NEW MICROWAVE PROCESSING METHODS
ENSURE RICE QUALITY AND SAFETY

Also inside:
Nebraska Tractor Test Lab celebrates 100 years
Circular food and agricultural systems
Looking to the future to create the world that never was
As I write this, I’m working from home because of the COVID-19 pandemic. Circumstances beyond our control are impacting our healthcare system, our economy, and our daily lives. For most of us, this may be our first encounter with finite resources. There are shortages of personal protective equipment (PPE) for medical personnel and toilet paper for the average household. Grocery stores have bare shelves. I’ve also seen fear—fear of scarcity and fear of having to do without—compounded by uncertainty about how long these shortages will last.

If we pay attention, this pandemic can teach us about our limits, both personally and as a community. Currently, we are just rate-limited for PPE, food, and toilet paper. We haven’t expended our finite resources for producing these items. We’re just consuming them at a faster rate than manufacturers can provide them. People are stocking up on basic items because they’re worried about not having enough, in the short term, so this is a great opportunity to learn about how we handle a crisis. For now, we’re coping, we’re watching out for each other, and we’re working together, given the restrictions of social distancing. But what if these short-term shortages are a preview of the future? Can we permanently change how we do things?

We’ve all read that the global population is projected to be 9.7 billion by 2050, which has serious implications for our use of soil, water, energy, the atmosphere, and other natural resources. And it gets worse: in a recent report, the National Academies predicted that 70% more food will likely be required to feed the world in 2050, and it must be produced with the same natural resources we have now.

We seem to have a built-in immunity to these kinds of dire warnings. We assume that bad stuff always happens somewhere else. Until COVID-19, I had similar untested assumptions—that widespread shortages don’t happen in the U.S., and that an outbreak can’t become a pandemic. Now reality has arrived. Hopefully, this experience will cut through our denial about what it means to live with finite resources in an interconnected world.

ASABE is working to address this challenge. In particular, we’re engaging with the research community to develop strategies to transition our food and agricultural systems from a linear economic model to a circular model. In our current linear economy, we extract resources, create a product, use the product, and then the product becomes waste. We may recycle some of the materials, but recyclability is typically not designed into the life cycle of a product. At best, it’s an afterthought. In contrast, a circular economy is based on maintaining finite resources in a system in which almost everything is recycled and very little is wasted. Can we design waste out of the system entirely? Can we design agricultural systems that rebuild our soil, water, and air?

In this issue of Resource, you’ll find an article that describes the circular systems in detail, as well as a description of how ASABE is positioning itself to be a driver of the transition toward resource use efficiency. Our profession is uniquely positioned for this challenge. We represent many of the systems involved, with members in facility systems, plant and animal systems, energy systems, natural resource and environmental systems, machine systems, processing and packaging systems, waste management, sensors, and big data. We also collaborate with many different science and engineering disciplines. We have all the right experience and all the necessary skills.

Is systemic change really possible? I’ve been fascinated by how my home state (and many others) has responded to the lack of PPE during the pandemic. Unusual suppliers have emerged for critical products, such as car companies building medical ventilators, research labs using their 3-D printers to manufacture face shields, and local distilleries producing hand sanitizer instead of vodka. My university department helped convert 250 gallons of ethanol into hand sanitizer for the campus hospital. Before this crisis, I would have said that such things couldn’t be done, at least not quickly. Now I know better. We can change quickly, and we can rally in a crisis.

Joel Makower, our keynote speaker at last year’s Annual International Meeting, said that if we are going to reinvent the U.S. economy, then the change must be led by the private sector rather than the government. I see this change happening on a small scale, in many different places, and I can envision how it could happen on a larger scale. COVID-19 has pulled our community together in ways we haven’t seen since World War II. We need to marshal this sense of urgency toward the impending crisis in global resources, and ASABE can lead the charge.

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FEATURES

4 The Nebraska Tractor Test Laboratory
100 years and counting
Roger Hoy

8 Microwave Drying Can Increase Head Rice Yield
Griffiths Atungulu and Deandrae Smith

11 From The Jetsons to Solving the World’s Wicked Problems
Generations of engineers must work together
Kelly Sandner and John Shutske

15 Toward Circular Food and Agricultural Systems
James W. Jones, Brahm P. Verma, Sue Nokes, Lalit Verma, Fedro Zazueta, and Allen Rider

UPDATE

18 Who you gonna call? Rotbusters! Sensors sniff out plant diseases

19 Finding a better way to detect worms in apples

20 Recovering phosphorus from ethanol production can help reduce pollution

21 Long-term Iowa State research shows poultry manure improves profits and soil health

DEPARTMENTS

2 From the President

23 Historical Landmarks

24 Meet the Fellows
Honoring the newly elected

25 YPC News & Notes
AIM events: Mark your calendars
Jason Schuster

26 ASABE Foundation Work in Focus
Support the Foundation at the 2020 AIM
Mark Riley

28 We Need Your Feedback
New reference handbook available for the ag-bio PE exam
Terry Howell Jr., P.E.

Events Calendar

29 Professional Listings

30 Last Word
COVID-19 and our next generation of engineers
Erin Webb, P.E., and Julie Carrier

ON THE COVER: Researchers at the University of Arkansas Division of Agriculture are engineering new microwave processing methods to ensure rice quality and safety.
The Nebraska Tractor Test Laboratory began with a farmer who purchased a tractor that did not perform as advertised. In 1916, Wilmot Crozier, a Nebraska farmer, bought a Minneapolis Ford Model B. He found this tractor to be unreliable, and he had trouble getting parts and maintenance because no such services were available in Nebraska. In 1919, Crozier was elected to the Nebraska State Legislature, where he teamed up with Nebraska Senator Charles Warner to write the Nebraska Tractor Test Law. Crozier and Warner were aided in this task by L. W. Chase, chair of the Agricultural Engineering Department at the University of Nebraska. The bill passed easily and was enacted into law in 1919.

The original Tractor Test Law contained several provisions that remain largely unchanged:

- The University of Nebraska’s Agricultural Engineering Department (now the Biological Systems Engineering Department) is responsible for testing advertised claims.
- At least one tractor parts warehouse and one repair facility are required in Nebraska.
- Permits to sell tractors are issued by the State Railway Commission (now the Nebraska Department of Agriculture).
- A board of engineers, under control of the university, develops the test procedures and reviews all test results.

Shortly after the law was enacted, the NTTL was established within the University of Nebraska’s Agricultural Engineering Department. A building was constructed and equipped with the necessary tools and office space, and an outdoor test track was built. Professor Chase convinced Claude Shedd, a former student, to serve as the NTTL’s first Chief Engineer. As required by the law, a board of engineers was established from department faculty to approve the test procedures. The first tractor test, involving a John Deere Waterloo Boy Model N, was completed on April 9, 1920.

The early years of testing

In the early years, tractor testing consisted of validating the manufacturer’s claims for drawbar horsepower and belt horsepower. Fuel consumption was also measured. For belt horsepower measurements, the flat belt drive on the tractor was connected to an electric resistance dynamometer, which provided the load. For drawbar testing, a load car was built by adding a traction dynamometer to a tractor frame that was

The first load car in use at the NTTL.
pulled in reverse. This load car was attached to the drawbar of the test tractor using a hydraulic cylinder with an internal spring. As the spring was compressed by the pull of the tractor, the increased hydraulic pressure was measured with a pressure gauge.

During the 1920s, various load cars and load units were developed for drawbar testing, and many changes in tractor testing have occurred since due to changes in tractor technology. However, measuring the drawbar pull using the pressure in a hydraulic cylinder was an excellent early choice, and this test method was used until 2011.

The Tractor Test Law had the intended effect of eliminating disreputable tractor manufacturers. Even outside of Nebraska, where the law did not apply, lack of successful NTTL testing became a barrier to sales. Further, the Great Depression of the 1930s caused consolidation, and elimination, of many tractor manufacturers, resulting in fewer tractor models.

A major change occurred in 1934, when the first rubber-tired tractor, the Allis Chalmers WC, was introduced. For the next several years, the NTTL often tested the same model on both steel wheels and rubber tires. However, by 1937, the last of the steel-wheeled tractors was tested. A new load car, designed by Charlie Adams, was implemented in 1938 and remained in use until 2003, although it was extensively modified over time. The Adams load car was equipped with precision pressure gauges for the hydraulic cylinders, among other features.

With the advent of World War II, the NTTL discontinued operations because tractor manufacturers converted to war production. Carlton Zink, one of the NTTL's long-serving Chief Engineers, spent the first two years of the war teaching farmers how to keep their equipment running. He left the NTTL in 1943 to work for Firestone and then Deere, where he retired in 1968. At Deere, Zink pioneered the development of rollover protective structures (ROPS) for agricultural tractors.

In 1946, the NTTL resumed operations with a new Chief Engineer, Lester Larsen, who led the NTTL until 1976, a period that saw much tractor development. Following World War II, agricultural mechanization greatly increased, and tractors largely displaced animal power. In 1956, a change was made to the Nebraska Tractor Test Law to refine the definition of a tractor. When the law was originally enacted, the machinery industry did not differentiate between agricultural tractors and construction equipment. The 1956 change created a more modern definition of an agricultural tractor, similar to the definition in ASABE Standard S390.

