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RESOURCE

engineering and technology for a sustainable world

SAFETY

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The Value of Local

In my first column as president, I want to share my experiences at the Northeast Agricultural and Biological Engineering Conference (NABEC) annual meeting. The group met in Groton, Conn., and had a lively meeting with a wide diversity of technical topics presented by professionals and pre-professionals. It was great to see the mix of U.S. and Canadian engineers, including ASABE/CSBE members as well as non-members, all enjoying the atmosphere. I especially admire the motto for their annual meetings, "Relax Professionally." In addition to the engineering content, the program included social interactions such as an open-air meal on Long Island Sound, lots of conversation, and an impromptu concert/sing-along. I know some of you will correct me if this is wrong, but I'll bet NABEC is the only regional ASABE-associated group with its own theme song. It's called "Down to NABEC." You should plan to attend next year in West Virginia to learn the words.

The enjoyable time that I had in Groton is a perfect example of why ASABE should emphasize effective local meetings and gatherings. When only about 25% of our membership will attend annual meetings or specialty conferences, much of the value that members receive from our Society can come from local events. One of the goals during my presidential term is to enhance our local Society activities. An ad hoc task force has been formed to study the value that ASABE provides to both members and their employers, and how we can enhance that value for all our members. If you have ideas of how your local group, whether a section or other subgroup, can be more effective, please share that with me.

I'm also pleased to report that the Board of Trustees is actively moving forward on a number of important issues. At the recent Spokane meeting, the Board took action on the creation of an editor-in-chief position for our refereed journals. That followed a consultant's report on possible actions that could enhance our journals in the rapidly changing environment for academic publications. We have general agreement that ASABE journals have low impact factors and long review times before publishing. Both of these are issues that the Board and the Publications Council are moving to address. I was particularly interested to learn from the consultant that the impact factor calculation only considers citations within the last two years, and that ASABE manuscripts have a citation half-life of about five years. While this makes the applicability of impact factor questionable for our journals, we still must improve the situation.

Other ongoing Board activities include assessment of progress on our strategic plan, engagement with the Institute of Electrical and Electronics Engineers (IEEE) on a programming effort in smart agriculture, helping the Smithsonian develop a display on the 100th anniversary of the lightweight tractor, and organizing an ASABE-sponsored event at the World Food Prize. You should know that your Board of Trustees is working hard on your behalf.

On the topic of working hard, I want to acknowledge and thank Sue Nokes for serving as treasurer for the last four years. She has served us well in that role. Thanks also to Gary Siebel for his willingness to take on the treasurer responsibilities in the next year.

I thank you for the honor of serving you as President and invite your comments and feedback at ssearcy@myasabe.org.

Steve Searcy, P.E.

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.

2018

Feb. 12-14	**Agricultural Equipment Technology Conference.** Louisville, Ky., USA.
July 29-Aug. 1	**ASABE Annual International Meeting.** Detroit, Mich., USA.
Sept. 25-27	**10th International Livestock Environment Symposium (ILES X).** Omaha, Neb., USA.
Oct. 3-6	**Global Water Security for Agriculture and Natural Resources: An ASABE Global Initiative Conference.** Hyderabad, India.

2019

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

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Magazine staff: Joseph C. Walker, Publisher, walker@asabe.org; Sue Mitrovich, Managing Editor, mitro@asabe.org; Glenn Laing, Technical Editor, laing@asabe.org; Melissa Miller, Professional Opportunities and Production Editor, miller@asabe.org; Sandy Rutter, Consultants Listings, rutter@asabe.org; Darrin Drollinger, Executive Director, drollinger@asabe.org.

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American Society of Agricultural and Biological Engineers
2950 Niles Road
St. Joseph, MI 49085-9659, USA
269.429.0300,
fax 269.429.3852
hq@asabe.org, www.asabe.org

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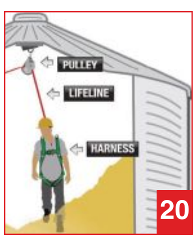
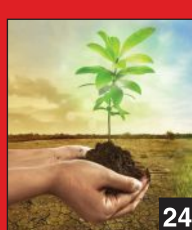
FEATURES



DEPARTMENTS



Is Safety a Means to an End, or the End of a Means?

Most of us learned safety very early in life with lessons like "Look both ways before crossing the road" or "Never touch a hot stove." Fire safety likely started when a caveman first struck a flint. For some activities, safety is a recommendation; for others, it is essential to life. Safety can be in the interest of a single person or for an entire community's well-being. When safety affects social norms, it's often presented as public policy.

While we all have a basic understanding of safety, we also have great variability in how well we practice it. We make split-second judgments about heeding warning signs or listening to advice. Many times, we evaluate the credibility of the source before taking action. If the safety message comes from a respected authority, it's more likely to be heeded. The opposite is also true: if the source has limited credibility, a history of false claims, or cumbersome application, then it's often disregarded.

Safety and health practices are entwined in our personal and professional lives. Some activities become intuitive, while others continue to be learned and tweaked as we go along. Following safe practices is not always a straight path. It's not a process of simply measuring our actions; it also involves calculating and evaluating our intentions to act, as well as the possible outcomes of our actions.

ASABE member and guest editor, Dee Jepsen
Associate Professor, The Ohio State University Department of Food, Agricultural and Biological Engineering, Columbus, jepsen.4@osu.edu.

Creating a culture of safety is a current practice in many industries. A culture of safety typically involves either of two approaches. The first approach takes the viewpoint: *Safety as an end of a means*. In other words, safety is a goal we strive to achieve in our workplace. When an industry prominently posts the number of days worked with no lost-time injuries, there may be an incentive for workers to reach the end of the next week, month, or year with no injuries. A similar process occurs when an individual sets a personal goal to work safely for an entire career, and thereby enjoy a healthy retirement. The second approach considers: *Safety as a means to an end*. With this viewpoint, safety is simply the best way to achieve a larger goal. It is a lifestyle, or a habit, that's practiced every day.

Regardless of the approach, safety, as a professional discipline, requires an understanding of science and engineering as much as it depends on the physical and psychological factors of the people involved and their interactions with the environment. Because of these intricate connections, safety is a complex discipline that involves multiple influences. In this regard, ASABE has become a respected authority in the discipline of agricultural safety and health.

In this special issue of *Resource*, a variety of guest authors share their perspectives on how agriculture has evolved into a safer industry. While the topics are diverse, a cohesive theme connects them. As guest editor, I was challenged to identify topics that show the breadth and depth of ASABE's influence on industry standards, equipment design, and human interactions with the work environment. It is my hope that this collection will encourage even more participation in ASABE's contributions to agricultural safety and health.

As an active member of ASABE, I've had the privilege to work with other members involved in this discipline. In particular, ASABE's Ergonomics, Safety, and Health (ESH) technical community provides a broad perspective on the engineering aspects of ergonomics, safety, and health for users of equipment, systems, and facilities within the industries served by the Society. I encourage you to get involved in the subcommittees for policy, standards development, technology exchange, publications, and awards.

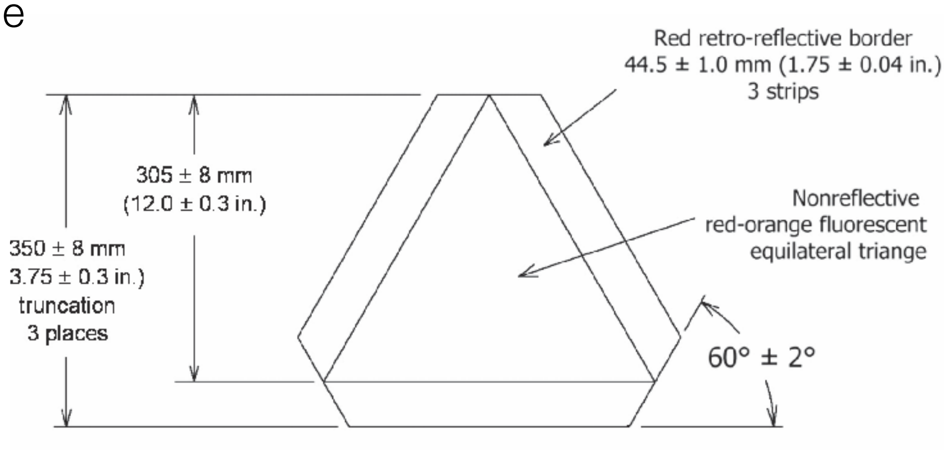
Student participation in ASABE is also important. Student involvement with safety typically occurs through Capstone design projects and ASABE-sponsored competitions. Student, faculty, and industry teams, working together, have developed many useful safety innovations, and they have shared their work at ASABE conferences and through publication in ASABE's *Journal of Agricultural Safety and Health*, a peer-reviewed outlet for research and applied applications of safety and health in agriculture.

I recognize that not everyone will choose safety and health as the focus of their career. However, given the breadth and depth of this discipline, there are continuous employment opportunities for engineers, educators, and public policy experts. Most important, safety and health should be concerns for everyone who works in agriculture. Sharing these concerns and increasing the awareness of our discipline is the "means to an end" of this special issue.

Safety Standards

Their worth, their value

Scott Cedarquist



If you ask an assortment of ASABE members about their involvement with standards, you're likely to get a wide range of answers. Some are not involved at all and don't use standards in their jobs. Others are involved in numerous standards activities and frequently use standards. And those who aren't involved often wonder why those who are engaged in standards devote so much energy to this work. As someone who spent the first half of his career using standards and the second half on the ASABE staff coordinating our standards program, I can definitively state that standards make the world go round. Whether you get to work by car, bus, train, or bike, standards are involved. The same can be said whether you are reading this article on paper or on an electronic device. And standards often become the international language of business. The U.S. Department of Commerce tells us that standards, or technical regulations that reference standards, are integral to the vast majority of international trade.

At a basic level, standards are a tool, a resource to be used and referenced. From an ANSI training session that I attended, standards can be defined as "formal technical documents for generally accepted products, processes, procedures, and policies." Standards help document what works, provide for interchangeability, offer repetitive and comparable ways to perform tests, set minimum design requirements, and much more. In many cases, as described below, standards help to improve safety. ASABE standards are developed as voluntary consensus documents, but a number of ASABE standards have become legal requirements.

There are many specific examples of how standards improve safety, but a more comprehensive look seems in order. ASABE currently publishes more than 260 standards, of which:

- 32 have "safety" in the title.
- 67 use "safety" as a keyword.
- 174 use the word "safety" in the text.

How are standards used to improve safety? First, let's start with the generally accepted injury control strategies:

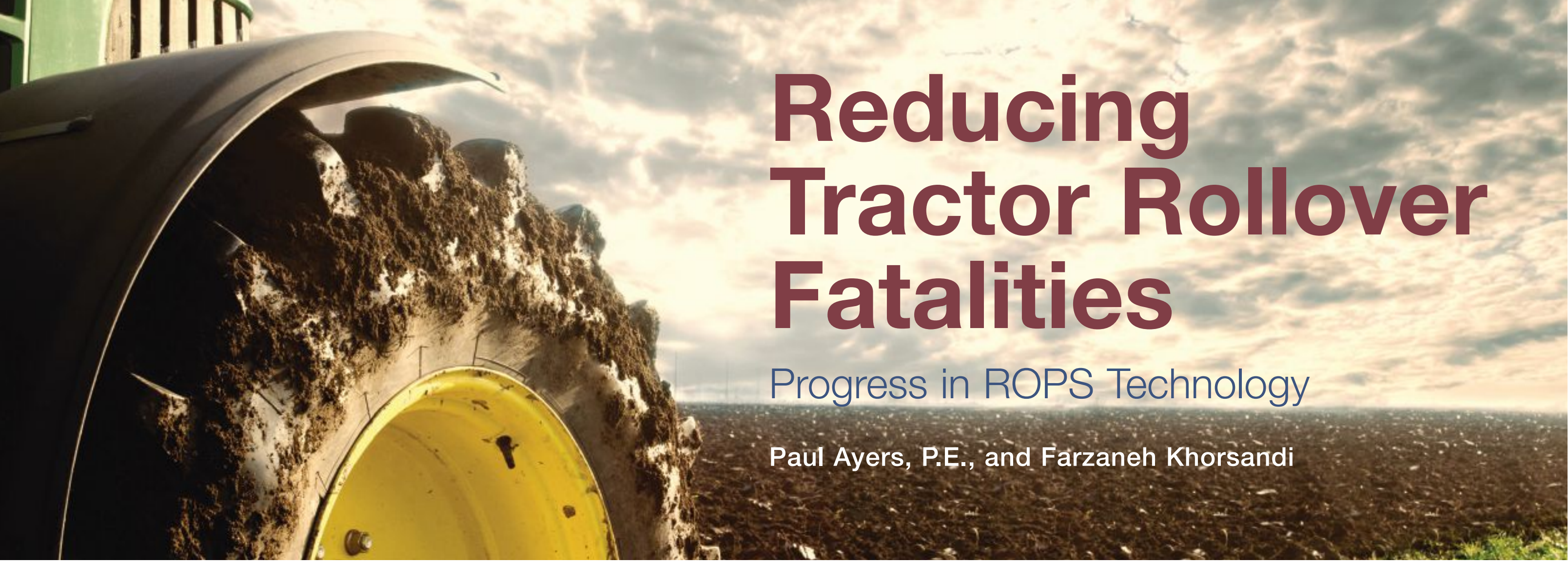
- Eliminate the hazard through design.
- Guard the hazard.
- Provide warnings and education.
- Provide personal protective equipment (PPE).

