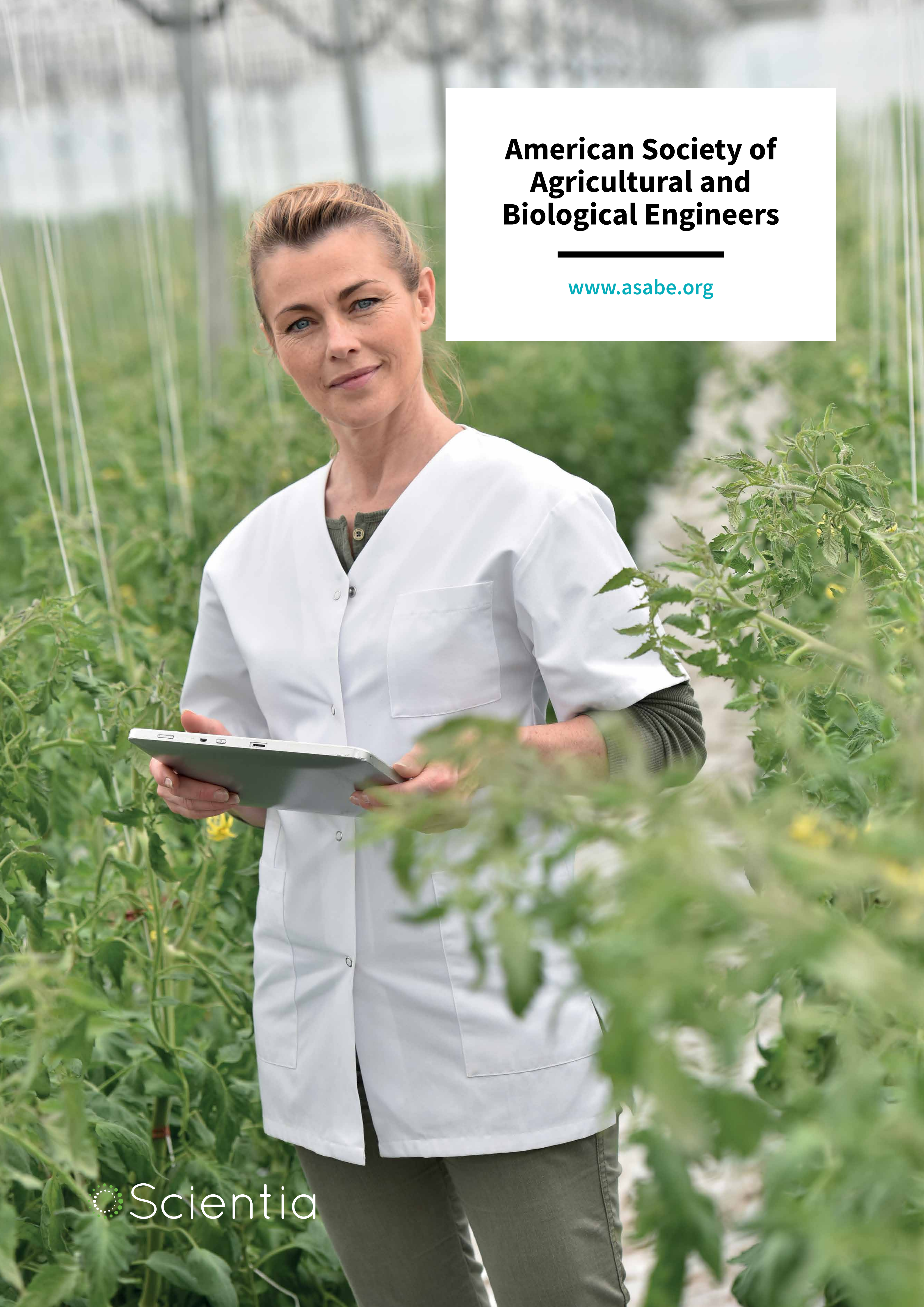

American Society of Agricultural and Biological Engineers

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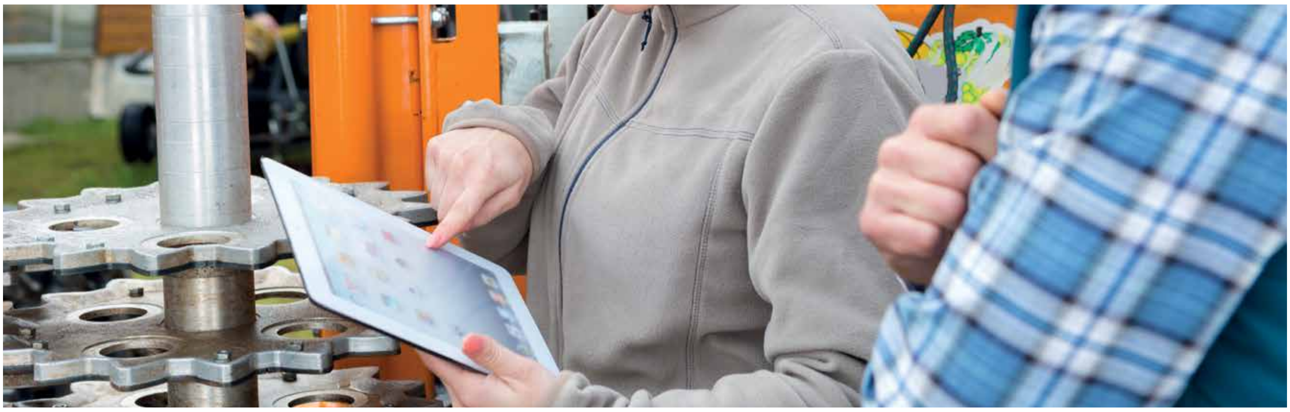
AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS

Representing approximately 7,000 members in over 100 countries, the American Society of Agricultural and Biological Engineers (ASABE) is devoted to advancing engineering research applicable to agriculture, food and biological systems. In this exclusive interview, we have had the pleasure of speaking with **Dr Sue Nokes**, President of ASABE, who discusses the myriad of ways that the Society accelerates this diverse research field, towards ensuring global food, energy and water security, in the face of our changing climate and growing human population.



To begin, please explain what agricultural and biological engineering entails.

Agricultural and biological engineering is the discipline that applies engineering principles and the fundamental concepts of biology to agricultural and biological problems. The agricultural or biological engineer creates systems and tools, ranging in scale from the molecular to ecosystem level, for the safe, efficient and environmentally-sensitive production, processing and management of agricultural, biological, food and natural resources systems.

When was the American Society of Agricultural and Biological Engineers (ASABE) founded, by whom, and why?

Beginning in the 1850s, the era of industrialisation prompted the founding of several engineering disciplines. Engineers who were applying engineering science to agriculture (at that time mechanical, civil and electrical engineers) realised that these disciplines did not adequately address the diversity of agriculture's engineering requirements. In 1905, J. Brownlee Davidson designed the first agricultural engineering college curriculum. In 1907, in Madison, Wisconsin, a group of mostly engineers from academia met to exchange ideas about the engineering needs of agriculture.

These 18 pioneers formed the American Society of Agricultural Engineers, whose constitution reads: 'The object of this Society shall be to promote the art and science of engineering as applied to agriculture.'

The profession quickly spread and most land-grant universities in the US began offering agricultural engineering as an engineering major. Over the next 98 years the professional society grew to its current size (approximately 7,000 members) and became more diverse. In 2005, the Society was renamed the American Society of Agricultural and Biological Engineers (ASABE) to reflect the important role that the biological sciences play in the profession.