Although steel-wheeled tractors were once widely used, by 1956 all agricultural tractors ran on rubber tires. With this change, the NTTL constructed a new concrete test track that required less maintenance than the original cinder track and provided more consistent testing conditions. By 1960, the Adams load car required significant modifications to handle the higher horsepower tractors that were becoming available. The modifications allowed the load car to handle up to 10,000 lb of drawbar pull, which could be further increased.
with the use of load units. This final configuration of the Adams load car, developed by John Carlisle, still exists and is on display at the Larsen Tractor Test and Power Museum.

Expanding responsibilities

The NTTL has always solicited opinions from farmers and manufacturers to improve the tractor tests. In the late 1960s, farmers suggested adding noise measurement to help them select quieter tractors. This test was instituted in 1971, and the noise testing procedure was developed by Ned Meier as part of his MS project. As soon as the noise results began to appear in NTTL reports, manufacturers began to compete to produce quieter tractors.

Meanwhile, in Europe, the OECD Tractor Test Codes were established in 1957, when the OECD developed tests to validate ROPS designs. During Lester Larsen’s tenure as Chief Engineer, the NTTL collaborated with the OECD to furnish the information needed for tractor performance tests. The OECD published its first tractor performance code in 1973. However, globalization soon began to play a larger role.

By the 1980s, cost-cutting efforts by manufacturers resulted in pressure on the NTTL to accept performance tests conducted at OECD test stations, rather than requiring that tractors be tested at both the NTTL (to meet the Nebraska law) and at OECD test stations (to meet European requirements). In 1986, the Tractor Test Law was changed to recognize testing at OECD test stations. Simultaneous to this change, the U.S. formally adopted the OECD Tractor Test Codes. The NTTL was appointed as the official review agency for OECD tractor testing. This designation allowed the NTTL to submit and approve OECD test reports.

As it happens, the OECD Code 2 performance test is essentially the NTTL’s testing procedure and has been embodied in several standards, most recently SAE J708. In the current version, the OECD Code 2 requirements are nearly 90% traceable to the NTTL. The OECD also supports protective structure testing of tractors for ROPS and falling object protection. While protective structure testing is not conducted at the NTTL, NTTL engineers typically direct 25 to 35 protective structure tests each year.

In 1984, hydraulic lift testing was added to the testing procedures, and in 1988, the NTTL began measuring and documenting the hydraulic power of tractors. Larger tractors created challenges. A new lab was built with doors 24 ft wide to accommodate larger machines; however, the concrete test track was only 15 ft wide. As a result, it was occasionally necessary to perform tractor testing at Lincoln Airport, which had a paved surface wide enough for the largest tractors.

Testing in recent years

More recent changes have involved environmental regulations. In 1996, the EPA introduced Tier 1 emission standards for off-road compression ignition engines. Evolving emission standards caused new tractor models to be introduced every three to five years, greatly increasing the demand for tractor testing. This trend continued through 2017, when the last Tier 4b models were tested.

In 1998, the Chief Engineer became known as the Director, and Leonard Bashford took on the role. Bashford was no stranger to the NTTL, having served many years as both a member and chair of the Nebraska Board of Tractor Test Engineers. A major change during Bashford’s tenure was the first significant upgrade of the load car since the 1960s. The new load car, acquired from Caterpillar, was based on an articulated dump truck chassis. A front yoke supported the hydraulic cylinders used to determine drawbar pull. A fifth wheel was added to determine the speed and distance traveled for calculating power and wheel slip.

Bashford retired in 2006, and I was induced to leave Deere and assume the role of NTTL Director. My first challenge was the concrete test track. The old track had been in use since 1956, and the surface was badly deteriorated. During the summer of 2007, the old track was replaced. The new track is longer, and the width has been increased from 15 to 22 ft, so no more testing at Lincoln Airport!

Current tractor performance tests are conducted according to OECD Code 2, which includes both mandatory and optional test procedures. An OECD test report requires only the mandatory procedures, which include PTO testing, hydraulic flow testing, three-point linkage testing, and drawbar testing. Testing of tractors is further defined by decisions of the Nebraska Board of Tractor Test Engineers. Their decisions are communicated through Board Actions, which are available on the NTTL website (tractortestlab.unl.edu/tractortestboard). Because the OECD only provides testing procedures, many Board Actions relate to verifying actual tractor performance. For example, Board Action No. 18 describes the evaluation of PTO and drawbar performance claims.
Future challenges

The use of electric power on tractors is a new challenge for the NTTL. In 2017, the NTTL evaluated two electric tractors manufactured by Solectrac. Those tractors were designed for orchard and vineyard work, a niche market. While the tractors were not officially tested, the evaluation provided useful information to both Solectrac and the NTTL. Another upcoming technology is the delivery of electric power directly to attached implements. This power may be produced by a flywheel generator or a diesel electric power train. When electric power is supplied to implements, it will become another available power source, just like hydraulic, PTO, and drawbar power.

Another challenge involves relating tractor tests to implement power requirements. Field implements typically consume tractor power through more than one power source. For example, an air seeder may use both drawbar power and hydraulic power. Measurement systems for drawbar, PTO, and hydraulic power can be deployed in the field to collect actual implement power requirements, while CANBUS data can be collected on engine speed and power. During official tractor testing, CANBUS data can then be collected for the same parameters, thereby establishing the efficiency of power transmission from the tractor’s engine to the various power outlets. This ability to correlate CANBUS data with actual power delivered during official testing will allow evaluation of tractor efficiency in the field, so farmers can select the best tractor for the intended use. We are working with researchers funded by the USDA to develop this new understanding of in-field power requirements.

Conclusions

Since the NTTL’s first test in 1920, tractor technology has changed enormously. The staying power of the NTTL can be explained by our consistency in supplying accurate, unbiased, and relevant performance data. Without our reputation for integrity, we would not have survived. At the same time, if we had not adopted new testing procedures with the changes in tractor technology, we would not have survived. As the NTTL begins its second century, those two qualities define our mission.

The NTTL also serves a secondary mission in educating agricultural engineering and agricultural mechanization students. Each semester, up to 30 students are employed part-time and provide much of the labor required for tractor testing, including everything from operating the computer on the load car (a great job) to cleaning up the occasional oil spill (a not-so-great job). Our students work with NTTL staff and with engineers from various manufacturers, gaining hands-on experience that is an excellent complement to their classroom studies. Today, former NTTL students are working at all levels of the equipment industry.

Modern agricultural tractors have evolved far beyond the early tractors that competed with horses. By 2120, they will be much evolved from today, and the NTTL will still be testing them.

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Further Reading


The global demand for rice continues to increase, and rice production is expanding to meet this demand. Consequently, the need to dry rice at peak harvest time has also increased. However, the rice harvesting window is relatively short and is often characterized by warm and humid conditions that favor the proliferation of microbes and pests in grain storage systems.

New harvesting technologies have increased the speed at which rice can be harvested. Larger and faster grain carts, trucks, and trailers for transporting rice from combines to dryers have resulted in much higher delivery rates to commercial drying facilities. Unfortunately, the rice drying infrastructure has not grown at the same rate as the harvest and transport technology. Temporary “wet holding” of rice has become inevitable, and this delayed drying poses risks, especially for rice coming in at higher moisture contents.

Courtesy of a USDA SBIR-NIFA grant, the Grain Processing and Post-Harvest Systems Engineering Lab at the University of Arkansas’ Department of Food Science has a long-term goal to develop, validate, and commercialize rapid, one-pass drying technology for rough rice that maximizes head rice yield and ensures rice quality. In collaboration with our industry partner, AMTeK Microwaves, this research project harnesses the volumetric heating characteristics of 915 MHz microwaves to minimize moisture content, temperature, and material phase gradients during rough rice drying and thereby discourage kernel fissuring, which reduces rice milling yield and quality.

This one-pass drying process provides the microwave energy level and treatment duration required to decrease the moisture in a unit mass of rough rice from the harvest moisture level, which is typically about 22% to 20% wet basis (w.b.), to a safe storage moisture content of 12% to 13% w.b. This new drying approach is expected to dry rice without reducing the milling yield and without reducing the nutritional, functional, and sensory properties of rice.
The specific goal is to achieve one-pass drying of freshly harvested rice to a safe storage moisture content with a head rice yield of >65%, which is at least seven percentage points higher than the head rice yield for lab-simulated, conventional two-pass and three-pass drying methods. Compared to the current average head rice yield of 58% obtained by lab-based simulations of conventional drying methods, the increased head rice yield with microwave drying will translate to a nearly $145 million annual increase in rice value, based on 2015-2016 U.S. rice production statistics.