Standards have been developed that apply to each of these strategies. For agricultural equipment and systems, this work has been going on for decades, but the job is far from complete. In our ever-evolving world, new technologies emerge and create the need for additional standards work. Fifteen years ago, there was little thought of fully autonomous or electrically driven equipment, application of plant-protective products with unmanned aerial vehicles, or LED lighting for horticultural operations, yet all these topics are now being discussed by ASABE committees. Initially, the discussions focus on research, but the discussions often evolve into the need for standards.

At the core of the ASABE standards program are the ASABE technical committees. Not all technical committees develop standards, but most include some standards work. These committees are all open to additional participation, and many welcome members who want to observe the committee at work. If you are interested in joining the more than 2,000 members and others who are part of the ASABE technical committee structure, let me know of your interest. We can help you connect with the current committee leadership.

It can be said that standards bring order from chaos. In cases where there are multiple possible solutions to a problem, there's a great benefit in defining "the one" answer. A classic example of this is the 540 rpm PTO that's found on nearly every compact utility tractor. Today, farmers take it for granted that the 540 rpm PTO has a specific spline size and rotates in a specific direction. But this was not always the case. Early PTOs had different rotational speeds, different spline dimensions, and did not always rotate in the same direction! This confusion was resolved in the 1920s, and it is a long-lived success story for ASABE standardization.

ASABE member Scott Cedarquist, Standards and Technical Director, ASABE, St. Joseph, Mich., USA, cedarq@asabe.org.



Reducing Tractor Rollover Fatalities

Progress in ROPS Technology

Paul Ayers, P.E., and Farzaneh Khorsandi

Agricultural tractors have played a critical role in agricultural mechanization. Tractors have high clearance, varied external forces, and often operate on steep or unstable terrain. Because of these conditions, tractors are prone to instability and rollovers. As tractor usage increased, overturn incidents and fatalities also increased. By 1955, an estimated 1,500 tractor rollover fatalities were occurring annually. To combat this situation, agricultural engineers worked to develop rollover protective structures, or ROPS. One of the first ROPS (called the "tractor driver safety frame") was successfully tested by the Department of Agricultural Engineering at the University of California, Davis, in 1956. In 1960, U.S. Patent No. 3,455,598 was issued to Deere and Co. for a tractor roll bar and canopy. This patent was shared without royalties. In 1962, the ASAE Rollbar Symposium was held at the Winter meeting, and by 1966, John Deere offered ROPS on all new tractors, but they could be deducted.

In 1967, ASAE established some of the initial engineering performance standards for ROPS design and testing. ROPS are designed to protect tractor operators in the event of a rollover by absorbing energy while providing a protected clearance zone for the operator. A ROPS is considered a protection system because it includes the use of a seat belt, and ROPS standards were developed to ensure uniformity of production. ASABE and members of the MS 23/2/2 ROPS committee (previously PM 23/2/2) have been instrumental in maintaining the engineering performance standards to make ROPS an effective method for reducing the frequency and severity of injury during tractor rollovers. To recognize its impact on agricultural safety, in 1986 ASABE dedicated the rollover protective structure as the 21st Historic Landmark.

However, tractor overturns were still resulting in high numbers of fatalities, as many tractors did not have ROPS, and new tractors were still being sold without ROPS. In 1975, OSHA attempted to address this problem by requiring ROPS on all agricultural tractors larger than 20 hp and manufactured after October 25, 1976. However, this regulation (29 CR 1928) could only be enforced on farms with more than eleven employees, limiting its impact. Recently, some states have introduced regulations requiring more widespread use of ROPS.

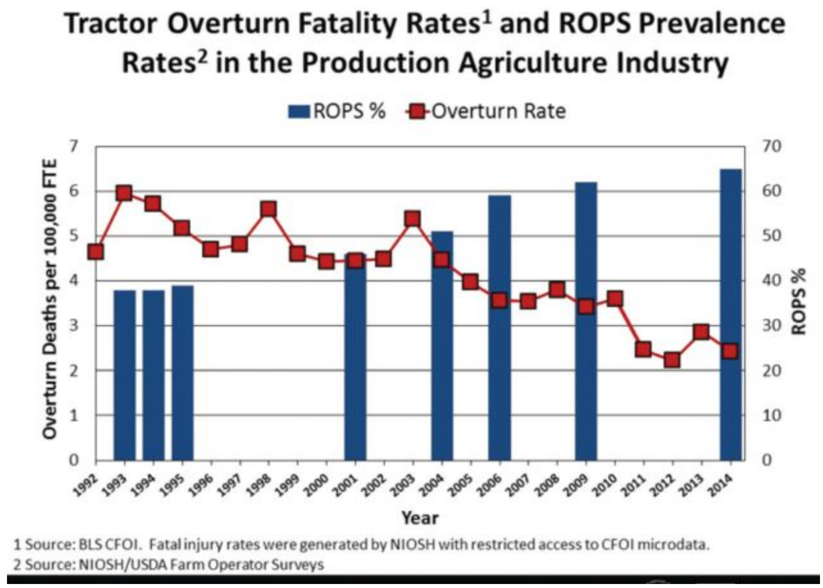
In 1985, ASAE Standard S318.8, Safety for Agricultural Equipment, required that ROPS be provided on all new tractors and meet appropriate engineering standards. North American tractor manufacturers agreed to sell all new tractors with ROPS. While ROPS were previously an option, this standard ensured that all new tractors went out the door with a ROPS installed. In the 1990s, tractor manufacturers (including John Deere, AGCO, Case IH, and Kubota) again worked together to promote ROPS usage and make ROPS available at cost to encourage ROPS retrofits. In 1990, a guide to tractor rollbars and other rollover protective structures was developed and provided a useful tool for identifying manufacturers that would provide retrofit ROPS for specific tractors. The guide

A typical ROPS retrofit from the National ROPS Rebate Program.

has been updated frequently and is currently available online at: http://rops.ca.uky.edu.

While these actions significantly improved the number of tractors with ROPS, there were still many tractors without ROPS, and tractor rollovers continued to be the leading cause of agricultural fatalities. In 1990, the National Institute of Occupations Safety and Health (NIOSH) launched an Agricultural Safety and Health Program, and the 1991 Surgeon General's Conference on Agricultural Safety and Health recognized tractor rollover fatalities as "an occupational obscenity."

The NIOSH-sponsored Tractor Death and Injury Prevention Workshop was held in Pittsburgh in 2003 to address the large number of tractor-related fatalities. The need for tractor ROPS retrofits was identified, and intervention, education, incentives, and regulation were considered. Although regulation (such as requiring ROPS on all tractors) was shown to be effective in some European countries, this regulation met stiff political resistance in the U.S. A NIOSH-sponsored National Tractor Safety Initiative (2005-2007) looked at further efforts to reduce tractor fatalities.



Trends in tractor rollover rates and ROPS usage, as presented by Captain Brad Husberg at the National ROPS Rebate Program meeting during the 2017 ISASH conference in Logan, Utah.

In 2014, the National Tractor Safety Coalition was formed and identified tractor rollovers and ROPS retrofits as its leading priority. A National ROPS Rebate Program (NRRP) was initiated, modeled after several successful state ROPS rebate programs, as originated in 2006 by the New York Center for Agricultural Medicine and Health (NYCAMH). A similar, smaller state program was launched by the Virginia Farm Bureau in 1995. These programs provide financial incentives for tractor owners to retrofit ROPS on existing tractors.

The NRRP was officially launched in June 2017 and has the support of U.S. government agencies, farm groups, ROPS and tractor manufacturers, academia, and other interested groups, with NIOSH providing the administrative support. Participation by tractor owners in the NRRP is voluntary, and the rebate funds are provided by state government contributions and private donations. ROPS rebates are approximately 70% of the cost of a retrofit, up to a capped amount. Program details are available at: www.ROPSr4u.com, and an example of a ROPS retrofit resulting from the NRRP is shown on the opposite page. In a separate effort to reduce the cost of ROPS, NIOSH developed the Cost-effective ROPS (CROPS) program, which provides construction specifications for low-cost ROPS that meet the appropriate ROPS performance standards.

These efforts have led to a reduction in agricultural tractor rollover fatalities, as shown in the above graph. Hopefully, in future years, these numbers will continue to decline as the percentage of tractors without ROPS decreases.

However, new potential concerns are on the horizon. When ROPS are installed, they increase the vertical height of the tractor, making vertical clearance an issue in orchards and when entering low-clearance structures. Although foldable ROPS, developed in the 1990s, allow lowering and raising of the ROPS when needed, there is a tendency for a tractor operator to leave the ROPS down after lowering it. Some say this is a step backward, as we are seeing an increase in tractor rollover fatalities with the ROPS folded down.

NIOSH has attempted to address this problem with the development of an automatically deployable ROPS (AutoROPS). The AutoROPS remains in the down position until an impending overturn is detected by stability sensors. The AutoROPS then deploys quickly and locks in place before the overturn occurs, thereby protecting the tractor operator. Although the prototype proved effective, a reliable commercially available unit was never adopted. In addition, lift-assist devices for foldable ROPS are being developed to encourage tractor operators to raise their foldable ROPS to the upright position. Efforts are also underway to provide real-time stability information to operators to help them avoid unstable operating conditions.

In this area and others, ASABE members have long addressed the safety needs of agricultural production, and they will continue to do so.

ASABE member Paul Ayers, P.E., Professor, Department of Biosystems Engineering and Soil Science, University of Tennessee, Knoxville, USA, pdayers@utk.edu.

ASABE member Farzaneh Khorsandi, Assistant Specialist in Cooperative Extension, University of California-Davis, USA, fkhorsandi@ucdavis.edu

Assistive Technology for Agriculture

Karen Funkenbusch and Shawn Ehlers

Advances in technology can allow disabled farmers, such as Scott Collier, to continue working. Collier was replacing a tire on his auger when a metal strut collapsed and pinched his spine, leaving him unable to walk. ***Photo by Renee Jones Schneider, © 2015 Minneapolis Star Tribune.***

Personal independence is a pillar of the farming profession. Unfortunately, that independence is often threatened by disability due to accidents, chronic health conditions, and aging. In the past, these limitations would likely end lifelong careers or result in drastic changes in the structure of the family farm. Today, however, with the help of assistive technology (AT) and support programs such as AgrAbility, farmers often retain or regain their ability to live and work independently, safely, and efficiently.

AT includes any item, equipment, system, or technology that increases, maintains, or improves an operator's functional abilities. In the past decade, agricultural productivity has benefitted enormously from advances in machine technology, data gathering, and data processing. Sophisticated technologies such as robotics, intelligent crop monitors, digital imaging, and geographic information systems are becoming common. In addition to increasing productivity, these advances provide a basis for developing AT solutions for those with physical, psychological, or functional limitations.

