**ever wonder about all the changes in the world around you? I do, and I admit I question if all are positive. But as engineers, we work to effect change—to make improvements to our world, even if the stereotypical image of an engineer is often someone who resists change.**

The basis for engineering is scientific facts that do not change, and our challenge is to use those principles for solving problems in new ways. The feature articles in this issue are excellent examples of using basic principles to solve issues.

I celebrated E-Week, helping judge the Future Cities Competition (http://futurecity.org/), and presented ASABE awards for Most Sustainable Food Production System and Best Use of Renewable Energy. It was inspiring to see the very talented 6th, 7th, and 8th graders’ projects, which creatively applied future technologies to address today’s food, energy, water, and health nexus issues. Recurring themes in their model cities included food production from advanced traditional farms to high-production facilities within urban centers—vertical gardens maximizing sunlight and rainfall, green roof gardens, hydroponics and aeroponics used in conjunction with aquaponic seafood farms, and fruits and vegetables harvested by sensor-equipped agribots ensuring optimum quality and nutrition. Future energy-conserving technologies and renewable energy sources were depicted—solar, tidal, wind, and geothermal, along with futuristic piezoelectric technology applied to walking path surfaces, shoe soles, and bicycle tires. Imagine private vehicle transportation by high-speed hyperbots and autonomous public-use electric cars for in-city transportation. Envision centralized waste collection systems with a vacuum tube network from point of origin to a central facility, collecting wastes for separation and conversion to energy and usable materials. Visualize adequate fresh water for personal use and food production using extensive gray water management by silver thread nanotechnology purification, rainwater harvesting from green roofs and porous media surfaces, and water from energy-efficient desalination in coastal areas combined with surface water where available.

Recognizing the importance of public spaces for healthy individuals and social systems in increasingly dense urban settings, attention was given to food producing and energy collecting areas as inviting public spaces. Conceive of public health monitored by chip implants improving diagnosis and delivery of health care. Dream of earthquake-prone buildings with ultra-high-strength graphene reinforcing materials, and carbon fiber wraps for existing structures with seismic invisibility cloaks to virtually eliminate risks.

At first glance, some of the proposed applications and their capacity to meet production requirements appear more imaginative than realistic. However, they are the result of brainstorming solutions to issues, making use of potential technologies. These are the first steps in the engineering design process (developing solutions once requirements are known) and the path that virtually all innovations follow.

On a somewhat less futuristic track, if you haven’t seen the new IMAX movie “Dream Big,” go see it, and take along one or two engineers of the future. Produced in partnership with ASCE and Bechtel Corporation, the film focuses on ways that engineers have made and are working to make our world a better place.

Let me know your thoughts at mherron@myasabe.org.

Maynard Herron, P.E.
FEATURES

4 Biomass Flowability
The bane of biomass feedstock engineers
James Dooley, P.E.

8 Solar Cooking
From the past and into the future
Paul Funk

10 New Ag Engineering Program at University of Wisconsin River Falls
Laura Walsh

12 Reducing Post-Harvest Loss in Developing Countries through the Feed the Future Initiative
Rumela Bhadra

16 ISO Standards for Mowers and Balers: A Success Story
Eur Ing Keith J. Hawken

18 The U.K. and the E.U.
Keeping up standards
Landwards interview with Keith Hawken

20 Bioenergy Crop Profitability through Equipment Innovation
Doug Otto, P.E.

UPDATE

24 Moisture meter will help prevent grain losses

25 Land-use planning is more efficient with targeted tools

26 Breeding resilience into plants

27 Yeast is good for a lot more than bread

DEPARTMENTS

2 From the President/Events Calendar

22 ASABE Foundation Work in Focus
Double donation makes a difference, twice over
Michael Hirschi

23 Meet the Fellows: Honoring the Newly Elected

28 YPC News & Notes
Funding the Future of ASABE

29 Professional Listings

30 New Member Last Word
Growing into Ag-Tech
Jeff Lorton
Poor feedstock flowability was identified by the U.S. Department of Energy’s Bioenergy Technologies Office and by the USDA as one of the critical issues limiting success in the emerging bioeconomy. Traditional analytical and laboratory flowability metrics are proving to be of little use for designers of hoppers, feeders, mixers, and other essential processing equipment. Even with advanced modeling tools, the performance of biomass hoppers and feeders is rarely successful on the first try. The best designers and builders have decades of experience and a junkyard full of lessons learned.