We are currently testing one-pass microwave drying on several widely grown rice cultivars with a variety of treatment conditions. Ultimately, this testing will lead to a technology that can be readily expanded for industrial-scale drying or retrofitted alongside existing dryers to improve drying capacity. So far, our results (shown in figs. 1 and 2) indicate that, for medium-grain rice at an initial moisture content of 23% to 24% w.b., drying to a moisture content of 14% to 16% w.b. is feasible with a specific energy of 600 kJ per kg of initial wet grain mass (600 kJ kg⁻¹), followed by 4 hours of tempering the rice at 60°C and natural air-cooling. The resulting head rice yield is not significantly different from that of control samples that have been gently dried using natural air (25°C and 65% relative humidity).

The tempering step is important because it eliminates sudden exposure of the rice to ambient conditions after microwave heating, thereby allowing stepwise cooling and moisture redistribution within the kernels, which ultimately improves the quality of dried rice. The 4-hour tempering step does not represent a significant technological shift for producers. Commercial dryers already temper rice, in most cases overnight for 8 to 12 hours. Without the tempering step, microwave energy of less than 300 kJ kg⁻¹ is recommended for heating the wet grain mass to obtain head rice yields comparable to the control samples.

We have also performed preliminary tests of a continuous 915 MHz microwave system in which rough rice is conveyed through an oven to achieve treatment durations of up to 8 minutes. For most common rice varieties, the average cost for drying and transporting the rice harvested from one acre has been estimated at $48. With rice yields varying from 100 to 200 bushels per acre, the drying cost with our continuous microwave system would range from $9.6 to $19.2 per ton of rough rice.
The results in the accompanying table show that, with a specific energy of 600 kJ kg\(^{-1}\) and an initial wet mass of medium-grain rice with a harvest moisture content of 24% w.b., one-pass drying using 915 MHz microwaves resulted in a significant reduction in moisture content. The final moisture content of the rough rice was 13.57%, and the drying cost, without factoring in the transport cost, was about $8 per ton of rough rice. In large-scale operation, these numbers may vary. However, this cost comparison underscores the potential economic benefit of microwave drying for rice.

Our new microwave drying approach will help increase rice drying capacity, head rice yield, and overall rice quality. The high heat fluxes associated with 915 MHz microwave drying may also provide the means to inactivate heat-tolerant, mycotoxin-producing fungal spores that typically survive conventional heat treatments. The secondary metabolites produced by some of these fungal spores are known carcinogens, and their proliferation in grain storage poses a significant public health concern.

Moreover, in typical rice processing, some of the rice is immediately parboiled when it arrives at the processing facility. In parboiling, the rice is soaked to at least 30% moisture content, steamed, and then dried. Drum dryers are used for drying parboiled rice; however, the time required to dry this high-moisture rice is very long. Therefore, the rapid drying time provided by microwave treatment may also have an important application in rice parboiling.

\[\text{Microwave Drying Cost} = \frac{\text{Experimental cost}}{\text{Theoretical cost}}\]

\[\text{Experimental cost} = \text{Theoretical cost} \times \text{Efficiency factor}\]

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Theodore von Kármán, an accomplished aeronautical engineer in the previous century, once said, “Scientists discover the world that exists; engineers create the world that never was.” Imagination has always been a driving force for engineers, yet some of their creative motivations have shifted in recent years.

Throughout history, engineers have focused on creating technology to improve the quality of life and to test the limits of human ingenuity. The fruits of their creativity were often plowed back into further innovations by each generation of engineers that followed. A driving force for all generations of engineers is that we design products, processes, and systems to address seemingly insurmountable challenges.

Over time, the scale of these challenges has changed. In the early 1900s, the challenge was flight, even if only for 59 seconds (and 852 feet). In the 1960s, the challenge was the space race, which was driven in part by the need to advance science in the name of national defense. In 2020, we are facing global challenges that transcend national borders.

The challenges that push engineers today include the need to mitigate climate change, feed and house a growing population whose food preferences are changing as societies advance, and protect our finite water and soil resources. Ironically, many of these global challenges are the unintended consequences of technologies developed by previous generations of engineers, including industrialization, widespread use of fossil fuels as a primary energy source, and intensive use of land and water for food production.

Creating the world that never was, that is the goal of the engineer. Through the years, we (Kelly Sandner and John Shutske) have both pulled out our crystal balls to foresee the future, to muse and dream, and to predict what might come in the decades ahead. John began this exercise back in 1997 when he wrote his first article looking to the future. He took to the keyboard again in 2014 when he predicted the life of a futuristic Extension worker. Kelly took her first stab at forecasting the future in 2019 when she envisioned life in 2030. Here we give you a brief look into the worlds we envisioned, hopefully encouraging you to dream a little, because sometimes dreams do come true.
In 1997, John, then at the University of Minnesota, wrote an article describing a typical day for an agricultural engineer and Extension specialist, ten years in the future. That article was intended to inspire university leaders who had a vague desire to invest in digital technology, which at that time involved the emergence of the internet and new devices like laptop computers. Consumer-level smartphones were not yet a thing in 1997, and university professors still taught with chalkboards and overhead projectors.

John’s 1997 article looked forward to 2007 and described a world in which new and exciting technology influenced even the most mundane tasks. A bedside sensor detects when you wake up each morning, the house’s control system sets the shower temperature based on your latent sleepiness and body temperature, and the perfect cup of coffee is brewed and waiting for you. This ideal day is coordinated by a virtual assistant using a “thought pad” and voice recognition. Work time, personal time, and family time are seamlessly integrated, including a fun evening of fishing with the kids. Transportation in this idyllic future is also convenient, with no worries about traffic jams or car ownership costs.

At work, Extension personnel deliver technical information directly to farmers via live-streamed video that is displayed on big screens in the barn. Information collected during face-to-face consultations is automatically documented, and follow-up activities are automatically scheduled to ensure that the recommendations are working. Data and other information are shared with rural service support providers so that local resource people, vendors, and others all know how to provide optimal support. John’s vision of the future from 1997 looked perfectly efficient, like the world of The Jetsons, and some of that vision has come true.

From John Shuttske’s 1997 article “A day in the life (of a ‘knowledge architect’).”  

7:30 a.m.—I kiss my wife and head out the door with my small “thought pad.” During the wee morning hours, this pad, roughly the size of an 8 1/2 by 11 inch legal pad, has been busy arranging my work schedule and helping me manage the information I need for today. The pad’s screen displays text, pictures, and video very crisply, resembling a high quality printed page like you might find in a magazine. But it stores the equivalent amount of information of every book in existence in the entire University of Minnesota library system and can update its memory with new information in seconds.
Seventeen years later, in 2014, John updated his 1997 article. As part of an effort to promote the evolving national Extension system, the updated article follows the fictional life of Natalie, a millennial employee in university Extension who enters the workforce in 2024. While the technology described still contains some luxury applications, many of the new applications are used to collect and analyze large volumes of data to make economic decisions and allocate resources. The advances in the 2014 version of John’s article are facilitated by hardware and software developed to reduce costs and improve efficiency.

In 2024, Natalie’s clients use autonomous UAVs to monitor crop conditions and relay the information to farm workers. User-friendly data updates are sent via text message from robotic milking machines to the dairy manager or to an Extension expert, who can be anywhere in the world. Natalie travels to an Extension workshop in a driverless car that allows her to work on the road. The article describes Natalie using software-enabled platforms to dramatically reduce her lodging expenses, and she spends the night in a shared-resource facility. Some of Natalie’s work includes speaking at presentations that she doesn’t actually attend. Instead, she appears as a hologram through virtual reality.

This new set of technologies includes making smart use of time, reducing Natalie’s energy footprint, and collaboratively sharing ideas, knowledge, and valuable resources. As in 1997, all of these technological developments are made possible by engineers, who integrate sensor systems, networked information, the growing sophistication of data analysis methods, and the increased capabilities made possible by artificial intelligence.

From John Shutske’s 2014 article “A future vision for technology in Extension.”
https://imaginingamerica.org/2014/09/03/a-future-vision-for-technology-in-extension/

Natalie will turn 30 in 2024, and like many in the millennial generation, she will have several meaningful careers and multiple jobs during her working years. She will enter a position in Extension having grown up as a “digital native,” with her use of technology having been fully integrated into her life from an early age. ... In addition to sitting and interacting with a constituent or colleague on a monitor, screen, or hologram, Natalie will see significant advancement in the use of wearable virtual reality (VR) displays (sound and video). In recent months, a VR system called “Oculus Rift” has been released along with a software developer’s kit that encourage individual inventors and entrepreneurs to develop highly customized applications of this amazing technology. In addition to using it for one-on-one “distance” interaction with other people, virtual reality will be used by Natalie to do educational demonstrations, and offer people other types of highly complex three-dimensional immersion experiences.
In the summer of 2019, Kelly, an undergraduate student working with John, was challenged to re-envision John’s two articles. The future that Kelly envisioned for 2030 is similarly saturated with technology, and applications are focused on creating solutions for seemingly intractable global issues, also known as wicked problems.

In Kelly’s vision, engineers use advances in CRISPR-Cas9 and genetic editing to improve the nutritional quality of staple crops and reduce global malnutrition. Small fleets of driverless tractors and harvesters improve farm-level efficiency and sustainability, while reducing soil compaction and greenhouse gas emissions. Augmented reality is fully implemented in multiple industries to increase worker safety and serve as a resource for mental health and wellness. With this increased automation, Kelly predicted that local, national, and world leaders will be forced to work together to deal with the social and legislative repercussions that pertain to the “rights” granted to new technologies. The use of artificial intelligence in warfare and robotic social rights will be at the forefront of these debates.