The future of assistive technology

In the future, large agricultural operations will need workers with a variety of skills. This will require job restructuring to match the skills of the workers with appropriate tasks while reducing the risk of injury. Because of improvements in AT, long-time farmers who are affected by disabilities, limited mobility, or aging may be good choices for these jobs because of their experience and maturity. Similarly, some operators with disabilities will be able to own and operate a small farm or agricultural enterprise through task modifications and other accommodations made possible by AT.

Some of these technologies are on the horizon—others are already common in our lives:

- The application of universal design principles to agricultural machinery will help to accommodate the needs of an increasingly diverse farm workforce.
- Automation and labor-saving technologies will increase employment opportunities for workers with disabilities.

- Pocket-size devices and wearable technology will provide a readily accessible interface between the farmer, the machines and systems that the farmer manages, and the farmer's support network of family, medical providers, and coworkers.
- The IoT (internet of things) will reduce the farm management burden by providing communication between smart devices and equipment on a common network. The IoT is already common in smart homes and offices, performing many day-to-day tasks automatically or in response to voice commands.
- Intelligent, self-learning devices will monitor and adjust their actions in relation to both the operator's safety and the agricultural production system.
- Deployable technology, such as aerial drones, in-field sensors, and livestock tags, will allow the operator to monitor and manage the production system while minimizing the physical demands and avoiding exposure to unsafe conditions.
- Behind all technologies are people. In particular, social media will continue to expand, creating connected communities and bringing people together around a common interest or shared goal.

Advances in AT will help farmers with disabilities remain independent and productive. Examples include "smart" wheelchairs that integrate separate technologies into a single device. In the near future, "smart" wheelchairs will monitor the user's health and provide surveillance functions to detect falls and injuries. Similar innovations in prosthetic devices are being developed for amputees. For example, 3D printing will allow prosthetic devices to be more durable, affordable, and accessible. In the near future, prosthetics will be seamlessly integrated into amputees' everyday lives with little effort and expense. These devices will be more natural in their fit and appearance, and they will be equipped with integrated sensors and control algorithms to provide more natural movement with less effort.

Farm machinery

Farm machine systems will continue to evolve, especially at the operator-machine interface. Manufacturers continue to improve control systems with electronic proportional controllers. These advances have benefitted operators with mobility or strength impairments, and they have significantly reduced the need for extensive third-party modifications. Other examples include electronic-controlled steering (autosteer), hydraulic accessory controllers, and transmission options such as continuously variable transmissions (CVT), infinitely variable transmissions (IVT), and hydrostatic and shuttle-shift transmissions, which eliminate the floor-mounted clutch and brake pedals. Highly automated agricultural machines (HAAM) continue to advance, with many more innovations to come. Following the lead of smart home technology, voice control will likely replace some manual or foot-operated controls, which will accommodate operators with arm or leg disabilities.

Safety automation

Influencing farmers to follow "safety first" practices will continue to be difficult. Accomplishing this change through machine technology may prove easier. Transportation and manufacturing industries have made great strides in assisting operators in making safe decisions. Current highway vehicles include hazard-detection systems and even automatic braking. The construction industry, which uses equipment similar to agriculture, is incorporating hazard-detection devices that can recognize bystanders and obstacles in the path of travel.

With current smartphone technology, farm managers can perform logistics planning, monitor their production systems, and even receive automatic notifications when a hazard is detected, such as when someone enters a dangerous area by crossing a virtual fence. This automation has great potential to improve farm safety without compromising the manager's decision-making authority.

Other areas for AT development

Emerging technologies extend beyond individual applications. Examples include inexpensive or open-source designs for rapid adaptation of standard AT devices, such as 3-D printer designs for modified handgrips, ergonomic controls, and other aids. Participants can share modifications, designs, and solutions with others who face similar challenges. Other practical benefits include tutorials (in print, photo, and video formats) and like-minded community involvement.

Acceptance of new technologies is critical for improved safety and sustainability on the farm. These technologies can also improve the quality of life for farmers with disabilities, which will encourage their acceptance by all farmers. However, despite all the recent advances in technology, farming remains hard work. Ag and bio engineers, agricultural safety and health specialists, and AgrAbility professionals must work together to educate farmers about the advantages of AT.

Both private and public funding will be required for the further development of the ideas identified here. Identifying funding sources and motivating public support for programs such as AgrAbility will continue to be a challenge. In the meantime, ASABE members are advancing agricultural technology through basic research and development, which underlies the AT advances mentioned in this article. These advances are already impressive, and many more are on the horizon.

ASABE member Karen Funkenbusch, State Health and Safety Specialist, Human Environmental Sciences; Instructor, Division of Food Systems and Bioengineering, Department of Agricultural Systems Management; and Director/PI, Missouri AgrAbility Project, University of Missouri, Columbia, USA, funkenbuschk@missouri.edu.

ASABE member Shawn Ehlers, Technology Outreach Coordinator, National AgrAbility Project (www.agrability.org), Purdue University, West Lafayette, Ind., USA, sehlers@purdue.edu.

Autonomous and Unmanned Vehicles

New challenges from a safety perspective

Brian Luck and Gary Roberson, P.E.

Agricultural production is on the cusp of an exciting new era. Autonomous machines are at the forefront of research and development. The introduction of small unmanned aerial systems (sUAS), also called unmanned aerial vehicles (UAV) or drones, followed by the development of autonomous tractors for field operations and small autonomous robots for tasks such as input application or harvesting, will give farmers new tools to enhance production. In agriculture, sUAS usually carry a sensor payload to collect data on crop health during the growing season. They have also been used in grazing animal production systems for herd location and animal assessment, and they are being considered for low-volume aerial pesticide applications. Autonomous machines can reduce the need for skilled labor in agriculture and perform field operations within the available weather windows without human input.

Data-driven agriculture has provided the motivation for the development of new sensors and other methods for assessing crop health, nutrient requirements, stress, and yield. Farmers and consultants are seeking new ways to collect crop data and implement management decisions in the most timely and efficient way. New tools, such as sUAS, can assist in this data collection process, and autonomous field machines will require vast amounts of data to precisely control what is done in the field, how it is accomplished, and when. In the near future, farmers could deploy a fleet of driverless tractors, all controlled by an operator with a tablet at the edge of the field or in the farm office. Hosts of small autonomous robots could swarm through the field, making pinpoint applications of nutrients or pesticides, removing weeds, and harvesting crops.

While these advances will have significant impacts on production methods, some safety concerns must be addressed before widespread implementation. For example, what happens if autonomous sUAS control fails? What are the risks of property damage or injury if an sUAS crashes, or if an autonomous tractor or robot loses control in the field? What redundancies can be built into these machines to ensure safe failure modes? How can ASABE create standards that ensure the safety and reliability of autonomous machines?

Insights into how we can safely implement sUAS and other autonomous machines can be gained from how the Federal Aviation Administration (FAA) has implemented rules for the use of sUAS in the national airspace. In 2016, the FAA released the Part 107 rules for commercial operation of sUAS. For use in agriculture, the Part 107 rules apply to any sUAS with a payload of less than 55 lb (25 kg) that is involved in measurement, visualization, input application, or any other task in crop or livestock production. The most significant aspect of these rules is the "remote pilot in command" license for commercial operation. This license requires that sUAS operators pass a written exam and prove sufficient understanding of how the national airspace works. This is a critical safety component of sUAS operation; avoiding manned aircraft begins with understanding the typical patterns and operation of manned aircraft. Other highlights of the Part 107 rules are:

Autonomous field machines have potential to revolutionize agricultural production, but safety concerns must be addressed before widespread implementation. ***Photo of Magnum autonomous concept tractor with model 2150 planter in transport courtesy of CNHi.***

With a view from the sky, sUAS can provide information beyond the abilities of ground-based systems. At less than 55 lb (25 kg), both of the sUAS shown in the inset are considered small, but their commercial operation, including agriculture, is subject to FAA Part 107 rules.

- Visual line-of-sight must be maintained at all times (a first-person view camera does not meet the "see and avoid" requirements).
- Daylight-only operation and maximum altitude of 400 ft (122 m).
- The sUAS platform must be registered with the FAA and have a tail number on the aircraft.
- Violation of the rules can result in license suspension or significant fines (more information is available at www.faa.gov/uas).

The Part 107 rulemaking process was conducted over several years, with input from interested groups in industry, government, and the public sector. The final version of the Part 107 rules did not achieve complete satisfaction for all the interested parties, but it provided a sufficient compromise so that new data collection tools could be used to their full potential. The major compromise in the Part 107 rules was the ability to have most of the restrictions waived based on an exemption application that demonstrates safe and reasonable operating parameters. In addition, while the Part 107 rules provide a consistent framework for the national airspace, many states have adopted their own regulations concerning sUAS.

The challenges associated with safe operation of ground-based autonomous machines are different from those associated with sUAS operation, but they are no less significant. As the scope of unmanned vehicles expands to include ground-based autonomous machines, we will need to consider standard guidelines to ensure that these machines are safe. For example, how close should the operator be to an autonomous tractor? Should the operator be in the same field, or is it safe to control the vehicle remotely, such as from the farm office? What information needs to be transmitted from the vehicle to the operator to ensure safe operation? What type of data connection is needed to transmit this information reliably? Should autonomous machinery be limited to specific tasks based on the power requirements of the operation or potential environmental risks? Most importantly, what will the machine do if a critical failure is detected?

ASABE has an opportunity to take the lead in developing industry standards and best practices for autonomous agricultural vehicles. These standards and practices will be the basis for future autonomous vehicle designs and will minimize the risk of accidents caused by autonomous machinery. The next step is the development of a working group consisting of researchers, safety engineers, and industry representatives to define safety protocols, system redundancies, and communication needs for autonomous vehicles. This process will also involve working with local, state, and federal government entities to identify concerns regarding transport, operation, and failure mitigation of autonomous field machines.

Innovation provides solutions to problems and increases efficiency. However, innovation also creates a new set of challenges. That's where we are with autonomous vehicles in agriculture. To ensure effective implementation, we need to focus not only on the capabilities of these machines but also on safe designs and safe operation.

ASABE member Brian Luck, Assistant Professor and Extension Specialist, zdepartment of Biological Systems Engineering,, University of Wisconsin-Madison, USA, bluck@wisc.edu.

ASABE member Gary Roberson, P.E., Associate Professor and Extension Specialist, Department of Biological and Agricultural Engineering, North Carolina State University, Raleigh, USA, gtrobers@ncsu.edu.

Small Changes Make Big Differences

The role of ergonomics in agriculture

Fadi Fathallah and Victor Duraj

Agriculture is one of the most hazardous occupations, not only in terms of fatalities but also musculoskeletal disorders (MSDs). MSDs are injuries to and compromised function of the body's system of muscles, tendons, ligaments, nerves, and spinal discs. Ergonomics is the term we commonly use in the evaluation and design of tools and workplaces to minimize the risk of MSDs.

Ergonomics is about fitting the job to the worker, by looking at the worker-workplace interface and helping workers avoid awkward postures, excessive forces, and repetitive motions. The term is based on two Greek words: *ergon*, meaning work, and *nomos,* meaning natural laws. Its first use can be traced to 1857, which was around the time when significant strides were being made in the early mechanization of agriculture.

Looking at this topic from the worker's perspective, the area of biomechanics is about understanding the motions, forces, and mechanisms of the body, from overall movements to specific muscles, tendons, and other tissues. Broadening this concept of human capabilities and limitations is the area of human factors, in which cognitive, physiological, psychological, and social elements are considered in the overall worker-workplace interface for improving safety and health.

