2017, several hundred tons of marine life have died along the gulf shore of Florida from exposure to algal blooms, known as a red tides. The intensity of these blooms is believed to be related to nutrients in freshwater releases from Lake Okeechobee, a large inland lake in south-central Florida that is managed for flood prevention. However, strong scientific evidence to support the connection between red tides and Lake Okeechobee water releases is lacking.

With NSF funding, ASABE member Natalie Nelson, assistant professor and principal investigator in the NCSU’s Biosystems Analytics Lab, will lead an effort to collect, analyze, and model water quality data prior to and throughout major freshwater releases. This specific grant, NSF RAPID, funds research to address existing, on-the-ground needs. The data collected will provide insights into cause-and-effect rela-
tionships between freshwater releases and algal blooms. The findings from this study will inform management of one of the nation’s most elaborate freshwater flood-prevention systems and support efforts to address the ecological emergency caused by red tides.

**Understanding ammonia emissions**

Animal feeding operations (AFOs) contribute 85% of total ammonia emissions in the U.S., emitting approximately 2.5 million tons of ammonia each year. Ammonia is associated with negative effects on air and water quality, soil health, and ecosystem health. With NSF funding, professor and **ASABE member Lingjuan Wang-Li** hopes to advance the understanding of ammonia emissions as well as the ecological and environmental impacts of ammonia emissions from AFOs. The findings will be transferred to students, industries, regulators, and the public through education and outreach programs to increase understanding of the environmental impacts of ammonia released from AFOs and inform policymakers to better protect human and ecological health.

**Can bivalves protect infrastructure?**

Scour, or the removal of sediment by flowing water, is one of the most common causes of bridge failure in the U.S. Previous studies have suggested that bivalve colonies can reduce local erosion. However, there is a gap in the knowledge required to assess and develop bivalve farms as a potentially self-sustaining scour mitigation method. **ASABE member Celso Castro-Bolinaga**, assistant professor, and **ASABE member Steven Hall**, associate professor, will seek to determine if bivalve colonies can reduce scour and erosion and if the adhesive proteins used by bivalves increase sediment strength and reduce erodibility. The NCSU researchers will work with a team at Virginia Tech. The project will also seek to increase diversity in the field of geotechnical engineering by emphasizing the recruitment of female students and students from diverse socioeconomic backgrounds.

For more information, contact **Rebecca Nagy**, program communications specialist, Department of Biological and Agricultural Engineering, North Carolina State University, renagy@ncsu.edu.
MWPS offers more resources for ag professionals

In Brief: Over its decades-long existence, MWPS (formerly MidWest Plan Service) has expanded its titles to include award-winning resources in the fields of agriculture and agricultural engineering.

MWPS has been a first-stop source for agricultural handbooks since the 1960s. Since that time, MWPS has branched out with a breadth and depth of titles related to various agricultural fields. And it’s doing this with an increased focus on digital accessibility.

If you’re an extension specialist, farmer, or agricultural educator looking for answers to on-farm engineering questions, MWPS offers more than 50 comprehensive, research-based publications. Each publication is peer-reviewed by agricultural engineers from across the U.S.

The newest addition is the award-winning Grain Drying, Handling, and Storage Handbook, released in July 2017. “This handbook is in its third edition and has always been a collaborative project by engineers from several universities,” said ASABE member Dirk Maier, professor of agricultural and biosystems engineering at Iowa State University and one of the authors of the handbook. “Our handbook has more than 150 pages full of expert advice on how to plan a modern grain drying, handling, and storage system.”

MWPS continues its commitment to providing reference publications that are professionally designed and edited, yet affordable, for on-farm work. “Most of our publications are related to engineering and infrastructure, and they provide information in a lot of areas where information isn’t readily available,” said ASABE Fellow Jay Harmon, professor and extension livestock housing specialist at Iowa State. “Our strength is the power of collaborative author teams that develop educational materials to help clients make informed decisions.”

Other titles range from topics on livestock facilities, manure, and electrical systems to sprinkler irrigation, private water systems and septic systems. These publications are readily available in the MWPS online catalog. MWPS is located on the campus of Iowa State University, with offices and warehousing in Elings Hall.

For more information on MWPS and how its research-based information benefits farmers, visit www.mwps.org or call 515-294-4337.

Manoj Karkee heralded as AI pioneer

In Brief: The online magazine Connected World has recognized ASABE member Manoj Karkee as one of 2019’s artificial intelligence pioneers.

Connected World chooses pioneers from around the world based on their work in artificial intelligence, data analytics, and technology. “Scientists from different prestigious universities are recognized,” said Karkee, associate professor of biological systems engineering at Washington State University (WSU). “It gives me a lot of pleasure to be selected into that elite group. Only ten to twelve people are nominated, and you can’t nominate yourself.”

After receiving the recognition, Karkee said that he and his students will be able to solve more challenges using robotics, automation, and smart technology. Working with students and other colleagues, his project on smart irrigation systems for fruit trees and grapes will be accomplished in a matter of months.