Two authors, two perspectives

Our two perspectives, developed over the last 23 years by authors of different generations, a baby boomer and a millennial, have some common features, particularly the pervasiveness and constant evolution of technology in our daily lives. Our two perspectives differ because of the historical events that shaped our lives. For John, Sputnik, the Cold War, and the space race were all significant influences on young engineers in the late 1950s through the 1960s. For Kelly, the September 11 attacks and increased public awareness of climate change drove her to pursue engineering as a way to create solutions for a troubled world.

As co-authors, we agree that all generations of engineers are influenced by historical events that affect their perceptions, motivations, and goals. To predict how the engineers of Generation Z (those born in the late 1990s) will address the wicked problems that plague our society, it might be useful to consider the historical events that have occurred during their lifetime. Generation Z has never known a time before the War on Terror, and they are more receptive to international and multicultural cooperation to solve problems. Conflict over water and other limited resources, which is already a pressing issue, will increase with increasing population. The increased population will also place additional strains on agriculture and increase the effects of global warming.

Most recently, as a result of the COVID-19 pandemic, human health will become a prominent issue, along with the interface between animal health, global travel, and universal access to healthcare. Having grown up with advanced technology, the engineers of Generation Z will continue the expansion of artificial intelligence and robotics. This expansion will need to address the social role of robots and intelligent machines, either as property or as individual beings with legal rights and protections.

COVID-19 is a sudden reminder that we’re facing complex, existential challenges. To solve these wicked problems, the next generation of engineers will need to build on the advances of their predecessors. Present and future generations of engineers must work together to create a world that we all want to live in.

Kelly Sandner, Student, Biological Systems Engineering, and ASABE member John Shutske, Professor and Extension Specialist, University of Wisconsin, Madison, kelly.sandner@wisc.edu and john.shutske@wisc.edu.
A simple description of a circular economy is an economic system that uses resources sparingly and recycles materials endlessly so that resources are not trapped in landfills and create environmental problems. Three principles for circular economies have been proposed:

1. Design out waste and pollution.
2. Keep products and materials in use.
3. Regenerate natural systems.

Although implicit, it is useful to add a fourth principle: Circular economies should provide economic benefits. This concept was highlighted in the March 2020 issue of National Geographic, which focused on “the end of trash” and the promise of a circular economy.

The circular economy concept is being embraced by major businesses. These businesses realize that consumers are increasingly demanding products that have been produced sustainably, without negatively affecting our soils, water, the atmosphere, and ecosystems. As a result, these businesses are motivated to address this growing demand while maintaining, or increasing, their profits.

The principles of circular economies are especially important for transforming food and agricultural systems and the businesses that support them. ASABE should move actively to lead this transformation.

Our current food and agricultural systems are predominantly linear. They consume resources that are lost in production and supply chains, and more than one-third of the food produced is discarded as waste. These losses and wastes create additional problems that require costly remediation, such as the environmental degradation due to agricultural nutrients flowing into water bodies. Nutrient runoff from agricultural areas in the Mississippi River watershed is partly responsible for the notorious “dead zone” in the Gulf of Mexico, which was larger than 18,000 km² in 2019. As another example, it is estimated that agricultural and food systems account for between 19% and 29% of total greenhouse gas emissions to the atmosphere and are responsible for about 75% of global deforestation. These problems will get worse unless major changes are made.

Additionally, the world population, which is projected to increase from 7.7 billion in 2019 to between 9.4 and 10.1 bil-
lion in 2050, will escalate the competition for resources between agriculture and other uses. The U.S. National Academies have estimated that 70% more food will be required by 2050 to feed the world’s population. It is not obvious how this increased production will be achieved, given the Earth’s finite resources and our current food systems.

These interacting challenges have enormous implications for our ability to meet the demand for food and agricultural products. The Earth has limited land, water, atmosphere, nutrients, and other natural resources. Sustainably increasing our food supply will require new developments in science and technology, new business models, increased resource use efficiency, reduced demand for natural resources, decreased environmental degradation, new national and international policies, and increased awareness by consumers and producers.

Circular economies for agricultural systems are already getting attention in some parts of the world, particularly in Europe. For example, the Netherlands Ministry of Agriculture, Nature, and Food Quality has adopted a goal of transforming existing linear agricultural systems into circular economies. In the U.S., similar transformations are being studied and proposed in public and private sectors. For example, the business community has created the VERGE Food initiative for businesses to share their best practices for sustainable food systems. Digitization of agriculture, advanced data analytics, and AI tools are being commercially developed for reducing resource inputs, and numerous universities are conducting research in digital agriculture.

Some producers, especially dairies, have made progress in reducing their use of resources by capturing and re-using nutrients and water in their production systems.

However, fundamental changes in our food and agricultural systems will not be achieved by a disjointed, piecemeal approach that focuses on isolated components of food systems. Currently missing is an integrated systems approach that provides a framework for transforming food production and distribution. Recently, a National Academies study identified five scientific breakthroughs needed by 2030 to increase the sustainability, competitiveness, and resilience of food and agricultural systems in the U.S. Among other things, the National Academies recommended a convergent systems approach that harnesses advances in economics and engineering, as well as in biological, data, materials, and behavioral sciences.

Our highly diverse food and agricultural systems include multiple interconnected sub-systems. The accompanying diagram shows how the elements of a food system are embedded within broader social and natural systems that includes population increase, economics, human cultural traditions, government policies, climate change, the environment, and natural resources.

The role of ASABE

Transforming our current linear systems into profitable circular systems that keep products and materials in use, design out waste and pollution, and regenerate natural resources is a significant leadership opportunity for ASABE. Research, develop-
ment, standards, and commercialization of the solutions will require a wide array of disciplines and deep understanding of the interconnectedness among related sub-systems. Fortunately, agricultural and biological engineers are uniquely qualified to understand the flows of mass, energy, value, and information in complex systems and to contribute to the design of circular economies for food and agriculture.

The ABE profession already provides significant contributions to most of the food system elements shown in the accompanying diagram through machine design and automation, facility design, sensors and instrumentation, environmental control, water use, packaging, resource recovery, waste reuse, data analytics, modeling, systems analysis, and management and decision tools, to name a few. These contributions support major industries beyond the farm gate, such as agricultural equipment, irrigation equipment, on-farm storage, livestock production facilities, energy, and many others. These supportive industries are essential for the transformations necessary in developing closed loop circular economies for food and agricultural systems. As a result, ASABE is uniquely positioned to connect stakeholders because our profession integrates knowledge from multiple disciplines to solve problems. We have interdisciplinary experience in working with a “system of systems” perspective, which is essential for this complex task.

ASABE leadership recognizes the importance of transforming food and agriculture from a linear economy to a circular economy. In November 2019, the ASABE Board of Trustees approved a new priority for the Society to develop its own programs, engage with other disciplines, and contribute to national and international efforts in developing circular economies for food and agricultural systems. ASABE has committed to participate in the newly formed VERGE Food initiative, as well as a proposed National Academies study. Currently, the study proposal has been endorsed by the Board on Agriculture and Natural Resources (BANR) and is being considered by the National Academies. The ASABE leadership is working hard to map out how ASABE will engage with other professional societies, the National Academies, and other organizations to ensure that our Society has a leading role in this important new initiative.

ASABE Fellow James W. Jones, Distinguished Professor Emeritus, Department of Biological and Agricultural Engineering, University of Florida, Gainesville, jimj@ufl.edu; ASABE Fellow and Foundation Trustee Brahm P. Verma, Professor and Associate Director Emeritus, College of Engineering, University of Georgia, Athens, bvverma@ engr.uga.edu; ASABE Fellow and President Sue Nokes, Professor and Associate Dean for Faculty Affairs and Facilities, College of Engineering, University of Kentucky, Lexington, snokes@uky.edu; ASABE Fellow and Foundation President Lalit Verma, Professor and Head, Department of Biological and Agricultural Engineering, University of Arkansas, Fayetteville, lverma@uark.edu; ASABE Fellow Pedro Zazueta, IAABE President and CIGR Secretary General, University of Florida, Gainesville, fsz@ufl.edu; ASABE Fellow and Past President Allen Rider, Past President of New Holland-North America, New Holland, Pennsylvania, rideracg@aol.com.

Further Reading


We are transforming agriculture. (2019). Newark, NJ: AeroFarms LLC. Retrieved from https://aerofarms.com/

Who you gonna call? Rotbusters!
Sensors sniff out plant diseases

In Brief: ASABE member Sindhuja Sankaran uses sensors to detect storage diseases like Pythium and soft rot at early stages, even before their symptoms become visible.

If potato farmers worry about storage losses, they might want to call “Rotbusters.” That’s the name Sindhuja Sankaran uses to explain her work using sensors to detect storage diseases like Pythium and soft rot at the early stages, even before their symptoms become visible.