A collaborative robot that assists workers in transporting strawberries during harvest. ***Photo courtesy of Stavros Vougioukas, University of California-Davis.***

In 2001, the National Academies Press published *Musculoskeletal Disorders and the Workplace: Low Back and Upper Extremities* (www.nap.edu/catalog/10032/musculoskeletal-disorders-and-the-workplace-low-back-and-upper-extremities). For all industries, it estimated a $45 billion to $55 billion annual cost for MSDs, and one million people taking time from work due to MSDs. For the scope of this issue in agriculture, we can look back to California's AgSafe program, which published a study of fatal and non-fatal injuries in California agriculture in 1991. Non-fatal injuries were primarily sprains and strains (43%) and caused by overexertion (25%). Overexertion was close behind being struck by something (28%) and just ahead of falls (17%). In a later survey in 2004 with a follow up in 2013 by the Western Center for Agricultural Health and Safety, 1,947 California farm operators reported 160 injuries, 29.4% of which were sprains and strains, and 24.2% of which were caused by overexertion and strenuous movements. In general, MSDs predominate among nonfatal injuries in agriculture and often involve extremities or the back.

Interventions in agriculture

Although many intervention efforts have been made over the last couple of decades, permanent solutions are hard to come by, for various reasons. In labor-intensive agriculture, solutions are often crop-specific. When labor shortages exist, more resources are focused on mechanization, which can eliminate existing risks but can also introduce new risks at the same time.

A successful intervention was the introduction of smaller harvest tubs for hand-harvesting of wine grapes. The smaller tubs reduced the average load from 57 to 46 pounds, bringing the weight below the common 50-pound limit used in general industry. Even though the NIOSH lifting equation suggests a much lower recommended weight limit for this job (www.cdc.gov/niosh/docs/94-110/default.html), this relatively small change made a big difference in workers' self-reported pain and discomfort, and the intervention was broadly adopted throughout the industry.

Work continues on orchard ladders with shorter spacing between rungs. Biomechanical studies in the field and in the lab indicate a strong preference for rung spacing that is less than the standard 12 inches by one inch or more. This small change appears to make a big difference. The relevant factors for preference may not necessarily be just worker anthropometry (e.g., height) but may also relate to joint health, body weight, and range of motion.

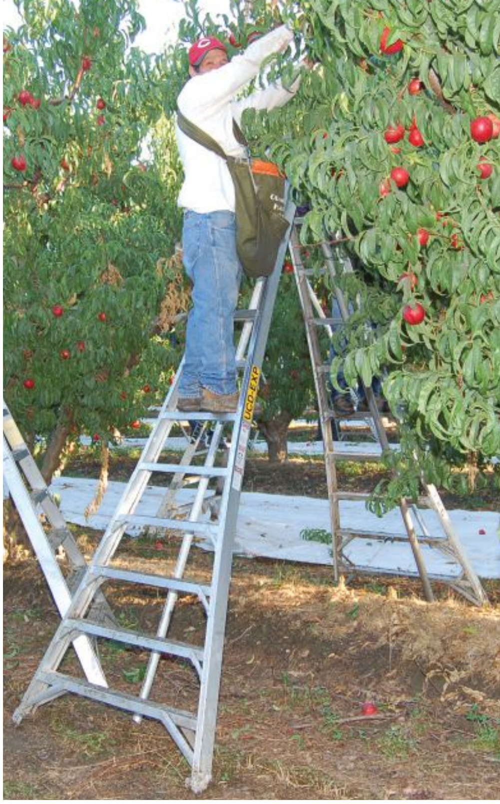
Machine solutions are gaining attention as labor shortages become more of a challenge in agriculture. Machines often eliminate certain hazards but can also introduce new ones. Conveyor systems in labor-intensive harvesting can improve productivity, but they can inadvertently eliminate the natural rest breaks that occur during the walking and carrying phases of the work. These breaks allow temporary relief of highly compressed spinal vertebrae during prolonged work in a stooped posture. Research in strawberry production showed that a five-minute break every hour during harvest improved the workers' well-being and reduced their fatigue, without affecting productivity.

Tractors, harvesters, and other self-propelled machines have benefited greatly from applied ergonomics over the years. The locations and operating forces of machine controls and the adjustability and vibration dampening of operator seats are good examples of efforts to fit the job to the worker. Color-coding of certain controls helps with human factors. Recent work by several ASABE member researchers has looked at control colors and visibility in depth, as operator cabs are being equipped with even more electronics and auto-guidance systems that require timely operator responses.

ROPS, of course, have been a great success in agricultural safety. New work on auto-deploying and foldable ROPS promises to move the field forward. But even here there are opportunities for ergonomics, biomechanics, and human factors considerations, such as improving the correct use of foldable ROPS. The effectiveness of a foldable ROPS depends on the operator unfolding the ROPS into the upright position. This process can include stopping the tractor, loosening clips and pins, dismounting from the tractor, and exerting considerable force, especially if the hinge joint is compromised. The reach distances, postures, required force, duration of the task, or simply remembering to perform the task also present opportunities for improved design. This is where a small change can make a big difference.

Emerging areas in agriculture

We see a shift toward less physically demanding and more mentally demanding jobs in agriculture. As new technologies are developed and deployed, their physical and cognitive implications for operators are sometimes overlooked. The increased use of handheld devices and computers to manage equipment is a case in point. The design and usability of the software that interfaces with equipment have important human factors aspects for safe, efficient, and error-free use. This shift toward digital interfaces with machinery places particular challenges on both the aging and young workforces in agriculture, as youth and elderly cognitive capabilities may not match with the operational requirements of a newly developed interface.



Nectarine harvesting using a tripod ladder with shorter rung spacing. *Photo courtesy of UC-AERC.*

Recent advances in robotics are also making their way into agriculture. For instance, tree nurseries have started deploying small robots to help space tree containers, a physically demanding job that historically resulted in high MSDs among nursery workers. Collaborative robots are under development for strawberry production to assist workers in transporting heavily loaded containers and, through the use of wearable sensors, monitor workers' exposure to stooped postures and provide programmed breaks for recovery. While these devices are ideal for reducing the physical demands on the workers, we need to be aware of new safety issues that these devices may introduce to the work environment, such as tripping and struck-by hazards.

As we work on improving the productivity, efficiency, and environmental impact of agricultural systems, we must not overlook the importance of the human-workplace interface. The principles of ergonomics and their proper implementation in agricultural systems can make a big difference in worker safety and health, while improving productivity and efficiency. After all, most of us already have an ergonomic office chair, an ergonomically adjusted computer screen, and an easily accessible coffee cup.

ASABE member Fadi Fathallah, Professor, Department of Biological and Agricultural Engineering, University of California-Davis, USA, fathallah@ucdavis.edu.

ASABE member Victor Duraj, Associate Development Engineer, Department of Biological and Agricultural Engineering, University of California-Davis, USA, vduraj@ucdavis.edu.

The Goal: Non-events

Edwin Brokesh, P.E.

Imagine that it's late evening, during harvest season, on a rural road. The driver of a minivan, carrying a youth soccer team, is running late and taking an unfamiliar shortcut. On the same rural road, a local farmer, tired and hungry at the end of a long day, is maneuvering a large piece of equipment from one field to another. These two vehicles are about to meet, in dim light, on this lonely stretch of road. Their meeting is a non-event because each driver sees the other one coming and takes the appropriate action. The driver of the minivan sees the lights and markings on the farm equipment and moves to the right to make room. The farmer sees the minivan and does the same. The drivers pass each other safely, without incident, and go on about their business.

Non-events like this happen every day across our nation and around the world thanks to the work of standards organizations like ASABE. The driver of the minivan, in this scenario, relied on the work of ASABE Standards Committee MS23/4/3, better known as the Lighting and Marking Committee. This committee is responsible for ASABE Standard S279, which is the guiding standard used by manufactures for the lighting and marking of agricultural equipment in the U.S. This standard is now the basis for a federal law, the Agricultural Machinery Illumination and Safety Act (AMISA).

Why was this law necessary? Because today's farmers are moving large equipment on public roads more often and for greater distances, often crossing state lines in the process. State legislatures recognized this potential hazard, and they considered enacting laws to govern the marking of agricultural equipment. However, at the state level, that approach could have resulted in fifty different lighting and marking configurations for farmers and manufactures to comply with. Drivers on public roads would have encountered these fifty different lighting and marking configurations, sowing confusion and decreasing the safety of everyone involved. AMISA preempts all state or local laws, ensuring that manufacturers and farmers must comply with just one law nationwide. A farmer can drive equipment across a state line without concern that his properly marked equipment will be in violation of another state's law.

Agriculture has long had innovative manufacturers building useful machines that must occasionally travel on public roads. Do these machines need to comply with the law? Yes, any new agricultural equipment manufactured after the effective date of AMISA must comply with this new law. The Association of Equipment Manufacturers (AEM) and the ASABE Lighting and Marking Committee are working to develop materials to provide guidance on marking machines properly.

ASABE standards, such as S279, make agriculture safer for farmers and for the general public. It's hard to appreciate the positive impact of these safety standards because nothing bad happens when equipment is used properly. Like the example of the minivan and the farmer at the beginning of this article, non-events are the ultimate goal of safety standards. ASABE will continue to work to make every farm safety event a non-event.

ASABE member Edwin Brokesh, P.E., Instructor, Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, USA, ebrokesh@k-state.edu.

ASABE Standard S279

ASABE creates high-quality standards like S279 through a 12-step process that is recognized by ISO. Throughout the standards development process, stakeholders from all aspects of the topic are brought together to provide input, and no standard can be created without all parties involved.

For ASABE Standard S279, safety professionals from industry, from academia, and end users were brought together to develop a standard that would use the best current technology for lighting and marking of agricultural equipment. S279 was first published in 1954, and it has been regularly updated. The current published standard is the 16th revision. The work of the ASABE Lighting and Marking Committee continues, making the standard easier to use and incorporating the latest lighting and marking technology. As safety needs change, S279 will change to meet those needs.

AMISA

The Agricultural Machinery Illumination and Safety Act (AMISA) was signed into law in July 2012. The U.S. Department of Transportation spent four years considering how to apply the law and ultimately determined that ASABE Standard S279 should be applied as written. That is a testament to the quality of ASABE Standards.

AMISA became effective on June 22, 2017. All new agricultural equipment put into service in the U.S. after that date must meet the AMISA requirements. Most U.S. manufacturers have been using ASABE Standard S279 for many years and therefore are already compliant with AMISA. Farmers who buy equipment from these manufacturers are automatically in compliance. The result is that AMISA will ensure consistent lighting and marking of agricultural equipment, with little impact on most farmers and equipment manufacturers.

See the following feature for a Q&A on AMISA.

Q&A on AMISA

An industry collaboration that became law

Mike Senneff

Editor's note: An earlier version of this article appeared on the AEM website on 19 September 2016 ("Ag Lighting & Marking: Collaboration Becomes Law") and is available at: https://www.aem.org/news/september-2016/ag-lighting-marking-collaboration-becomes-law.

On July 6, 2012, President Obama signed into law the Moving Ahead for Progress in the 21st Century Act (MAP-21), a $105 billion bill to fund federal surface transportation spending for two years. Buried deep within this legislation, which addresses funding for more than thirty different surface transportation programs managed by the federal government, is the Agricultural Machinery Illumination and Safety Act (AMISA).

With the signing into law of MAP-21, the roadway lighting and marking of agricultural machinery becomes, for the first time, subject to regulation by the U.S. National Highway Transportation Safety Administration (NHTSA). Prior to the AMISA, the requirements for lighting and marking of agricultural machinery that operated on public roadways were left up to each state. While a small number of states adopted ASABE Standard S279, Lighting and Marking of Agricultural Equipment on Highways, as their law, most states specified minimal and outdated requirements for lighting and marking of agricultural machinery. In some cases, the state requirements conflicted with ASABE's well-established standard.

In 2009, public and legislative affairs staff from Deere & Company, CNH Industrial, 3M Company, and AEM joined together to develop and promote to Congress a bill that would establish ASABE Standard S279 as the minimum national requirement for lighting and marking of agricultural machinery when operated on public roadways in all fifty states. With the sponsorship of several farm state legislators in both the U.S. House and Senate, a proposed Act was developed and ultimately attached to the pending surface transportation funding bill. With passage of the funding bill (MAP-21) in 2012, ASABE Standard S279 became the law of the land.

What does AMISA require of equipment manufacturers?