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Why is research in the fields of agricultural and biological engineering so vital to ensuring global food and water security, particularly in this era of climate change, biodiversity loss and population growth?

Research in the fields of agricultural and biological engineering is vital to ensuring global food, water, and energy security for many of the same reasons that the profession was formed back in the early 1900s. Solutions to agricultural and biological production, processing, packaging and distribution problems require a systems approach. Engineers working in this area need to understand the interactions of many systems, at least one of which is biological, to adequately design a workable engineering solution.

The National Academies of Science, Engineering, and Medicine (NASEM) issued a report in 2012 pointing out that by 2050, 70% more food would be required to feed the world’s burgeoning population, resulting in major threats to achieving global sustainability goals. That report also identified promising scientific breakthroughs needed by 2030 to increase the US food and agriculture system’s sustainability, competitiveness and resilience, such as improved food processing and packaging technologies to reduce waste and maintain nutritional value, improved decision making to maximise food security, and enhancing consumer understanding and acceptance of innovations. In support of the profession, ASABE touches all the natural systems needed to address these challenges and maintain a thriving planet.

Providing the world with ample, safe, and nutritious food, while regenerating the planet’s natural resources presents a complex challenge that will require enormous cooperation and creativity to address. The challenges of nourishing the planet are daunting, and agricultural and biological engineers are not going to solve these problems in isolation. One of the skills we do bring to the table though is the ability to integrate knowledge from disparate professions, and enable dialogue between traditional engineers and traditional agricultural/life scientists. NASEM calls this a convergent research approach and asserts that this convergence is needed to harness advances in data science, materials science, biological sciences, behavioural sciences, economics, and other fields to address the challenges climate change, biodiversity loss, and population growth present to our nation’s food system.