Sankaran, an associate professor in the Washington State University (WSU) Department of Biological Systems Engineering, says the sensors can “sniff” the differences in potatoes that a disease emits. For example, a farmer might use a portable sensor to scan different potato storage areas. If the sensor detects a certain marker compound produced by rot or another disease, it triggers an alarm. That allows the farmer to address the problem before it spreads.

The stakes are large. Every year, storage diseases damage up to 6% of the potato crop, according to WSU researchers. The sensor system can be used in manual or automatic mode, and Sankaran is looking for processors who are willing to field-test the system. As part of the project, Sankaran plans to inoculate potatoes in a storage facility to determine the sensitivity of the system. “The goal is a threshold much less than that of the human nose,” she said. “If we can know early enough, we can stop the spread of infection.”

The special olfactory sensors can detect differences quantitatively, enabling farmers to make early decisions on how to handle the problem. Sankaran also uses the sensors to help measure qualities not visible to the human eye, such as disease resistance. Her team studies whether a potato releases certain compounds as a way to determine its disease resistance.

Sankaran and her students are incorporating the sensors into reliable applications that will help farmers monitor their crops and storage facilities. “Any sensor can give you a bunch of numbers,” she said. “We want to make sure the numbers make sense and provide useful information that can assist in management decisions.”

The use of such technology is becoming more common. Sankaran joined WSU in June 2013. At the time, her position was one of the first in phenomics, which is the study of the interaction of genes and the environment.

Sankaran works on wheat, legumes, tree fruits, grapes, potatoes, onions, and forage crops, and she also wants to adapt existing tools to help growers, said Mark Pavek, WSU potato specialist. Sankaran’s work is “the next step in a lot of things that we do,” Pavek said. “Once the tools are available, people will say, ‘What did we do without it?’” he said. “Any tools that give growers more information so they can help market their product is going to be useful.”

Sankaran loves applying the things she learns to what’s needed by farmers. “Farming is a lot of hard work,” she said. “If we can use technology to make it easier, safer, and more efficient, then why not?”

For more information, contact Matthew Weaver, field reporter, mwweaver@capitalpress.com, or Sindhuja Sankaran, sindhuja.sankaran@wasu.edu.
Finding a better way to detect worms in apples

In Brief: Researchers at the University of Kentucky are studying non-invasive ways to improve detection methods for codling moths in apples.

Worms poking out of apples may be a cute back-to-school theme, but they are not welcome in orchards. Researchers at the University of Kentucky (UK) are studying non-invasive ways to improve detection methods for codling moths in apples.

Codling moths are the most devastating insect pests for apple growers. Each spring, adult moths lay their eggs on or around the developing apples. When the eggs hatch, the larvae tunnel into the apples, where they feed on the fruit, and develop for three to five weeks. The larva then exit the fruit to pupate in a nearby location over the winter.

The U.S. is the world’s largest exporter of apples, and a codling moth infestation can mean huge losses for U.S. growers. Many countries have strict regulations related to insect pests and will not accept codling moth-infested apples. If an inspector finds just one infested apple in a shipment, it can reduce producers’ profits by more than 50%. In recent years, incidences of codling moth infestation in U.S. apples have increased by 276%.

A team led by ASABE member Akinbode Adedeji, an assistant professor and food process engineer in UK’s Department of Biosystems and Agricultural Engineering, plans to develop a way to quickly and non-invasively identify moth-infested apples. Their project is funded through a $475,000 grant from the USDA’s National Institute of Food and Agriculture. “With no current method to rapidly scan every apple, U.S. producers are vulnerable to having their shipments rejected or greatly devalued,” said Adedeji. “Our goal is to help the multibillion dollar U.S. apple industry remain globally competitive and sustainable.”

Currently, inspectors at apple processing plants randomly select a certain number of apples from each shipment to inspect for moths. If the inspectors find an apple that a moth may have entered, they cut open the apple to see if an insect is inside.

The UK research team will combine two non-invasive sensing methods, acoustic emission and hyperspectral imaging, to greatly increase the rapid detection of insect-infested apples. “This will increase the detection accuracy and effectiveness without having to cut the apple, which is especially useful when the inspectors cannot see an insect entry point on the apple,” Adedeji said.

To do this, the research team must determine the acoustic emission, or sound, that an infested apple emits and if that sound is affected by the apple’s storage conditions. They will combine that knowledge with hyperspectral imaging data, which uses remote sensing to detect problems in fruit, to teach processing machines how to quickly identify infested apples. Plant operators can then channel any infested apples to a lesser use or discard them before they enter the supply chain.

This research will greatly benefit U.S. apple growers, and it can also help U.S. inspectors who must rapidly scan apples coming into the U.S. from other countries to ensure that those apples are also insect-free.

For more information, contact Katie Pratt, agriculture communications specialist, katie.pratt@uky.edu, or Akinbode Adedeji, akinbode.adeedji@uky.edu.
Recovering phosphorus from ethanol production can help reduce pollution

In Brief: ASABE members Vijay Singh and Ankita Juneja have shown that a simple process can recover phosphorus from dried distiller’s grains with solubles (DDGS).

Dried distiller’s grains with solubles (DDGS), a coproduct of corn ethanol processing, is commonly used as feed for cattle, swine, and poultry. However, DDGS contains more phosphorus than the animals need. The excess ends up in manure and drains into watersheds, promoting algae production and eventually contributing to environmental problems, such as the notorious “dead zone” in the Gulf of Mexico.

Removing excess phosphorus from DDGS before it becomes feed could alleviate this problem. A recent study at the University of Illinois (U of I) examined the best way to recover phosphorus as a co-product, which can then be used as fertilizer for corn and soybean production.

“A lot of phosphorus is in the corn itself,” says ASABE member Vijay Singh, the study’s co-author. “When corn is processed, you get different products. Some of it is fed in animal diets, which already contain plenty of phosphorus, so the additional phosphorus comes out in the manure and leaches into the groundwater.” Singh is a professor of agricultural and biological engineering and director of the Integrated Bioprocessing Research Laboratory (IBRL) at U of I. “We asked, can we do something in the process itself to recover this phosphorus, and put it back on the land as fertilizer? Then it would be a circular economy,” he adds.

ASABE member Ankita Juneja, a postdoctoral research associate in the Department of Agricultural and Biological Engineering, is the study’s lead author. She explains that the researchers first looked at how phosphorus flows through an ethanol production facility. “We started with a model and estimated the flow of phosphorus in the entire plant. Then we determined where the maximum concentration of phosphorus occurs, which will help us recover it economically,” she says.

The researchers were able to recover 80% to 90% of the phosphorus through a simple process of increasing the alkalinity of the thin stillage and adding calcium chloride, followed by stirring the product for five minutes in a reactor.

Juneja explains that the goal was not to remove all the phosphorus, because some is needed as a nutrient in animal feed. “The animal nutrient requirement of phosphorus is 3 to 4 milligrams per gram of DDGS. Previously, the DDGS had about 9 to 10 milligrams per gram, so the rest was excess, which gets into the manure. We were able to reduce the phosphorus to 3.25 milligrams per gram, which is within the range of what animals actually need.”

Removing phosphorus also drains protein from the DDGS, but Juneja says the study’s recovery process was optimized to ensure that the amounts of protein and phosphorus left in the DDGS were calibrated to meet, but not exceed, the requirements for animal feed.

The product that is recovered with this process is in the form of a solid precipitate or paste, which contains about 60% to 70% water. It can be dried and eventually used as fertilizer, although the study does not address that application. Singh says that application is being tested by researchers in the U of I Department of Crop Sciences. “We have clearly shown that excess phosphorus can be recovered from an ethanol plant so that it doesn’t have to go into co-products such as animal feed,” he notes.

The researchers evaluated both the technical and economic aspects of the recovery process. While plant operators will have to invest in new equipment to perform the separation, there is potential for selling the recovered co-product for use as fertilizer. “We did an economic analysis of how much it would cost to add the recovery process to an

Dried distiller’s grains with solubles (DDGS) is commonly used as feed for cattle, swine, and poultry. However, DDGS contains more phosphorus than the animals need.
existing dry grind plant, how much it would cost in terms of fixed cost, how much it would cost to operate each year, and how much extra revenue could be generated by producing this extra co-product,” Juneja explains. “We found that the required investment is $5.7 million for a dry grind plant that produces 40 million gallons of ethanol a year. The amount of added revenue is a little less than $1 million dollars each year.”

Ethanol plants are not yet implementing this practice, but processors are very interested in learning about the study’s findings. “They want to know how to do it,” Singh notes. “Just providing them with information on how phosphorus flows in their plants is of value to them, and a strategy for recovering the phosphorus and turning it into revenue is very appealing,” he adds.

This study is the second of three studies that Singh and Juneja are conducting on phosphorus recovery as part of a larger project. “We are looking at three refineries in the Upper Sangamon River watershed,” Singh says. “There are many different processing plants in this watershed because Illinois has lot of bean and corn processing.”

The first study looked at corn wet milling plants, where corn is converted to starch for making high-fructose corn syrup, and the third study will focus on soybean processing plants. Funding for the studies was provided by the National Science Foundation’s Division of Earth Sciences.