In brief, the Act and its implementation rules require that agricultural equipment manufactured as new on or after June 22, 2017, must be equipped with roadway lighting and marking in accordance with ASABE Standard S279.14 (revised July 2008) or any subsequent revision of the standard.

How is agricultural machinery defined?

The machinery included within the scope of the Act includes agricultural tractors, self-propelled machines, implements, and combinations thereof designed primarily for agricultural use as identified by ASABE Standard S390.4, Definitions and Classifications of Agricultural Field Equipment.

Do the lighting and marking requirements of the regulation apply to used machinery?

No. The requirements apply only to agricultural machinery manufactured on or after June 22, 2017.

Does the regulation define how the manufacturing date is to be established?

No. When a piece of agricultural machinery is considered to have been manufactured is a determination made by the manufacturer.

Does the Act apply to new agricultural machinery that was manufactured before June 22, 2017, but that was sitting on a dealer's lot as new equipment on or after June 22, 2017?

No.

Will the regulation be updated to reflect newer revisions of the standard?

The current revision of the standard is S279.17 (revised July 2013). The NHTSA has determined that the provisions in the latest revision of the standard do not warrant an update to the regulation at this time.

Do I need to read and study the regulation in order to understand the lighting and marking requirements for new machinery?

No. The text of the regulation is very specific in that it makes repeated references to S279.14 or later revisions of the standard. If a manufacturer meets or exceeds the technical provisions of S279.14, or any later revisions of the standard, the machinery will be in compliance with the regulation.

Note: The regulatory text includes a section that attempts to summarize the lighting and marking provisions of ASABE Standard S279.14. However, this summary includes significant errors and omissions. Manufacturers are advised to refer to the original standard, and not the text of the regulation, when determining the lighting and marking requirements for new machinery.

Where can I get a copy of ASABE Standard S279?

The latest revision of the standard is available for purchase and download from ASABE (www.asabe.org/publications/order-publications/standards.aspx). Archived copies of previous revisions of the standard are also available from ASABE.

ASABE member Mike Senneff, Consultant, Product Safety Help, LLC, Bettendorf, Iowa, USA, MikeSenneff@ProductSafetyHelp.com.

Emerging Safety Technologies

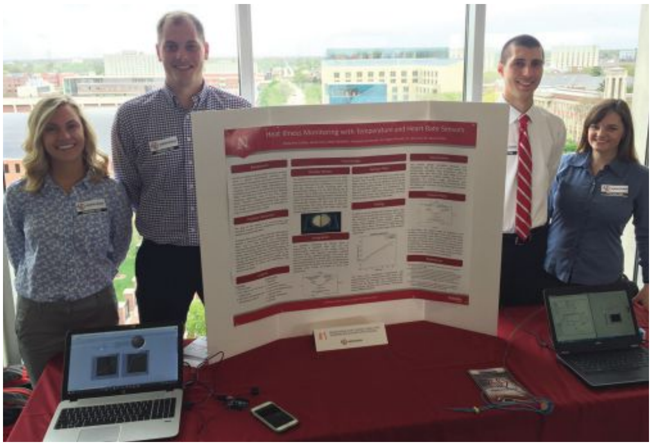
Aaron Yoder

As wearable and mobile devices and their software applications, or apps, become ubiquitous, their use in agriculture is expanding as well. A smart device paired with a well-designed app has great potential for improving workplace safety and health, if the user can act on the information that it provides. A wide variety of emerging technologies already exists for assessing workplace hazards and implementing worker protections. However, the abundance and diversity of these technologies can create challenges in evaluating them and assigning value.

In agriculture, the first step in this process was to develop a framework for evaluating apps and other technologies that have potential application for worker safety and health. This framework exists and can be found in "An evaluation tool for agricultural health and safety mobile applications," which appeared in the *Journal of Agromedicine* in 2016 (www.ncbi.nlm.nih.gov/pubmed/27494309). This evaluation framework is easily transferable for evaluating emerging technologies in a variety of areas.

Over the past few years, researchers have explored the use of wearable technology, which was originally designed for the fitness industry, to protect agricultural workers. One example of this effort is the use of heart rate monitors to evaluate the ergonomics of tasks performed by agricultural workers. Researchers in other industries have found that heart rate monitors can measure an individual's performance as well as health and wellness. In agriculture, this concept can be used to test how well tools fit the needs of individual users by monitoring each user's heart rate. Research on this topic is being done in the Department of Agricultural Systems Management at the University of Missouri.

This worker is wearing hearing protection, a respirator, and a smart watch that monitors his heart rate.



Capstone teams, like this one at UNL, are working on wearable technologies for agricultural workers. UNL seniors (left to right) Katherine Dudley, Jacob Inez, Mitch Misfeldt, and Anastasia Sanderson studied "Heat illness monitoring with temperature and heart rate sensors."

Wearable devices have also been explored to monitor solitary workers and to detect the onset of heat-related illness. Researchers in the Department of Biological Systems Engineering at the University of Nebraska-Lincoln (UNL) have explored these topics. Solitary workers are more likely to become injured and have poorer outcomes than workers who are supported by others. A partnership between Capstone design students at UNL and LoadOut Technologies, a 2011 AE50 Award winner, explored the use of heart rate monitors to protect workers near automated systems at grain handling facilities. A second project looked at monitoring the core body temperatures of agricultural workers who were exposed to high-temperature environments. The study found that core body temperature, which can be monitored through skin temperature and heart rate, is the best indicator of heat-related illness.

As new technologies continue to emerge, we need to be prepared to evaluate them, and implement systems that can improve the safety and health of the agricultural workforce. With interdisciplinary collaborations, our profession is uniquely qualified to lead this effort.

ASABE member Aaron Yoder, Assistant Professor, Department of Environmental, Agricultural and Occupational Health, College of Public Health, University of Nebraska Medical Center, Omaha, USA, aaron.yoder@unmc.edu.

The Land Grant Perspective

A report on the NCERA committee

Michael Pate

Agriculture is one of the most hazardous industries in the U.S., and the safety and health challenges of this industry are often complex due to the combination of home and workplace. A farm or ranch is often an occupational worksite as well as the residence of the workforce. Research in this field is challenging due to the wide variety of characteristics that can lead to differences in hazard vulnerability for different populations. Addressing the complex safety challenges of these vulnerable populations requires innovative research to document the effectiveness of interventions in a timely manner, before the affected population is no longer accessible or conditions change. It's especially critical to conduct research on outreach and communication efforts that assist farm workers in identifying hazards, avoiding hazards, and implementing appropriate actions when encountering a hazard.

To address these dynamic safety and health issues, collaborative efforts—multi-institutional as well as multi-discipline—are encouraged. The discussions often focus on "translational" research (or "research to practice") to enhance the benefits for the workforce that is targeted with an intervention. In agricultural safety and health, translational research means the application of basic science to enhance the health and well-being of the farm population. The goal is to translate research results into practices that have meaningful outcomes.

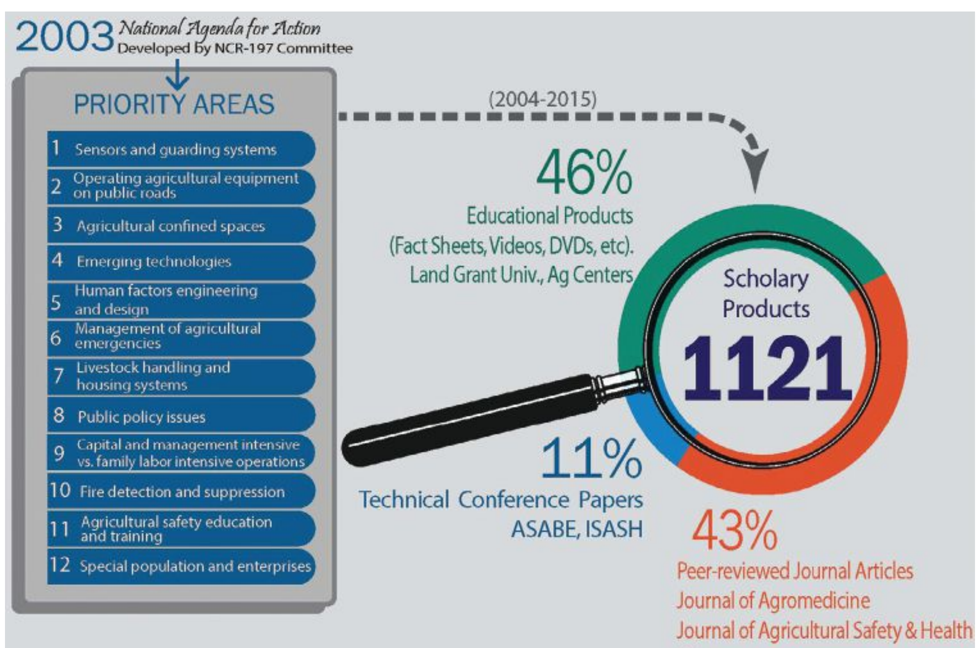
The land grant university system was founded in the nineteenth century to address the needs of agricultural producers through research, outreach, and service. The land grant system continues to provide translational research as well as basic research to these stakeholders.

In 2000, the North Central Education/Extension Research Activity (NCERA) committee was founded to develop strategies to leverage the research and extension capacity of land grant institutions as well as the experience of agricultural producers to reduce work-related injuries, illnesses, and fatalities. Land grant faculty have led this effort by combining their expertise in agricultural education, vocational education, agricultural and biological engineering, and public health. I became a member of the NCERA committee in 2010.

In 2003, the NCERA committee created the National Land-Grant Research and Extension Agenda for Agricultural Safety and Health (http://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1122&context=abe_eng_pubs), which prioritized twelve areas with 115 individual topics related to agricultural safety and health in which research or extension gaps exist. Two of these priority areas have been the focus of NCERA committee white papers (see sidebar):

- "Agricultural Equipment on Public Roads" (http://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1121&context=abe_eng_pubs).
- "Research and Extension Agenda for Agricultural Confined Spaces" (http://articles.extension.org/sites/default/ files/ConfinedSpaces.pdf).

In 2016, the NCERA committee completed a review to determine the level of scholarly activity associated with the twelve research and extension priorities, as well as to identify



In 2016, the NCERA committee completed a review to determine the level of scholarly activity associated with twelve research and extension priorities. More educational products were produced in 2012-2015 than peer-reviewed journal articles. Educational outreach is an important dissemination mechanism for agricultural safety and health research.

the major contributors of research articles and extension education products. The data search was conducted between January and July 2016. Scholarly publications were defined as peer-reviewed journal articles, technical conference papers, or educational products. Publication dates from 2004 to 2015 were included in the search. The review showed that a high percentage of scholarly publications in the priority areas were produced between 2012 and 2015. The committee also found that more educational products were produced than peer-reviewed journal articles within the timeframe of the review.

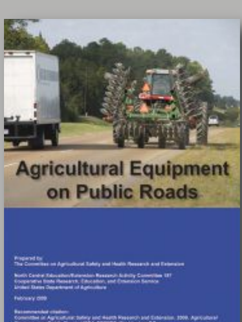
The benefits of joining the NCERA committee have been successful funding collaborations as well as enhanced strategic efforts to improve agricultural safety and health. The committee encourages members to participate in other organizations related to agricultural safety and health, and current efforts involve collaborations with these organizations. Over the years, numerous relationships have been developed with organizations such as USDA-NIFA, ASABE, the National Institute of Occupational Safety and Health (NIOSH), the Agricultural Safety and Health Council of America (ASHCA), the International Society for Agricultural Safety and Health, AgSafe BC, and the Canadian Agricultural Safety Association.

The NCERA committee also encourages new and improved industry standards through participation in ASABE standards development. The committee particularly seeks to provide input into standards development to ensure that the perspectives of the agricultural workforce are taken into account. Numerous NCERA committee members serve on technical committees, such as the Ergonomics Safety and Health Technology Exchange. These collaborative efforts have been successful, and maintaining them will be necessary to address the future challenges of agricultural safety and health.