In addition to facilitating solutions by integrating expertise from other engineering and biological science disciplines, agricultural and biological engineers look for the system implications of design changes ‘upstream’ and ‘downstream’, regardless of the agricultural or biological system. Agricultural and biological engineers are trained to look at the systems more broadly, as a ‘system of systems’, and to ensure that the solution being designed integrates smoothly. Engineers working in this area need to understand the interactions of many systems to adequately design a workable engineering solution. For example, a seed planter will not operate correctly if the engineer does not understand the biological requirements the seed needs for germination, and the mechanics of the soil in which the seed will be placed.

A simple example may help illustrate this point. A nearby production facility that uses large-scale fermentation to produce products such as alcohol, omega-3 fatty acids, or industrial enzymes by growing microorganisms in a water-based nutrient broth, installed a new production facility. The engineering firm that designed the facility did not consider the biological system to be used in this facility. The engineers did not realise that water piped to the fermenters needed to be sterilised to avoid contamination by undesired microbes. The

fermenters could not be used until the entire system was retrofitted to include water sterilisation before filling the fermenters. This is a straightforward example of the type of system integration knowledge that agricultural and biological engineers bring to their solutions.

Similarly, explain how agricultural and biological engineers work to produce efficient renewable energy sources, towards a more sustainable future.

Many sources of fuel originate from solar energy through the process of photosynthesis. Petroleum, natural gas and coal are formed when dead plant material is exposed to high pressures and temperatures, and over time is converted to a dense source of energy. The dead plant material from which the densified energy originated was created by photosynthesis, using solar energy.

Agriculture in effect also harnesses the sun to produce products of value for civilisations. Agricultural and biological engineers work to convert the stored energy (in plants or agricultural waste) into a denser form of energy that is more convenient to use in our advanced technologies, such as fuel alcohol, natural gas and electricity.

Many of the renewable energy production technologies are biological processes. For example, anaerobic digestion is used globally to produce either natural gas or electricity. Fuel alcohols are produced similarly through fermentation. Converting sugars and starches for fermentation into fuels (such as alcohol) is technically straightforward, but involves processing agricultural products into glucose for fermentation. In this process, the remaining plant biomass is a waste product which is partially recycled as animal feed and soil amendments.

The use of sugar and starch-based crops creates a food versus fuel trade-off, however, leading to current second-generation cellulosic ethanol production facilities. Here, only non-food biomass (such as agricultural residues) is partially depolymerised to release sugars which are fermented to make fuel alcohol. Converting the actual plant material into sugar is technically much more challenging than converting starch to sugar. Agricultural and biological engineers are providing much of the research to advance this technology.

Agricultural and biological engineers are also involved in using other renewable energy sources, such as solar energy, to power technology used in agriculture, such as agricultural machinery. Solar-powered tractors may be a disruptive technology that can mechanise parts of the world that do not have consistent access to liquid fuel for machinery. These are just a few examples of how agricultural and biological engineers are working to produce efficient renewable energy sources, and to apply these energy sources to create a more sustainable future.

Please detail some of the many ways that ASABE supports the agricultural and biological engineering community and promotes research in this field.

ASABE provides a venue for agricultural and biological engineers to gather, share knowledge, discuss new ideas, and network. The Society promotes research by bringing engineers from industry and academia together, so research can be grounded in real-life problems.

ASABE also hosts a technical library, which is the most expansive collection of technical information available for agricultural and biological engineers. More than 30,000 technical documents, including journals, standards, proceedings, textbooks, and reference books are available 24/7. ASABE also publishes Resource Magazine, which keeps members up-to-date on the latest technical news, with content written and driven by members working in agricultural and biological engineering. Published six times a year, each issue highlights case studies, research and features on a variety of topics.

ASABE is built on committees run by volunteers. Within these committees our members can develop their leadership skills and collaborate, discuss and network with like-minded individuals from around the world. Technical projects typically originate from these committees, such as new standards and specialty publications. ASABE provides forums, which are places for members to gather on-line, get feedback on their work, receive advice, and connect with other professionals from around the globe on topics of interest.

ASABE hosts an annual meeting, which is the most important agricultural and biological engineering meeting of

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the year. At the meeting, members learn of the latest trends, research and techniques of the profession and connect and build relationships with peers.