For more information, contact Marianne Stein, science writer, mfstein@illinois.edu, or Vijay Singh, vsingh@illinois.edu.

**Long-term Iowa State research shows poultry manure improves profits and soil health**

**In Brief:** A study from Iowa State University shows that when properly managed, poultry manure is a great source of nutrients to enhance crop production and can also benefit soil and water quality.

A 20-year study by Iowa State University researchers shows that fertilizing cropland with poultry manure can benefit soil health and farm profits when compared to a commercial fertilizer.

The study looked at the long-term impacts of poultry manure on soil quality, crop yield, production costs and water quality in conventional Iowa cropping systems.

“The data show that, when properly managed, poultry manure is a great source of nutrients to enhance crop production and can also benefit soil and water quality,” said ASABE member Michelle L. Soupir, associate professor of agricultural and biosystems engineering, who joined the research team in 2009.

And Iowa has a good supply. The state’s consistent top placement in poultry production results in enough poultry manure annually to treat as many as 40% of the continuous corn acres or 7% of the total row crop acres, according to calculations by Soupir’s research team.

Poultry manure can benefit soil health and farm profits when compared to a commercial fertilizer.

“This is the first and only study of its kind that we are aware of,” said Kevin Stiles, executive director of the Iowa Egg Council, which for 20 years has been the project’s primary funder. “I give our board a lot of credit for having the vision to fund this long-term effort to objectively evaluate the potential advantages and impacts of poultry manure for the cropping systems we use in Iowa and the Midwest.”

The research began in 1998 with 11 plots on Iowa State’s Agricultural Engineering and Agronomy Research Farm near Boone. In its first decade, experiments compared three treat-
ments in a corn-soybean rotation. A commercial fertilizer, urea ammonium nitrogen (UAN), was applied at the recommended rate of 150 pounds per acre, and manure was applied at two rates, one that reflected the commercial fertilizer rate and the other, for comparison, at double the recommended rate.

In the research’s second decade, the focus was on comparing treatments on continuous corn. Manure and UAN were applied at the recommended rate of 200 pounds of nitrogen per acre for continuous corn, along with a half application rate for comparison.

After 20 years, the study found that the particulate organic matter and several other measures of soil quality were significantly better in the manured plots. Particulate organic matter helps stabilize soil particles, which can improve soil’s resistance to erosion and water holding capacity.

Soil carbon—another common soil health measure—did not show increases, but the researchers point out that soil carbon changes can be difficult to quantify during the time-frame of the study.

Corn yields increased 25% during the continuous corn studies when poultry manure was applied at the same rate as UAN. During the corn-soybean phase of the study, average corn and soybean yields were similar when poultry manure was applied at the same rate as UAN.

“During the continuous corn phase, average revenue returns increased by about 15% for manure treatments compared to UAN, due to the increased yields,” said ASABE member Ji Yeow Law, a research associate who analyzed crop yields and economics for the study.

Though manure costs were generally higher, the manure was still more profitable during the continuous corn phase, when considering the total production cost per bushel of output. The higher revenues linked to the manure treatments in the continuous corn system suggest that it may be more economical to transport manure over greater distances from poultry facilities to farms.

“This could result in more manure availability for growers seeking fertilizer and also mean a larger potential market for poultry producers selling manure,” Law said.

He noted that the economic results will vary depending on fertilizer prices, manure price and availability. Manure value also will vary due to different nutrient levels. The researchers found wide variation in manure nutrient levels, leading them to emphasize the need for regular manure testing.

“The economic benefits of poultry manure are likely to be lost if landowners also apply UAN as ‘insurance,’ adding nitrogen fertilizer that’s not needed,” said Soupir. “This also applies to the positive water quality benefits we found.”

Nitrate-nitrogen losses measured in tile drainage from manured plots were 7% to 16% lower from the continuous corn and corn-soybean plots, respectively, than from plots commercially fertilized at comparable rates.

Topsoil phosphorus levels increased with continued manure applications, but these increases did not result in significantly greater phosphorus levels in subsurface drainage water coming from the plots. The researchers caution, however, that this might be due to the research site’s loamy, calcium-rich soils, which have a high capacity for holding phosphorus. The site was not designed to monitor surface flow, but the study points out that high topsoil phosphorus levels could be expected to result in increased phosphorus in runoff over time.

“The research shows a number of important benefits from using poultry manure,” said Soupir. “It also confirms the importance of using good conservation and nutrient management practices to avoid phosphorus buildup when manure is applied at the nitrogen rates.”

Stiles said the Iowa Egg Council intends to support continuing the research and expects to recruit additional partners. Future plans, which are already underway, include shifting the application timing from the spring to the fall and studying microbial water quality in drainage from the poultry manure applications.

For more information, contact Michelle Soupir, msoupir@iastate.edu, or Ann Y. Robinson, Agriculture and Life Sciences Communications Service, ayr@iastate.edu.
The Historic Commemoration Committee of ASABE (M-170), in cooperation with local sections, has been selecting and recognizing historic developments in U.S. agricultural and biological engineering for over nine decades. Currently there are 59 ASABE historic landmarks, and more on the way. Significant events continue to be identified and commemorated. Get acquainted with the landmarks, and perhaps you are within a short drive of visiting one. Resource highlights two landmarks in this new column: the second and the second to last recognized (58th). For more information, visit https://asabe.org/HL.

1926

Historically, the second ASAE (ASABE) landmark is the Agricultural Engineering Building at the University of Wisconsin, first dedicated in 1907, named a landmark in 1926, and re-dedicated in 1982. Located at 460 Henry Mall, University of Wisconsin, Madison, the building plaquereads as follows: “American Society of Agricultural Engineers Founded in this Building, December 27, 1907.”

The Agricultural Engineering Building, completed in 1907, was designed by Arthur Peabody with distinctive fanlights on the east, north, and south faces. On December 27th of that year, 18 members of the profession gathered in the building to found the American Society of Agricultural Engineers (ASAE, now ASABE).

The historic Agricultural Engineering Building, built in 1907 and added to the National Register Historic Places in 1985, is situated at the corner of Henry Mall and Linden Street. It is the main building for BSE, and houses department administration, offices, and classrooms.

USDA-ARS Experimental Watersheds

The USDA Small Watershed Program was identified in 2011 as deserving landmark status. Dedication ceremonies for the three identical plaques took place in 2013 in Riesel, Texas. Plaques are located at the Blacklands Experimental Watershed, Riesel Watersheds, near Riesel; the Central Great Plains Experimental Watershed, USDA Meat Animal Research Center, Clay Center, Nebraska; and the North Appalachian Experimental Watershed near Coshocton, Ohio, re-dedicated and relocated in 2016 at the Agricultural Engineering Building, The Ohio State University, Columbus.

In the mid 1930s, the USDA Soil Conservation Service (SCS) realized the importance of hydrologic processes in agricultural fields and watersheds, determining their impact on soil erosion, floods, water resources, and the agricultural economy. In response, the SCS Hydrologic Division established experimental watersheds at the locations named above and operated them until 1954, when the watersheds were transferred to the newly created Agricultural Research Service (ARS). The three original watersheds established the foundation for the vibrant, national USDA-ARS experimental watershed network, that to this day, produces the science and engineering to protect and manage the world’s soil and water resources.

2013

#58

Original USDA-ARS Experimental Watershed
A Historic Landmark of Agricultural and Biological Engineering

The Historic Commemoration Committee of ASABE (M-170), in cooperation with local sections, has been selecting and recognizing historic developments in U.S. agricultural and biological engineering for over nine decades. Currently there are 59 ASABE historic landmarks, and more on the way. Significant events continue to be identified and commemorated. Get acquainted with the landmarks, and perhaps you are within a short drive of visiting one. Resource highlights two landmarks in this new column: the second and the second to last recognized (58th). For more information, visit https://asabe.org/HL.
Twelve new ASABE Fellows were recognized at the Annual International Meeting in Boston, Massachusetts, last July. Resource is proud to highlight these Fellows. In this issue, we continue by shining the spotlight on three more honorees.

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

As the ASABE Constitution states, Fellows are “of unusual professional distinction, with outstanding and extraordinary qualifications and experience in, or related to, the field of agricultural, food, or biological engineering.” Election to Fellow is one of the highest distinctions an ASABE member can achieve, and Resource looks forward to acquainting you with more of ASABE’s best and brightest.

Tom Richard, Professor, Department of Agricultural and Biological Engineering, and Director, Institutes of Energy and the Environment, Pennsylvania State University, State College, is honored for his outstanding contributions to fundamental engineering design and practical solutions for sustainable agroecosystems and the bioeconomy. Throughout his career, Richard has developed innovative engineering strategies to enhance the environmental and economic benefits of biorenewable systems. He has applied fundamental engineering science to design a range of microbial bioconversion processes, including composting, ensilage, and anaerobic digestion. Richard has developed engineering analysis for the sustainable design of systems ranging from the industrial ecology of cities to the agroecology of rural landscapes. Across all of these application areas, he has translated engineering fundamentals into practical system design and process control strategies that have been adopted by farmers, companies, and governments in countries around the world. His contributions include a range of market-based strategies that enhance the environmental performance of agroecosystems while simultaneously improving agricultural productivity, farm profitability, and rural community resilience. These have included developing new markets for perennial grasses, winter crops, and manures, with products ranging from renewable energy and materials as well as livestock feed and soil amendments. His group's current work on sub-field economics and crop responses to stress is establishing a new paradigm for agricultural resilience in an era of increased climate and environmental risk.