Advances in agricultural technology as well as the changing demographics in the agricultural workforce are two of the future developments facing agricultural safety and health professionals. Another area that the committee will need to address is infrastructure support to fund agricultural safety and health research and extension efforts, as well as identify emerging issues. The NCERA committee relies on ASABE as a leader in developing agricultural safety and health standards, as well as in supporting innovative safety engineering.

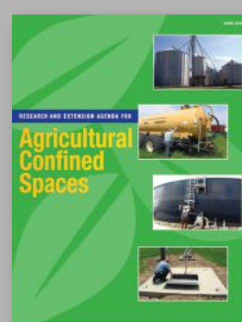
ASABE member Michael Pate, Nationwide Insurance Associate Professor of Agricultural Safety and Health, Pennsylvania State University, University Park, USA, mlp79@psu.edu.

NCERA committees provide opportunity for scientists, specialists, and others to work cooperatively to solve problems that concern more than one state, share research data, and coordinate research and other types of activities. Additionally, these committees serve to integrate education (academic and/or extension) and research on a particular topic where multistate coordination or information exchange is appropriate, have expected outcomes, convey knowledge, and are peer-reviewed. In 2007, the NCERA committee for agricultural safety and health created white papers on two significant topics. The goal of these documents is to highlight current problems in agriculture, and find effective solutions to mitigate the hazards and risks.



Agricultural Equipment in Public Roads

Issues relating to equipment operation on public roads are multifaceted and complex. This report looks at a number of issues, including the rural/urban traffic interface, state and federal regulations, higher-speed tractors, and transport of workers on public roadways with farm equipment. Several suggestions in the areas of research, standards, education/outreach, and policy have been developed to help guide future work as a result of this review.



Research and Extension Agenda for Agricultural Confined Spaces

Hazards associated with agricultural confined spaces continue to be significant causes of work-related injuries and fatalities within production agriculture. A definition used in general industry identifies a confined space as any space found in a workplace that is not designated or intended as a regular workstation, has limited or restricted means of entry or exit, and has potential for associated physical and/or toxic hazards to workers who intentionally or unintentionally enter the space.

In agriculture, there are many types of confined spaces, including grain and feed storage facilities, forage storage structures, livestock manure storage facilities, various agricultural transport vehicles and equipment, food processing and storage equipment and facilities, and other non-traditional forms, including conveyer enclosures, diked areas around storage tanks, spray and fuel storage tanks, greenhouses during certain operations, and other areas around the farm. This white paper outlines a research and extension agenda to address the concerns for agricultural confined spaces.

Coalition Building

Improving occupational safety and health for the ag industry and farmers

Bob Aherin

In my 40-plus years working as an agricultural safety program leader at a land grant university, I have learned through experience when dealing with significant agricultural safety issues that pulling together a group of professionals and target audience leaders who can address various aspects of the issue can have significant benefits. These benefits include enhancing the legitimacy of the issue, sharing expertise, sharing resources, enlarging grant support potential, improving communication to target audiences, and enhancing understanding of various aspects of the issue.

While I have been involved in forming coalitions on several issues, one of the most involved and effective coalitions I have worked with is the Grain Handling Safety Coalition, which I helped lead the formation of in 2010.

On July 28, 2010, in the small northeastern town of Mt. Carroll, Iowa, 14-year-old Wyatt Whitebread and 19-year-old Alex Pacas were killed while working in a grain bin. Will Piper, 20, was trapped for several hours before being rescued. Chris Lawton, 15, was able to escape and call for help. This incident gained national attention and was one factor in OSHA making the grain industry a target industry, resulting in enhanced fines and inspections of grain facilities, which are required to comply with the OSHA grain standard. Because this tragic incident involved both a grain company and farmers who had leased the facilities, it also gained the attention of farmers.

About a week after the incident, Catherine Rylatt—an aunt of Alex Pacas—contacted me to discuss what more could be done to prevent these types of tragedies. I suggested that we pull together individuals from various organizations who had both an interest and a responsibility to address various aspects of grain safety. Initially, we identified 14 individuals from various organizations for an initial meeting with the purpose of obtaining an understanding of the many perspectives and ideas on how to more effectively address the issues. Some of the organizations represented in the initial meeting included University of Illinois Extension, the Grain and Feed Association of Illinois, the Illinois Farm Bureau, Purdue University Extension, OSHA, the Illinois Department of Agriculture, Carle Medical Center, the Community Health Partnership of Illinois (representing migrant workers), FFA, and representatives of various large grain companies. The coalition now has representation from more than 25 organizations.

The first two meetings were mostly focused on getting to know each other, the interest level in working together, and what possible resources each group could provide to enhance our grain safety efforts. It was decided to form a coalition with the University of Illinois, as the facilitator providing administrative assistance, and establish a 501(3)c fund for the coalition within the university's foundation for any contributions the coalition may receive.

The agreed-upon mission of the coalition was "to prevent and reduce accidents, injuries, and fatalities across the grain industry spectrum through safety education, prevention, and outreach." The coalition developed a set of objectives and activities.

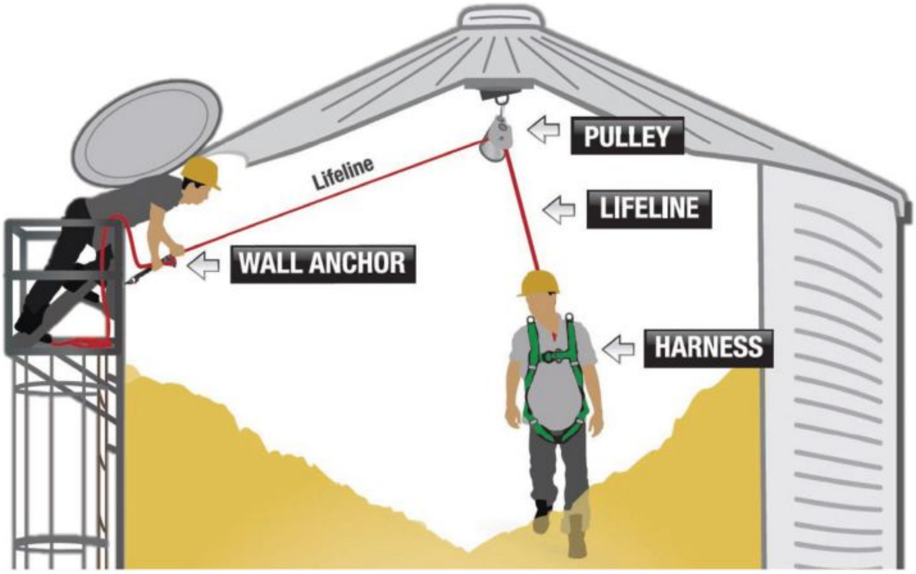
One of the needs identified by the coalition was for a more comprehensive low-cost training program that was easily accessible. There was a variety of training resources, but they were not consistent, not easily accessible, or too costly according to coalition members. Thus, with myself serving as the project director and through the University of Illinois, the coalition applied for competitive training grants, primarily from OSHA but also from two NIOSH-funded agricultural centers over the past six years. The applications were very attractive to these funding organizations because they were supported by so many organizations from across the grain industry.

To date, the coalition has received approximately $800,000 in funding to support various grain safety initiatives. The coalition has conducted training programs for workers, supervisors, farm operators, and safety professionals, as well as train-the-trainer programs for more than 3,000 participants throughout the country, involving nearly

7,000 contact hours. Resources developed include training modules on 12 different grain safety topics, which include three modules focused on older youth. Each module includes:

- PowerPoint slides
- Hands-on activities
- An instructor guide and notes
- Additional resource information
- Evaluations
- Student quizzes
- Pre- and post-tests
- Fact sheets on issues presented.

The coalition has developed four videos to support the training program. All the PowerPoints include a Spanish version. More information on these resources and the coalition can be found at: grainsafety.org.



Primary components of a grain bin lifeline system.

The coalition has also addressed a couple of significant national grain safety issues, including a method to establish a lifeline in existing grain bins and a procedure to allow a worker to be in a grain bin when the sweep auger is running. OSHA has accepted both. Some members have also been involved with the ASABE committee that is developing a new grain bin safety standard, X624 Grain Bin Access Design Safety. The coalition is currently developing a plan to be self-sustaining.

A Grain Handling Safety Coalition trainer demonstrates how to use a lifeline when entering a grain bin to ag technical systems management students.

Coalitions need to have an operational structure that is comfortable for the group. Currently, the coalition has an executive committee with an elected chair and vice chair. A set of operating guidelines was developed. The structure was developed after conducting a survey among the members about the type of structure desired. This structure is continuing to evolve as needs change.

The coalition has been engaged with a professional evaluator in assessing the impact of the program. This allows identification of any needed changes as well as those things that are working well.

Coalitions have many positive potential outcomes that can be significantly beneficial in addressing major agricultural safety and health issues. However, moving interventions forward often involves making compromises. Coalitions generally require more time to do some things, such as develop training materials, because of the need for coalition members to review materials before release, and modifications may be needed to allow acceptance by most members.

Coalitions with the right mix of representation—and with the right people who are willing to work together and compromise when needed to effect positive changes in injury and health risks—can pay big benefits on many levels.

ASABE member Bob Aherin, CSP and Professor, Agricultural Safety and Health Program Leader, Department of Agricultural and Biological Engineering, University of Illinois, Urbana, USA, raherin@illinois.edu.

ASABE: Contributing to International Product Safety

Karl Klotzbach

The challenge: one standard, one test, one certification recognized and accepted globally. Easily said, but not so easy to accomplish. We live in a complex world where technologies in production agriculture cover the spectrum from manual labor to highly automated machines for tilling, planting, cultivating, spraying, and harvesting. The common concern across this spectrum is the safety of those engaged in agriculture. Unfortunately, there is no "one-size-fits-all" solution to address the broad range of safety concerns.

Throughout the world, agriculture contributes to the well-being of everyone by providing food, fiber, and a source of renewable fuels. However, the economic and technological advances are not evenly distributed. Highly industrialized regions, such as North America and Europe, have increased their agricultural productivity with larger, more powerful, and technically sophisticated machines, such as self-propelled harvesting machines and tractors that can sense tractive loads and automatically adjust gear ratios to match working conditions. Developing regions, such as India, China, and most of Africa, are evolving from manual labor to low-end mechanization and are still working through a progression that more highly developed regions experienced long ago.

Even in developed countries, the technological advances in production agriculture have outpaced human adaptations to the increased machine output. Desirable productivity factors, such as increased power and speed, provide opportunity for risk of harm to machine operators. Demand for higher-output machines placed the focus on known technologies for the transmission of power from the on-board engine to the functional components. Those known technologies, such as pulleys, belts, chains, and sprockets, replaced operations that were once performed manually. In earlier times, those simple devices were better understood than potential risks to machine operators, such as entanglement, dismemberment, and rollover.

In some countries, the response to these concerns was to impose strict regulations and to legislate safety into agricultural machinery. Europe published the Machinery Directive—supported by CEN, the European Committee for Standardization—for the creation of product safety standards, some or which were applicable to agricultural machinery. Brazil enacted a regulatory standard, NR12, that implies employer responsibility for providing appropriate protective measures for workers, although the real impetus for machine safety has moved upstream to the manufacturers.

International standards development: making it all work together.

In Canada and the U.S., government regulatory involvement in the design of agricultural machinery has not been the experience. Instead, soon after its inception in 1907, ASABE (initially ASAE) began accepting drafts and publishing voluntary consensus standards guiding the design of agricultural machinery. Over the years, that portfolio of machinery standards has grown—mainly for machine design, but increasingly product safety concerns have found their way into published standards, along with standards for operator instructions and safety labeling.

Other safety concerns for agricultural machinery include traveling on public roadways, including lighting and marking of agricultural machines to make them visible to other traffic, which is often moving much faster. Many agricultural machines must be driven long distances between fields and other work locations. In addition to traffic safety, these larger, heavier, and faster machines, of course, require appropriate levels of controllability, such as steering and braking. In European countries, ag machines that travel on public roadways must pass a formal inspection and approval process, known as homologation, that is similar to the testing, documentation, and licensing required for trucks and automobiles. In addition, standards have been developed for testing and reporting on the performance of steering and braking systems.