Karkee is also co-founder of the Joint Center for Agricultural Robotics, a partnership between WSU and the University of Technology in Sydney, Australia. This partnership is an important development in the field of agricultural engineering, he said.

Karkee is looking forward to the new age of agricultural engineering, in which new technologies will revolutionize how people view agriculture. “Meanwhile, I’ll continue to do my agricultural robotics research,” Karkee said, “Including automated harvesting of fruits and vegetables, reduced use of chemicals, and structuring the farming industry for greater efficiency and sustainability.”

For more information, contact Kuria Pounds, staff writer, The Daily Evergreen, news@dailyevergreen.com, or Manoj Karkee, manoj.karee@wsu.edu.

ASABE member Manoj Karkee
The “Farm in a Box” initiative for Africa

In Brief: AGCO, a major manufacturer and distributor of agricultural equipment, unveiled its Farm in a Box (FIAB) initiative for Africa at International Green Week 2019 in Berlin, Germany.

“With FIAB, we aim to take farm mechanization, plus all its necessary support facilities, deep into previously underserved rural communities in Africa,” said AGCO president, chairman, and CEO Martin Richenhagen.

In sub-Saharan Africa, human labor provides 65% of the power required for land preparation. Capacity-building and agricultural mechanization are a priority to ensure food security and unlock the potential of small-scale farming in Africa. FIAB is an innovative solution that allows small-scale farmers to gain access to the machinery they need to transform their operations and achieve profitability.

FIAB offers a package of essential farm equipment, including a 45 to 80 hp tractor and implements, such as a ripper, disc harrow, trailer, and planter, to perform land preparation, planting, and crop transport, plus the parts and workshop tools needed for service and maintenance. Some of the equipment is packed inside a modified shipping container, which can be used as an office or workshop.

The objective is to offer mechanization for hire to smallholder farmers, enabling them to reap the benefits of agricultural equipment without having to invest in capital assets. The package includes training and support from a dedicated AGCO Operations Support Center, which provides technical advice and guidance. FIAB also takes maximum advantage of the latest telemetry and mobile technology to enable remote monitoring of the equipment and the use of mobile apps. This high level of monitoring, support, and guidance from AGCO sets the concept apart.

FIAB is an entrepreneurial platform that operates on a franchise model, with franchisees appointed and trained by AGCO and in-country distribution partners. Typical franchise holders would be relatively well-established businesses that are successfully serving the agricultural community in their area. This franchise model helps build the capacity of small-scale enterprises and provides business opportunities for entrepreneurs, contractors, and the many specialty agricultural supply stores, known as agro-dealers, that are present throughout Africa’s rural areas.

Acting as a localized hub of knowledge and practical help, the franchise partner offers hire of equipment and drivers to local farmers, enabling them to boost their crop production. Franchisees can also expand their businesses and create new employment opportunities. Local communities benefit from improved economies due to enrichment of the agricultural value chain. For AGCO, the program leads to increased sales of products and services and further develops the company’s footprint in Africa.

“There is an urgent need to empower the millions of smallholder farmers in Africa to ensure food security,” said Richenhagen. “Tailored, inclusive, integrated approaches to agricultural mechanization can increase the welfare of farm households and create opportunities for economic growth in rural areas, fulfilling AGCO’s commitment to ‘Run Africa from Africa.’”

For more information, contact Shlobi Maluleke, marketing and communications manager, AGCO Africa, Johannesburg, South Africa, Shlobi.Maluleke@agcocorp.com.

Research has shown that demand for machinery is high in remote areas, but mechanization faces barriers, such as affordability, maintenance and repair services, and inadequate farmer training. FIAB is designed to overcome these barriers by delivering mechanization for hire to smallholder farming communities.
Here is your chance to convey and celebrate the beauty of your work, your research, or your technical community. It’s up to you and your camera, so be creative!

Submit as many entries as you want. All entries should be original work, and the image resolution must be 300 dpi or greater. The deadline for submissions is October 4, 2019.

E-mail your entries, as attachments, to miller@asabe.org. Write “VisualChallenge9” in the subject line, and include a title and brief description for each image. If necessary, include a name for crediting the image and written assurance that permission has been granted to submit and possibly publish the image.

The best images will be selected by ASABE staff and published in the January/February 2020 issue of Resource. Good luck! Have fun! We’d love to see what you do!

To see the winning entries from previous Visual Challenges, visit: www.asabe.org/VisualChallenge.
ANNUAL MEETING BASICS

DATE
July 7 - 10, 2019

DESTINATION
Boston, MA

Meeting Venue & Host Hotel
Boston Marriott Copley Place

More Info
asabemeetings.org

MEETING REGISTRATION IS OPEN
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Register Early to Lock in the Discounted Registration Rate

Keynote Speaker
Joel Makower
Chairman/Executive Editor
GreenBiz Group

Key Meeting Deadlines
- May 1 - Last Day For Early Registration Discount
- May 1 - Manuscripts Due
- June 20 - Cut-off to Make Reservations at Marriott Rooms Are Going Fast, So Book Soon!

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