Pictured above, Tom and his spouse Clare Hinrichs at a prairie refuge outside Brush, Colorado, where Tom’s family farmed and ranched for four generations.

Zhongli Pan, adjunct professor, department of biological and agricultural engineering, University of California-Davis, is honored for his long career providing scientific leadership in food and bio-processing. Pan is an internationally recognized leader and outstanding food engineer and scholar in the field of food and agricultural processing engineering. Pan has performed extensive outreach, teaching, technology transfer, and commercialization. He leads and conducts innovative and impactful scientific research and development on new food and agricultural processing technologies. Pan’s research has resulted in new infrared processing of food and agricultural products, a new rice milling standard, and value-added product development from food and agricultural waste streams. The new infrared heating technologies have yielded significant savings of energy, water, and chemicals while improving food nutrition, quality, and safety as compared to existing processing technologies. Pan’s new technologies have been successfully transferred to private industry and contributed significantly to the global advancement of engineering solutions to food and agricultural problems.

Pictured above, Zhongli (center, front row) and his research group conduct demonstration tests of new sequential infrared and hot air drying technology for producing healthy snacks at Treasure8 Company in California.

Tom Richard, Professor, Department of Agricultural and Biological Engineering, and Director, Institutes of Energy and the Environment, Pennsylvania State University, State College, is honored for his outstanding contributions to fundamental engineering design and practical solutions for sustainable agroecosystems and the bioeconomy. Throughout his career, Richard has developed innovative engineering strategies to enhance the environmental and economic benefits of biorenewable systems. He has applied fundamental engineering science to design a range of microbial bioconversion processes, including composting, ensilage, and anaerobic digestion. Richard has developed engineering analysis for the sustainable design of systems ranging from the industrial ecology of cities to the agroecology of rural landscapes. Across all of these application areas, he has translated engineering fundamentals into practical system design and process control strategies that have been adopted by farmers, companies, and governments in countries around the world. His contributions include a range of market-based strategies that enhance the environmental performance of agroecosystems while simultaneously improving agricultural productivity, farm profitability, and rural community resilience. These have included developing new markets for perennial grasses, winter crops, and manures, with products ranging from renewable energy and materials as well as livestock feed and soil amendments. His group’s current work on sub-field economics and crop responses to stress is establishing a new paradigm for agricultural resilience in an era of increased climate and environmental risk.

Pictured above, Tom and his spouse Clare Hinrichs at a prairie refuge outside Brush, Colorado, where Tom’s family farmed and ranched for four generations.
July is right around the corner, so you know what that means: ASABE’s Annual International Meeting! The Young Professionals Community has been working hard for the past year to plan a variety of events to educate, develop, and entertain members. There are many YPC-sponsored events that you will not want to miss!

Saturday, July 11. 2020 marks the 100th anniversary of the Nebraska Tractor Test Laboratory at the University of Nebraska-Lincoln. After the Saturday celebration and tour, join us for the YPC Dinner Social at Blatt Beer & Table.

Sunday, July 12. Sunday kicks off bright and early with the YPC 5K Run / 1 Mile Walk. We have a fun route planned and prizes for each participant. Interested in development and data processing? You will want to be at the CPD session Introduction to Controller Area Network and Data Processing with MATLAB. Attend the AIM Meeting Orientation to learn about the conference and plan your agenda. During the Welcome Reception on Sunday, help ASABE end food insecurity by packing food bags with the Omaha Against Hunger Volunteer Opportunity.

Monday, July 13. On Monday, we will host the Guide to Professional Licensure for members interested in obtaining their PE license. We will be visiting Nebraska Hop Yard during the Local Agriculture Tour: Hops and Industrial Hemp Production. Graduate students, get to know your peers at the Graduate Student Social!

Tuesday, July 14. Tuesday is another busy day! Thinking about attending graduate school? You will want to be at Grad School 101 and the Graduate Student Professional Development Roundtable. We have a full table of local producers excited to share their farm practices with you at our Local Agriculture 101 session. The YPC Business Meeting will be held Tuesday afternoon.

Wednesday, July 15. The Department Chair Breakfast is a great way to interact with academic leaders. YPC is co-sponsoring an Engineering Ethics session with EOPD-412 on navigating ethics in the corporate world.

Have questions during AIM? Stop by the YPC Booth any time to speak with a young professional! See you in Omaha!

ASABE member Jason Schuster, Engineer, John Deere Product Engineering Center, Waterloo, Iowa, jnschust@gmail.com.

**Kenshi Sakai**, Professor, Department of Ecoregion Science, Tokyo University of Agriculture and Technology (TUAT), is recognized for his work as a pioneering world leader in the application of non-linear dynamics and chaos theory in agricultural and biological engineering. Sakai’s career began when he worked on a tractor-vibratory subsoiler system for his dissertation and found that nonlinear dynamics are ubiquitous in agricultural tractors and machinery. He had observed small-scale variability in tillage data during his PhD research and also noticed similar variability in infiltration data at UC Davis. He started to see chaos, determinism, self-similarity, and fractals all around in the field of agriculture in general and in agricultural and biological engineering in particular. He has demonstrated the presence of nonlinear dynamics in not only soil-tillage tool interaction systems, but also in alternate bearing of fruits and nuts, weed infestation in fields, citrus and pistachio yields, acorn yield, and forest ecology. He is now considered a world authority in applying the principles of nonlinear dynamics to various problems in agriculture and proposing techniques based of nonlinear dynamics and synchronization theory. Sakai has also worked tirelessly to pursue and promote international collaborative education programs between TUAT and UC Davis in advancing educational opportunities for students to broaden and deepen the quality of their experience.

_Pictured above, Kenshi and his family pose for a formal picture._
The ASABE Foundation serves as the charitable arm of ASABE, generating funds and awarding grants to aid the Society and its members in building a stronger future for the agricultural and biological engineering profession. Funds administered by the Foundation are used for scholarships, competitions, special projects, and support of ongoing ASABE programs and awards.

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

The 2020 Annual International Meeting will be held in Omaha, Nebraska. Founded in 1854, Omaha’s central location in the U.S. spurred the city to become an important national transportation hub. Today, Omaha is home to four Fortune 500 companies and has a large presence in insurance, finance, construction, transportation, and food and agriculture. The 2020 AIM will give ASABE members and their guests an opportunity to learn about this great heartland city, network with colleagues, and have some fun while supporting the Foundation in the following activities:
Gale Holloway Memorial Golf Outing  
**Sunday, July 12, 8:00 a.m. tee time**

The ASABE Foundation will continue the tradition of the Gale Holloway Memorial Golf Outing at this year’s AIM. Join us for a relaxed game at Tiburon Golf Club (https://tiburongolf.com/), about 20 minutes from the AIM site. The team format will be a four-person scramble (all play from the best shot), so all skill levels are welcome. Greens fee, cart rental, and lunch are included in the $120 cost (additional fee for club rental), and we will coordinate transportation to the course. It will be a great day out, and your participation will help support the efforts of the ASABE Foundation and promote our Society.

ASABE Foundation Dinner  
**Tuesday, July 14, 7:00 to 10:00 p.m.**

The annual Foundation Dinner will be held at the Durham Museum, which is housed in Omaha’s beautifully restored Union Station. The Durham Museum is one of Omaha’s unique treasures. The museum offers a fascinating look at the region and the U.S., with a broad range of exhibits on history, culture, science, and industry. Its affiliation with the Smithsonian Institution and strong ties with the Library of Congress, the National Archives, and the Field Museum enhance the authenticity of the exhibits. Take time to visit the displays before dinner in the stunning ballroom.

Our featured speaker will be Joe Starita, a professor of journalism at the University of Nebraska-Lincoln, who has received numerous awards for his book on Standing Bear, a Ponca chief who won civil rights for native people (https://journalism.unl.edu/joe-starita). In 2019, a statue of Chief Standing Bear was installed in the U.S. Capitol, replacing William Jennings Bryan as one of Nebraska’s two statues in Statuary Hall.

Before joining the journalism faculty in 2000, Joe spent 13 years at the *Miami Herald* and served as the paper’s New York bureau chief from 1983 to 1987. His lifelong interest in local history and culture led him back to his native Nebraska in 1992, and he began work on a book about five generations of a Native American family. *The Dull Knives of Pine Ridge: A Lakota Odyssey*, published in 1995, was translated into six languages and nominated for a Pulitzer Prize.

Joe’s book on Standing Bear, *I Am a Man: Chief Standing Bear’s Journey for Justice*, published in 2009, was the “One Book One Lincoln” selection for 2011 and the “One Book One Nebraska” pick for 2012. In 2011, Joe received the Leo Reano Award, a national civil rights award, from the National Education Association for his work with the Native American community.