With the increasingly global exchange of products, a more consistent approach to product safety in agricultural machinery is needed. With input from larger, globally integrated manufacturers, participation in the International Organization of Standards (ISO) was an appropriate response for ASABE. Today, ASABE supports international standards development through its membership and associated activities. ASABE plays a role in reporting U.S. national positions to ISO through the American National Standards Institute (ANSI) by sponsoring Mirror Committees of ISO Technical Committees and associated Working Groups. Many ASABE standards include normative references of ISO standards, most notably the "umbrella" product safety standard for agricultural machinery in North America (ASABE Standard S318).

Thanks to its long history and active membership, ASABE continues to have a positive influence on product safety practices, domestically and internationally.

ASABE member Karl Klotzbach, P Eng, P.E., Product Safety and Homologations Engineer, CNH Industrial America LLC, Racine Wisc., USA, karl.klotzbach@cnhind.com.

Global Partnerships for Climate Change

Editor's note: As part of its on-going effort to build global partnerships, ASABE is sponsoring a series of Global Initiative conferences. The first conference in this series, The 1st Climate Change Symposium: Adaptation and Mitigation, was held in May 2015 in Chicago, Ill. This article, which was also published as an ASABE white paper, summarizes the conference presentations. The next Global Initiative conference, Global Water Security for Agriculture and Natural Resources, will be held in October 2018 in Hyderabad, India (http://asabewater.org).

The American Society of Agricultural and Biological Engineers (ASABE) has a long history of helping its member engineers solve problems in food, agriculture, natural resources, and the environment. In 2012, ASABE implemented a global initiative, recognizing the need to connect its members with other organizations around the world to address emerging challenges:

"ASABE will be among the global leaders that provide engineering and technological solutions toward creating a sustainable world with abundant food, water, and energy, and a healthy environment."

In 2015, ASABE published "Global Partnerships for Global Solutions: An Agricultural and Biological Engineering Global Initiative," which identified six goals related to food security, energy security, and water security in the context of sustainability and climate change. To further explore these issues, ASABE is hosting a series of Global Initiative Conferences in locations around the world. This paper reports on the first of those conferences, which focused on climate change.

The Challenge

The 2009 report from the U.S. National Agricultural Biotechnology Council (NABC) indicates that agriculture produces about 10% of global greenhouse gas emissions, which are the major contributor to climate change, and states that agricultural production systems must mitigate their emissions while adapting to the stress of climate change. The NABC report identifies multiple adaptation strategies and emphasizes the importance of education (bringing climate change to classrooms and informing the public), climate modeling with increased precision and reduced uncertainty, soil science as a basis for plant breeding (as well as a sink for carbon), and economics and policy, with the intent that scientists educate policymakers and the public about climate change and its impact on food production.

The 2014 U.S. National Climate Assessment recognizes that the effects of human-induced climate change are occurring throughout the U.S. and include increased droughts, floods, heat waves, wildfires, and assaults from invasive species. These extreme events are already affecting our ecosystems (including agricultural, urban/suburban, forest, and wetland areas), while glacial melting, sea level rise, and saltwater intrusion in coastal areas are stressing our water resources.

Climate change is also a global concern, as documented by the annual conferences held by the United Nations Framework Convention on Climate Change (UNFCCC), particularly the 1997 conference that established the Kyoto Protocol. In December 2009, the Copenhagen Accord was drafted by the U.S., China, India, Brazil, and South Africa. The Accord recognized that climate change is one of the greatest challenges of the present day, and that actions must be taken. The draft Accord was debated by all the participating countries, with many countries and non-governmental organizations initially opposed. However, in January 2010, 141 countries signed the Copenhagen Accord. More recently, the 2015 Paris Conference, sponsored by the United Nations, achieved a legally binding agreement to keep global warming below 2°C.

Climate change is the most pressing challenge of our time. In responding to this challenge, agricultural and biological engineering will be essential for meeting the food, water, and energy needs of future generations with environmentally and economically sustainable solutions.

ASABE's Response: The First Climate Change Symposium

As a first step in responding to this challenge, ASABE organized the "1st Climate Change Symposium: Adaptation and Mitigation," which was held on May 3-5, 2015, in Chicago, Ill. The symposium was organized around the following topics:

- Adaptation strategies
- Mitigation strategies
- Ecosystem health
- Ecosystem sustainability

- Climate change modeling
- Uncertainty and complexity
- Water resources policy.

Recognizing the need for partnerships to address climate change, ASABE reached across disciplines and national boundaries to bring together a diverse group of professionals from a range of organizations, including the USDA National Institute of Food and Agriculture, the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, Land Grant and other universities, as well as representatives from other countries and regions, including Canada, South America, Asia, and Europe. Agricultural and biological engineers, hydrologists, soil scientists, atmospheric scientists, plant biologists, animal scientists, and other experts documented the alarming stress that climate change is imposing on agriculture, water resources, and natural ecosystems. These experts presented their research on strategies for adapting to climate change, and on methods and technologies for mitigating emissions of greenhouse gases. The conference proceedings are available from ASABE (see "Further Reading"). The following sections provide highlights of the presentations.

Adaptation strategies

We are already experiencing changes in climate, as evidenced by longer summers, more severe storms, species migrations, changing patterns of precipitation, and melting glaciers and ice caps. These changes are affecting the availability of natural resources. For example, rising water tables in coastal areas reduce the productive land area, reduce access to clean water for domestic use, and increase flooding and water pollution. Adaptation strategies must be developed to sustain agriculture without further harm to our ecosystems. These strategies include:

- Incorporating climate information and sustainable practices into crop production systems.
- Using satellites, unmanned aircraft, and computer-based modeling to collect and share climate information that affects crop production.
- Implementing large-scale practices for reducing discharges of pollutants, including chemical runoff from agricultural areas.

Mitigation strategies

The symposium participants demonstrated that mitigation strategies must include more than greenhouse gas emissions. To sustain agricultural production in a changing climate, mitigation strategies must ensure efficient use of all resources—soil, water, air, and energy. Research, education, and public policy must emphasize environmentally sustainable production. Mitigation strategies include:

- Producing energy from biomass, such as agricultural waste, without adversely affecting the organic matter content and fertility of the soil.
- Assisting farmers in installing digesters to capture methane from animal production, which can generate energy while reducing greenhouse gas emissions.
- Using biochar as a soil amendment. Biochar production can transform agricultural waste and other biomass into stable carbon, which can be sequestered in the soil. Biochar can also increase soil water storage, adsorb pollutants in the soil, and reduce water pollution.

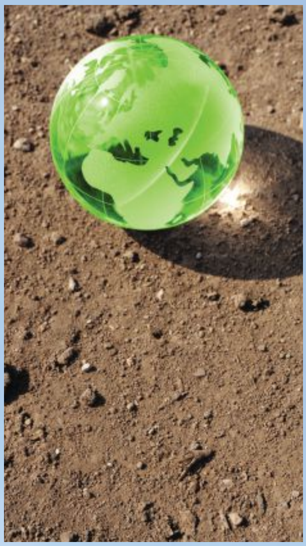
Ecosystem health

Despite the immense benefits that agriculture provides, there is clear evidence that agriculture adversely affects the health of local and regional ecosystems. Deeper understanding of the relationships among climate, agriculture, and native biological communities will help us assess the impacts of climate change on fragile ecosystems. For example, most models of climate change predict increased flooding in the U.S. mid-Atlantic region. This flooding will particularly affect wetlands, which are essential for long-term environmental sustainability through reduction of sediment and pollutants, sequestration of carbon, and control of insect pests, such as disease-carrying mosquitoes. We can improve ecosystem health by abandoning policies that have led to environmental degradation.

Ecosystem sustainability

Sustainability is the ability of an ecosystem to maintain ecological processes, biodiversity, and productivity into the future. Unfortunately, in many parts of the world, sustainability loses priority when confronted by poverty, food insecurity, water scarcity, and the lack of human health. According to a 2002 report by the United Nations Development Program, more than one billion people lack access to clean water and proper sanitation. Maintaining ecosystem sustainability in a changing climate requires economic and environmental strategies that also maintain the sustainability of our agricultural production systems, for both ecological health and human health.

Climate change modeling



Because science cannot measure the future climate, climate forecasting must rely on computer-based models. These climate models are generally designed for large areas, such as entire continents, and their resolution is often very coarse. On the other hand, specialized models of hydrology and water quality are frequently applied to ecosystems that range in size from field to watershed, while specific crop models are often applied at field scale. Combining these different modeling scales will allow researchers to forecast the impacts of climate change at the local farm scale as well as the global scale.

Uncertainty and complexity

As climate scientists, agronomists, and ecologists work together to explore how a changing climate will affect agricultural sustainability and natural ecosystems, they must also evaluate the uncertainty inherent in their models, as well as the uncertainty in climate information. The relationships among climate, crop yields, and natural resources are complex, and projections from oversimplified models will undermine adaptation and mitigation strategies. For example, elevated levels of carbon dioxide in the atmosphere, due to climate change, may actually increase grain yields. Similarly, increased temperatures may increase photosynthesis, and thus increase crop water use, which would offset increased precipitation.

Water resources policy

According to a 2011 report from the Overseas Development Institute, "water will be the primary medium through which climate change impacts will be felt." Water scarcity in many parts of the world, unsanitary conditions due to limited fresh water, yield losses due to water shortages, and shrinking lakes and aquifers are all evidence of a growing water crisis. Policies to protect water resources and promote water conservation must be established at regional, national, and global levels. These policies can start by limiting withdrawals of groundwater and other water resources to sustainable levels. In addition, controlled drainage systems can help mitigate climate-induced flooding and drought. Controlled drainage also reduces greenhouse gas emissions and can mitigate the effects of rising temperatures.

The Path Forward

The ASABE 1st Climate Change Symposium demonstrated that multi-disciplinary collaborations can meet the challenges of climate change. The symposium's overall findings are as follows:

- We are facing an existential threat in climate change, as we must meet basic human needs while enhancing environmental quality and sustaining economic vitality for an increasing population.
- We must deal with various forms of uncertainty, including the uncertainty of our own predictions; therefore, we must identify the sources of uncertainty and rigorously verify our results.
- Agricultural and biological engineers are uniquely positioned to respond to this challenge. Our work benefits the world—and it would do so without the impetus of climate change. The reality of climate change makes our work essential.

Global partnerships will allow us to extend our knowledge, share our experience, and pursue a common strategy for adapting to climate change and mitigating its effects. The ASABE 1st Climate Change Symposium is an example of that collaboration, as ASABE successfully brought together scientists, engineers, and other experts from a variety of backgrounds and regions. Similar efforts and improved communication will lead to workable solutions and an informed society.

ASABE is committed to leading this global engagement, and including partners from other engineering societies and professional organizations from around the globe, to address the challenge of climate change.

Selected papers from the ASABE 1st Climate Change Symposium were published in *Transactions of the ASABE* 59(6), and a USB containing 122 extended abstracts is available at: www.asabe.org/CCSymposiumUSB.

Further Reading

ASABE. (2015). ASABE 1st Climate Change Symposium: Adaptation and Mitigation. St. Joseph, MI: ASABE. Available at www.asabe.org/CCSymposiumUSB.

ASABE. (2015). Global partnership for global solutions: An agricultural and biological engineering global initiative. St. Joseph, MI: ASABE. Available at www.asabe.org/media/195967/globalinitiative.pdf.

NABC. (2009). Adapting agriculture to climate change. Report 21. Ithaca, NY: National Agricultural Biotechnology Council. Available at http://nabc.cals.cornell.edu/Publications/Reports/pubs_reports_21.htm.

ODI. (2011). Climate change, water resources, and WASH: A scoping study. London, UK: Oversees Development Institute. Available at www.odi.org/publications/5998-climate-change-water-resources-water-policy-wash.

UNDP. (2002). Human development report 2002: Deepening democracy in a fragmented world. New York, NY: United Nations Development Program. Available at http://hdr.undp.org/sites/default/files/reports/263/hdr_2002_en_complete.pdf.