Major scale-up and start-up problems at cellulosic biorefineries and biomass processing facilities are being traced to feedstocks with poor flowability. Augers stall, drive motors burn out, hoppers bridge, mixers plug—the litany goes on and on. Many of the agricultural and biological engineers who are designing facilities for the advanced bioeconomy have a background in grain handling, and they dream of a time when biomass feedstocks might flow like corn, wheat, rice, or marbles. Unfortunately, ground corn stalks and shredded poplar trees behave more like matted cat fur than marbles.

It’s a running joke in my company that we have never designed and built a biomass feed hopper that worked without many artisanal modifications and iterations. If we build a hopper, we have to add a platform for a human assistant, who uses a big stick to keep things flowing.

There are two solutions to the problem of flowability. One is to preprocess fibrous biomass materials into particle forms that have better flow properties and less propensity to interlock. The other solution is to quantify the physical properties of available biomass feedstocks in engineering science terms and develop better analytical models to enable design of equipment and handling systems that actually work. This article is a summary of current research in biomass flowability.

Making biomass flowable

ASABE member David Lanning at Forest Concepts is leading an effort funded by the Bioenergy Technologies Office of the U.S. Department of Energy to design biomass comminution and screening equipment that produces flowable feedstocks. The Crumbler® rotary shear machine, which received a 2016 AE50 Award, operates in tandem with optimized screening to produce feedstocks that have low aspect ratios, uniform cross-sections, and low compressibility—all of which improve flowability. This machine system and knife mills from other manufacturers are gaining market share. However, although new comminution methods can improve flowability, the best materials produced by these innovations are still marginally flowable compared to corn and small grains.

Idaho National Laboratory (INL) has been working on technologies that blend biomass materials into pelletized “uniform format feedstocks” that can be handled like conventional fuel pellets. This approach deals with flowability at the biomass source and at depots close to the source. Biorefineries can then use material handling technologies from the established wood pellet industry.

Although the INL approach greatly reduces downstream issues, those who convert raw biomass and wood chips to densified pellets still face the flowability problem. ASABE Fellow Shahab Sokhansanj at the University of British Columbia and team members at the Oak Ridge National Laboratory in Tennessee are studying the interactions of biomass grinding and flowability characteristics. In particular, they seek to understand the relationships between particle size, shape, and flow properties.

ASABE member Amit Kumar and associates at the University of Alberta in Edmonton have been developing workable methods for transporting biomass feedstocks in

Flowable 2 mm poplar wood feedstock from Forest Concepts’ Crumbler® rotary shear machine (left) compared to non-flowable and clumpy material produced by a hammer mill (right). Photos by Forest Concepts.
pipelines using water slurry. Pipeline transport over long distances presents unique challenges that are associated with feedstock physical properties. The same mixing, slurry stability, compressive dewatering, and feedstock issues are present within the short-distance piping, pumping, and mixing unit operations of biorefineries.

Flowability testing and modeling

Research engineers around the world are extending their understanding of flowability from related work with minerals, soil, powders, and grain to the problems of biomass feedstocks. They are finding that some flowability metrics, such as the Hausner index, angle of repose, and aspect ratio, correlate well with the observed relative flowability of biomass. Laboratory equipment for quantifying internal shear properties, hopper friction angles, and the like is being applied with variable success to biomass. However, to go beyond saying that one material flows well while another flows poorly, much new research is needed. This will enable engineering of biomass handling and processing equipment that is not negatively impacted by feedstocks that do not flow well.

Researchers at the Department of Energy’s INL Biomass Feedstock National User Facility (BFNUF; https://bfnuf.inl.gov) in eastern Idaho use the facility’s characterization laboratory to develop high-quality data on biomass physical properties that affect feedstock handling. Physical characterization includes methods to measure particle density, bulk density, compressibility, elasticity, unconfined yield strength, effective angle of internal friction, wall friction angle, and permeability. Researchers determine the 3-D size and shape distributions of particles, as well as the storage modulus and loss modulus of slurries and pastes, using automated digital imaging.

INL also includes the Process Demonstration Unit (PDU), a full-size, fully integrated feedstock preprocessing system. The PDU allows BFNUF scientists to empirically measure the feeding and handling behavior of particulate solids using a suite of custom augers and hoppers. Researchers can test the flowability of biomass materials using a specialized hopper with a continuously adjustable outlet that makes it possible to characterize materials in-line and in real-time for quality assurance and control. Empirical research and experiments with the PDU help engineers get closer to success in materials handling on their first try with specific materials of interest.