The program for the Foundation Dinner includes roundtrip transportation between the AIM site and the Durham Museum, a tour of the museum, and dinner. The cost is $125 per person ($100 for students).

As you complete your AIM registration, consider including these Foundation events to add some adventure and enhance your meeting experience while advancing the good work of the Foundation. To find out more about how you can contribute to the Foundation, contact Susan Lane, ASABE Foundation Development Specialist, at lane@asabe.org.

**ASABE member and Foundation Trustee**

Mark Riley, Associate Dean for Research, College of Engineering, University of Nebraska-Lincoln, mriley3@unl.edu.

This is one in a series of articles from the Foundation Development Committee.
The Society’s Engineering Licensure committee (EOPD-414) has just announced that a Supplied Reference Handbook (SRH) is available for the agricultural/biological (ag/bio) engineering professional engineering (PE) exam. The SRH, which has been developed by a committee within EOPD-414, can be used as reference material during the exam, along with a small set of ASABE Standards. The current Standards materials are available at www.asabe.org/PERM.

The PE exams in all engineering disciplines are moving to computer-based testing (CBT), and CBT for the ag-bio PE exam will begin in October 2021. Due to the COVID-19 crisis, the last paper-based exam (originally scheduled for April 2020) has been rescheduled for October 2020. A paper copy of the SRH can be used for that exam. More information is available on the NCEES website (https://ncees.org/covid-19/). Check the rules in your state for materials that can be brought into the exam room for a paper exam.

When the ag/bio PE exam is administered electronically, candidates will use two monitors at the testing center: one monitor will display the exam, and the other monitor will display the reference material, including the SRH. The current version of the SRH has been compiled for use with the 2020 paper exam, and it will need its formatting updated for use with CBT.

The members of EOPD-414 welcome your feedback about the SRH as well as your suggestions for improvements. We particularly welcome feedback from practitioners, faculty, and anyone who completes the 2020 paper exam. The SRH has been reviewed against the bank of questions that are available for use on the exam and also covers the topics candidates will find in the exam. All future questions will be solvable by the SRH reference and ASABE standards as well.

Keep in mind that the SRH is not a comprehensive reference for all things related to ag/bio engineering nor a review manual; it contains tables, charts, and equations in each subject area. It’s only intended to provide the reference material needed for the current PE exam.

You can access the SRH at www.asabe.org/ABERM. E-mail your feedback to PE-SRH@asabe.org. Please send in your comments by November 15, 2020. Thank you for helping to make the SRH a useful tool for PE candidates and for helping to advance the profession of agricultural and biological engineering.

ASABE member and EOPD-414 chair Terry Howell Jr., P.E., Executive Director, The Food Processing Center, Lincoln, Neb., PE-SRH@asabe.org.

We Need Your Feedback
New reference handbook available for the ag-bio PE exam
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ast fall, ASABE President Sue Nokes assembled an ad-hoc committee to consider ways to improve the experience of first-time attendees at the Annual International Meeting (AIM). The committee, which was made up of representatives from the Board of Trustees, the Meetings Council, and the Young Professionals Community (YPC), among others, brainstormed ideas to help first-time AIM attendees find their way around and connect with other attendees with similar interests.

We started this process by studying AIM attendance data provided by ASABE Headquarters for 2017 to 2019, as shown in the accompanying graph. We knew that graduate students are an important demographic of AIM attendees, but we were surprised by what we learned. In the past three years, graduate students have made up more than 1/3 of all AIM attendees! With that in mind, we began to think of ways to distribute information to graduate students and their faculty advisors about opportunities available at the AIM and how they can connect with other engineering professionals.

During this process, life changed dramatically with the spread of COVID-19. In fact, as we are writing this, we don’t know if the 2020 AIM will still take place as planned. However, one thing that has not changed is the importance of graduate students, a group that is often not heard from, both in ASABE and in the engineering profession. And the COVID-19 crisis is impacting this ASABE member population more than any other.

As of this writing, all 50 states have reported cases of COVID-19, and guidelines have been issued for the entire U.S. population to practice social distancing. Most states have established even stricter rules, calling for everyone, except essential workers, to stay home. This is a crisis that most of us had never imagined, much less prepared for. It favors those with ample resources, such as comfortable homes, surplus food, and extra cash. Most graduate students do not enjoy such resources while pursuing their studies. Those of us who attended graduate school can still tell funny stories about clunker cars, rundown apartments, and ramen noodle dinners.
This is different. Graduate school was already stressful. Now graduate students have to learn quickly how to teach their classes and perform their own coursework online, while adapting their research programs to limited university access. How will they complete their graduate studies, now that most laboratory and field experiments are on hold indefinitely? And what will the job market look like, as the U.S. and other countries struggle to emerge from the recession, or the depression, caused by the COVID-19 crisis? The uncertainty surrounding our economy and our healthcare system means that the graduate student lifestyle is more scary than humorous. That added stress, combined with isolation from friends and family, can lead to mental health concerns.

As with so much of this crisis, solutions to the challenges facing our graduate students are not clear. However, we are confident that university faculty and administrators will do all they can to ease the burdens facing their graduate students. Others in industry or government can also play a role by reaching out to graduate students. In the next few years, many of us will have the opportunity to mentor or hire these recent graduates. The unprecedented circumstances of 2020 will have an impact on their resumes. It will have an even greater impact on their attitudes, and their fears.

When we emerge from the COVID-19 crisis and reconvene at the AIM, please give special attention to the graduate students who attend. Most of them will have overcome great obstacles—much greater obstacles than the rest of us did—to obtain the research results that they present. We can support them by welcoming them as peers, helping them engage in committee work, introducing them to colleagues with similar interests, or just by offering them a cup of coffee and a little encouragement.

ASABE member Erin Webb, P.E., Agricultural Engineer, Oak Ridge National Laboratory, Oak Ridge, Tennessee, webbeg@ornl.gov, and ASABE member Julie Carrier, Professor and Head, Department of Biosystems Engineering and Soil Science, University of Tennessee, Knoxville, dcarrie1@utk.edu.

Views expressed are solely those of the authors and do not necessarily represent the views of ASABE.
ASABE ANNUAL INTERNATIONAL MEETING
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May/June 2020

2020 GUIDE TO CONSULTANTS

PUBLISHED BY AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS
This Guide to Consultants is presented as a service to people interested in agricultural and biological engineering assistance. This listing is not an offer or advertisement to provide engineering services in any state or jurisdiction where the professional engineer or professional engineering firm is not registered/licensed. All information was provided by the listed consultant. The American Society of Agricultural and Biological Engineers (ASABE) assumes no responsibility for the validity of the qualifications listed or the consulting services performed.

Listings for both registered professional engineers and consultants who are not registered engineers are included. In the United States, the registration/licensing of professional engineers is vested in the states/territories. Administration of the relevant laws governing the practice of engineering is assigned to engineering boards. The primary role of these regulatory boards is to protect the life, health, property, and welfare of the public and to ensure that unqualified individuals do not practice engineering. Many other countries also have laws and regulations pertaining to the practice of engineering. When selecting a consultant, it is recommended that any jurisdictional registration/licensing requirements be identified for specific services.

In the following listings, the date after the specialty description is the professional engineer’s initial registration date. The state(s) or country in which the consultant is registered follows the date. The consultant’s availability is given on the next line, including geographic area of service.

Indication of registration in a single state does not imply that a professional engineer cannot be registered in other states. Most state engineering registration laws and rules are patterned after guidelines prepared by the National Council of Examiners for Engineering and Surveying, P.O. Box 1686, Clemson, SC 29633, USA, www.ncees.org. Most states have laws that permit a professional engineer to become registered in other states, either temporarily or permanently, without re-examination. Consideration of the consultant should be on the basis of the consultant’s qualifications and not on where registered, because many consultants can obtain registration in other states or jurisdictions.

Consultants who are not registered professional engineers may have qualifications and expertise in areas other than those requiring professional registrations. Prospective clients should always confirm, through independent sources, the qualifications of all consultants for the services to be performed.
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<td>Maurer-Stutz, Inc.</td>
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<td>Neosho Engineering &amp; Technology 20475 Udal Road Stark, KS 66775, USA 620-754-3500</td>
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<tr>
<td><strong>Ivan Droessler, P.E.</strong></td>
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<tr>
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Initial date of registration 1977; IA, OK, IL, KS, OH, ID, CO, MO, MN, MS, WI, NC, KY, NE, PA, IN, MI, NJ, AR, MD, TN, AL, VA, CA, NY, WA, WY Available full-time; Domestic and International
Other Consultants

**Nellie J. Brown, M.S., C.I.H.**
Director of Workplace Health & Safety Programs  
Lead Programs Manager  
Cornell University, ILR School  
617 Main Street, Suite 300  
Buffalo, NY 14203, USA  
716-852-1444 ext 111  
njb7@cornell.edu  

Nellie Brown is a certified industrial hygienist, providing health and safety training and technical assistance. She developed a process failure and hazard assessment protocol for anaerobic digesters used for processing manure and generating electricity on dairy farms. Nellie serves on an ASABE committee developing a standard on manure pit ventilation.

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