UNEP. (2015). COP21 Paris Conference. Nairobi, Kenya: United Nations Environment Program. Available at www.cop21paris.org.

UNFCC. (1997). Kyoto Protocol. Bonn, Germany: United Nations Framework Convention on Climate Change. Available at http://unfccc.int/kyoto_protocol/items/2830.php.

UNFCC. (2009). Copenhagen Accord. Bonn, Germany: United Nations Framework Convention on Climate Change. Available at http://unfccc.int/resource/docs/2009/cop15/eng/l07.pdf.

U.S. National Climate Assessment. (2014). Climate change impacts in the United States. Washington, DC: U.S. Global Change Research Program. Available at http://nca2014.globalchange.gov.

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- David Bosch, USDA-ARS, Tifton, Georgia (co-chair)
- Rafael Muñoz-Carpena, University of Florida (co-chair)
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- Paul Leisnham, University of Maryland College Park
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- USDA Climate Hubs
- McGill University
- University of Guelph
- NOAA
- USDA Agricultural Research Service

Let's Be Friends

Through the hard work and dedication of a few key members, the Young Professionals Community (YPC) was established in 2001 to aid young members' development into long-term ASABE members and leaders. One of the major goals of the YPC is to ease the transition from pre-professional membership to professional membership and to be the voice of the ASABE members from the time that transition is made until the age of 35.

Beginning in 2013, the YPC began a tradition of annually recognizing a member who has been particularly influential in helping us achieve our goals and making the YPC a success. This accolade is known as the "Friend of the YPC" award. Recipients are members outside the YPC who have gone above-and-beyond to assist us with event planning, increasing our impact, or other efforts.

Candidates for the award are nominated by YPC members and voted on by the YPC Executive Committee. The award is presented before the keynote speech at the ASABE Annual International Meeting. Previous recipients include:

- Chad Yagow (2013)
- Travis Tsunemori (2014)
- Sharon McKnight (2015)
- Candice Engler (2016)
- Mark Crossley (2017)

To make a nomination for the 2018 "Friend of the YPC" award, contact any member of the 2017-2018 YPC Executive Committee:

- Shane Williams (Chair)
- Noel Menard (Vice-Chair)
- Bailley (Richardson) Thomas (Membership Development Council Representative)
- Josh Sander (Standards Council Representative)
- Gurdeep Singh (Publications Representative)
- Jason Schuster (Meetings Representative)
- Qualla Ketchum (Graduate Student Representative)

ASABE member Noël Menard, Applications + Evaluations Engineer, John Deere, Waterloo, Iowa, USA, MenardNoelR@JohnDeere.com.

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ASABE Foundation Work in Focus

Support of global outreach to promote the ABE profession

Lalit Verma, P.E.

A new award, available through the ASABE Foundation, to recognize outstanding sustained efforts in promoting agricultural and biological engineering globally was endowed in 2016 and presented at the 2017 AIM. The eponymously named Lalit and Aruna Verma Award for Excellence in Global Engagement, which recognizes outstanding contributions toward global advancement and recognition of the profession of agricultural and biological engineering, and excellence in global engagement and international education, outreach, and research, could not have been possible without the support of the ASABE Foundation. For someone who came to the U.S. 45 years ago, as a 21-year-old graduate student, to be able to sponsor such an award is a dream that could not have been realized without ASABE and the ASABE Foundation. I remain eternally grateful.

Agricultural and biological engineers (ABEs) are vital in addressing global hunger to feed an additional three billion people by 2050. Our profession's past contributions to safe, affordable, and abundant food are duly documented. Yet it is disturbing that the number of academic programs around the world that are preparing graduates to be ABEs has dwindled. ABEs do not yet have the respect or clout that we have earned and deserve. The ASABE Foundation has several established funds that recognize and support our current and future ABEs.

ASABE's global engagement was formally initiated at the 2013 Annual International Meeting (AIM) in Kansas City. At the 2014 ASABE/CSBE AIM in Montreal, we mapped out the global challenges and opportunities for ABEs as part of the Global Engagement Day activities. To further our global initiative, a strategic position paper that identifies ABEs' importance and responsibility in sustainably feeding the world in 2050 has been developed and is available at: www.asabe.org/media/195967/globalinitiative.pdf.

Finding ways to meet the food, water, and energy challenges facing billions of people is at the heart of our global initiative, and the Foundation has been instrumental in supporting this effort by recognizing outstanding global outreach and funding projects that help underserved populations. The "Engineering and Technology Innovation for Global Food Security" Conference, held in Stellenbosch, South Africa, last October, was the second in a series of conferences to be held biennially with the goal of tackling the Grand Challenges of global food, water, and energy security. The next conference, "Global Water Security for Agriculture and Natural Resources," which is set for October 3-6, 2018, in Hyderabad, India, will focus on water security (http://asabewater.org).

I am proud that we have developed a strategic vision for our role in a global context. Publicizing this strategic vision to affirm our unique expertise in sustainably providing the essential needs of life is ongoing and critically important. We are expanding our global influence and membership through collaborations and ASABE-led global summits. It will be gratifying when the world recognizes our relevance and competence for solving the Grand Challenges facing the world. The ASABE Foundation will continue to play a key role in our success.

The integral partnership of ASABE and the ASABE Foundation in communicating who we are, what we do, and how we are vital is to be celebrated. The ASABE remains vital to the success of these initiatives through outreach, fundraising, and promotion of the ABE profession. Ask yourself, "How can I encourage and support the global work of ASABE?" It begins with supporting your Foundation. Whether it's making a one-time gift, a bequest in your will or living trust, or setting up a donor-advised fund, I challenge you to help us all move forward.

ASABE Fellow, Life Member, and Past President Lalit Verma, P.E., Professor and Head, Department of Biological and Agricultural Engineering, University of Arkansas, Fayetteville, USA, lverma@uark.edu.

PURDUE UNIVERSITY

FACULTY POSITIONS IN AGRICULTURAL AND BIOLOGICAL ENGINEERING

ASSISTANT PROFESSOR DIGITAL AGRICULTURE: This is an academic year, tenure track, teaching and research position. The successful candidate is expected to work and collaborate effectively with other faculty in a highly interdisciplinary effort to address digital agriculture discovery and learning needs. The individual will engage local, state, national and international government, and non-government agencies, industry, and other stakeholders, and contribute to Purdue's research and teaching efforts focused largely on digital agriculture data handling/analysis. Research areas may include: application of cyber-physical systems for improved logistics, sustainability, or product quality improvement; design of improved processes and decision tools using computational strategies and data streaming; application of machine learning adapted from other industries that bring productivity and sustainability improvements to agriculture; engineering of solutions that address data quality and security; data architectures, ontologies, and ownership of data; cultivation of an open-source culture for rapid innovation; involvement in data standards and annotation automation. Teaching in related subject matter for upper division and/or graduate-level Agricultural Systems Management and/or Agricultural Engineering majors is expected. The individual will also develop a successful externally funded research program. Applicants must have a Ph.D. degree in agricultural engineering, agricultural systems management, computer engineering, computer science or a related discipline. Excellent communication and grant writing skills are required. Address inquiries to Dr. Dennis Buckmaster at dbuckmas@purdue.edu. For additional details, see https://engineering.purdue.edu/ABE/people/open-positions/digital-agriculture.

ASSISTANT OR ASSOCIATE PROFESSOR MACHINE SYSTEMS ENGINEERING: This is an academic year, tenure track, teaching and research position. The successful candidate is expected to work and collaborate effectively with other faculty in a highly interdisciplinary effort to address machine systems discovery and learning needs. The individual will engage local, state, national and international government, and non-government agencies, and other stakeholders, and contribute to Purdue's research and teaching efforts focused largely on machine systems engineering. Research areas may include: Design of intelligent machine systems enabling digital agriculture; Advanced machine driveline and actuation technology; Pneumatics/hydraulic systems in automation; Robotic/autonomous field and process operations; Engineering for safety; Interactions of machines and biological materials; Diagnostics/prognostics of machine systems. Teaching in related subject matter for Agricultural Engineering degree seeking students is expected. The individual will also develop a successful externally funded research program with support from federal agencies and industry. Applicants must have a Ph.D. degree in agricultural engineering or a related discipline. Excellent communication and grant writing skills are required. Address inquiries to Dr. John Lumkes at lumkes@purdue.edu. For additional details, see https://engineering.purdue.edu/ABE/people/open-positions/machine-systems.

APPLICATION MATERIALS: Letter of interest, resume, official academic transcripts, statement of teaching and research philosophies, and names, addresses and phone numbers of three references. Purdue University is committed to advancing diversity in all areas of faculty effort, including scholarship, instruction, and engagement. Candidates should address at least one of these areas in their cover letter, indicating their past experiences, current interests or activities, and/or future goals to promote a climate that values diversity and inclusion. Applications for the Digital Agriculture position should be submitted to abejob@ecn.purdue.edu. Applications for the Machine Systems Engineering position should be submitted to abejob2@ecn.purdue.edu. A background check is required for employment in this position.

Review of applications for both positions will begin November 15, 2017 and continue until positions are filled.

PURDUE UNIVERSITY IS AN EOE/AA EMPLOYER. ALL INDIVIDUALS, INCLUDING MINORITIES, WOMEN, INDIVIDUALS WITH DISABILITIES, AND VETERANS ARE ENCOURAGED TO APPLY.

Resource is published six times per year: January/February, March/April, May/June, July/August, September/October, and November/December. The deadline for professional opportunities copy to be received at ASABE is four weeks before the issue's publishing date.

For more details on this service, contact Melissa Miller, ASABE Professional Opportunities, 2950 Niles Road, St. Joseph, MI 49085-9659, USA; 269-932-7017, fax 269-429-3852, miller@asabe.org, or visit www.asabe.org/JobAdsInfo.

Safety is about You

Charles Schwab

Ask any safety professional, insurance actuary, or medical doctor, and they will say that the risk of injury is an inherent part of life, and the small decisions we make every day can affect our safety and well-being. However, when we leave for work in the morning, we assume that we'll come home safe at the end of the day. That also applies to travel—we expect to arrive at our destination whole and unharmed. Those expectations are not unrealistic, but some effort is needed to achieve them. That is especially true for the industries served by ASABE.

Visualizing a goal is the first step to meeting it.

Production agriculture is hazardous, but ASABE safety professionals believe in the goal of zero agricultural fatalities. The safety advances that we have made toward this goal have been astounding, and the rates of injuries and fatalities have been declining for decades. These safety advances have been achieved by professionals in many fields, and you are likely one of them:

Whether you provide your expertise as a standards developer to ensure safe machine operation,

... or as a structural designer to protect tractor operators from being crushed in rollover accidents,

... or as an innovator in assistive technology to help farmers with disabilities keep doing the work they love,

... or as a researcher to develop a better understanding of how to recognize risks and avoid hazards,

... or as an ergonomist to apply new technology that provides real-time feedback on worker health,

... or as an educator to assemble and train a coalition of volunteers to spread the safety message,

you are part of the larger safety team.

As Dee Jepsen said in the First Word for this special issue of *Resource*, safety is both a means to an end, and the end of a means. Make sure you are always participating in safe behaviors, accept safety challenges when they arise, and consider the role of safety in every project. As educators, we can emphasize safety as it relates to our course topics, we can elevate safety to a graded component, and we can require safety considerations in our students' Capstones. As engineers and manufacturers, we have developed standards for guidance, and we continually update those standards as new technologies are introduced. No matter what we do, safety is a concern.

And it's not just our professional role. In life as in work, we are all responsible for safety—our own safety and the safety of others. Ensuring that one more person makes it home at the end of the day is a proud accomplishment. As an ASABE member, you are part of a diverse team making that basic difference in people's lives. The goal of zero fatalities is still in front of us, and it's achievable.

ASABE member Charles Schwab, Professor and Extension Safety Specialist, Department of Agricultural and Biosystems Engineering, Iowa State University, Ames, USA, cvschwab@iastate.edu.

AGRICULTURAL EQUIPMENT TECHNOLOGY CONFERENCE

FEBRUARY 12-14, 2018
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