A Continuing Education Center is administered by ASABE, and compiles courses from all types of engineering disciplines, searchable by subject area. These courses provide Professional Development Hours guaranteed to be accepted by all state boards of licensure. The Society also curates jobs relevant to our members who are looking for employees or looking for employment. ASABE also encourages excellence by providing professional and student awards honouring outstanding achievements in the profession. Scholarships are also available to students.

Give us a few examples of the standards of practice that ASABE develops, and how their dissemination supports the community.

While the exact number can be debated, agriculture is always the top consumer of water in the world by percentage. Much of this water is used for irrigation, and in many places around the globe water use for irrigation is regulated due to scarcity. Efficient use of irrigation water is a long-standing topic within ASABE, and has resulted in the publication of many national and international standards. This work continues within a number of established ASABE technical committees and through our involvement in ISO/TC23 Subcommittee 18, Irrigation and Drainage Equipment and Systems. This work is expected to continue far into the future and become even more refined by standardising data acquisition and use to more precisely define and provide for the moisture needs for defined areas.

We also develop standards of practice within the area of evolving technology. The interest in autonomous and electrified vehicles is not limited to automotive applications. There is a huge interest in these technologies from the agricultural sector. One of the main drivers for automation in agriculture is the cost of labour. In many areas, seasonal agricultural work faces stiff competition from other employment sectors, and automation may be a partial solution to this lack of available labour. The benefits of machinery electrification are more varied. One benefit is simple efficiency. An engine used to produce electricity to power electric drive motors uses less fuel than an engine combined with a mechanical transmission. In addition, the electric power created by the tractor can be used to power implements instead of using mechanical drivelines or hydraulics. Much of the standards work for these two areas will occur in ISO. Work has already begun in ISO/TC 23 Subcommittee 3, Safety and Comfort of the Operator, and ISO/TC23 Subcommittee 19, Agricultural Electronics.

The use of genetically modified (GM) crops in agriculture has revolutionised some areas of human food production. However, the use of such plants remains controversial worldwide. Please explain how ASABE promotes the development of safe and efficient GM varieties towards the sustainable production of food, fibre and energy.

This is a great question and one we are asked frequently. The detailed science of genetically modifying crops is not an area where ASABE has a lot of programs and activities. However, ASABE is a strong supporter of sound science and the science tells us that genetically modified crops offer tremendous benefits to humanity and reduce agriculture’s environmental impact on the planet. As engineers, we put science to work to solve problems.

The science supporting the use of genetically modified crops has unlocked powerful tools which allow society to feed a growing global population while minimising agriculture's environmental footprint. While GM tools are revolutionary, they are just one of many advancements like the mechanisation of agriculture, rural electrification, trickle irrigation, soil conservation, controlled environment agriculture and precision agriculture which have revolutionised agriculture and human food production in recent history.

One collective challenge we face is producing nutritious foods, ample feed and fibre that are acceptable and available to people of varying cultures and socioeconomic backgrounds. In order to meet this challenge, we need engineers, food scientists, nutritionists, plant scientists and many others beyond the food production areas all working together to nourish the planet.

Finally, one of the Society's goals is to foster an inclusive culture that values diversity within the fields of agricultural and biological engineering. Please explain why diversity is so important to the advancement of research in this area, and what the Society does to ensure inclusivity.

Diversity and inclusivity are important to the field of agricultural and biological engineering because working with a team for a common purpose creates synergy, sparks creativity, and allows for resource pooling. Diversity is important in advancing research in our field because agricultural and biological engineers want to design technological systems that are functional for all people.

For example, autonomous farm equipment relies on sensors and image processing to determine the machine's proximity to objects, including people. Skin shade is a key design element because the system has to be able to automatically identify humans of all skin shades and separate the person from the background image. If the entire team of development engineers have similar skin colours, this factor may be overlooked.

A diverse and inclusive design team has a much higher probability of addressing multiple groups' concerns instead of just designing to the physical attributes of the majority. In addition, ASABE members work across the globe, and the engineering solutions we develop must take into account the social and political culture in which this solution will be deployed, for the technology to be successful.

Our Society is working to cultivate a diverse, thriving, and engaged membership. In 2019, ASABE joined the Societies Consortium on Sexual Harassment convened by AAAS and the Education Counsel. This group of professional societies banded together to pool resources and work towards establishing policies and procedures related to appropriate conduct at meetings and for members receiving honours and awards. We are working to establish an environment at our meetings and within our membership where everyone feels safe to be their authentic selves. Once we have this structure in place, our Society will continue to encourage inclusivity through regular programming at our national and regional meetings.

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