Idaho National Laboratory's Process Demonstration Unit is a full-scale, fully integrated preprocessing system. The PDU allows researchers to measure the feeding and handling behavior of particulate solids. Photos courtesy of Idaho National Laboratory.
Álvaro Ramírez-Gómez at the Technical University of Madrid in Spain is developing engineering data on how the physical and mechanical properties of biomass affect flowability, the design of storage facilities, and the like. Physical and mechanical properties are determined at the particle level for use in numerical models based on the discrete element method and at the system-of-particles level for use in numerical models based on the finite element method. These numerical models allow researchers and engineers to study the flow patterns and pressures that develop in storage facilities. Properties determined at the particle level include Young’s modulus using a texture analyzer, the true density, the particle-particle restitution coefficient, and the particle-wall coefficient of friction, among others. System-level properties include bulk density, angle of repose, angle of internal friction, etc., depending on the nature of the biomass material. Full-scale tests are also carried out in a test facility that includes three silos with different eccentric hoppers for understanding and validating the load distribution of stored materials during filling and discharge.

Dr. Ramírez-Gómez is a member of a European flowability working group that includes five universities. The Bio4Flow consortium collaborates on feedstock handling research for biorefineries (www.bio4flow.com). Another Bio4Flow consortium member, the Wolfson Centre for Bulk Solids at the University of Greenwich (www.gre.ac.uk/engsci/research/groups/wolfsoncentre/home), has world-renowned laboratory facilities for quantifying the flow properties of biomass materials. Current research includes developing methods to measure the tensile strength of clumps and bulk fiber solids. Tensile failure of particles and small clumps from larger bulk biomass at discharge openings may lead to better engineering designs for hoppers and feeders.

In the private sector, Jenike & Johanson (http://jenike.com/) is a world leader in the design of hoppers and biomass feedstock handling systems that work (unlike our own company’s hoppers that often don’t!). Jenike has perfected the application of the discrete element method to design hoppers, chutes, augers, and the like for biomass materials. They also have large-scale physical modeling capabilities and the most comprehensive and multi-continent infrastructure of test laboratories for flow properties.

Jenike & Johanson is not alone in developing models for the flow of particulate materials. The ASABE Technical Library currently lists more than 80 documents related to the use of discrete element modeling for various materials, including biomass feedstocks.

The bioprocess engineering laboratory at Auburn University, led by ASABE Fellow Oladiran Fasina, conducts studies and quantifies the physical properties that are needed in the design and selection of equipment and systems for handling, processing, storage, and transport of biomass feedstocks. Some of these properties include bulk density, tap density, compressibility, particle size and size distribution, fluidization, flowability, cohesion, angle of internal friction, and angle of wall friction. Unlike most other researchers, Dr. Fasina is exploring the effects of moisture content and particle shape on these properties because (1) biomass feedstocks are biological and therefore they exchange moisture with the environment, and
(2) particles of ground biomass feedstocks are non-uniform in size and shape. This multi-sized nature of ground biomass particles makes it difficult to measure the flowability of biomass feedstocks with shear-type testers, which are typically used for quantifying the flow properties of bulk materials. The Auburn lab is gaining recognition for its finding that compressibility testing is a better predictor of flow properties of multi-sized and non-spherical materials, such as biomass feedstocks.

At West Virginia University, ASABE member Kaushlendra Singh has first-hand experience with the difficulties of feeding woody biomass and poultry litter into gasifiers. To him, statistical size descriptors are insufficient. He has found that just one or two long, thin pieces in an entire load of fuel can clog the feeders and jam the augers—a piece as big as a new pencil can pass through a 9 mm screen opening. With poultry litter, the problem can be particle cohesion due to chemical bonding or surface moisture. Dr. Singh is currently studying the flowability and friability of biochar products that easily break down to dust during handling and spreading with conventional equipment.

Poor flowability is not just a problem for those who handle biomass such as corn stalks, bagasse, and wood fiber. Fiber-rich fractions from milling grains for corn ethanol biorefineries have flowability issues as well. ASABE Fellow Kasiviswanathan Muthukumarappan (aka Muthu) at South Dakota State University and his colleague ASABE member Kurt Rosenstrater at Iowa State University are developing engineering data for a corn milling co-product: distillers dried grains with solubles (DDGS). The flow of DDGS often becomes restricted by caking and bridging, which occur during transport and storage. These issues probably result from a number of factors, including storage moisture, temperature, relative humidity, particle size, time, and temperature variations. The flow properties of DDGS (including cohesion, effective angle of friction, internal angle of friction, yield locus, flow function, major consolidating stress, and unconfined yield strength) have been studied using the Jenike shear tester. In addition, the Carr powder tester has been explored to measure various flow properties of DDGS. A simple yet robust model was developed by combining the important flow properties obtained from conventional Carr and Jenike tests using dimensional analysis and response surface modeling. However, the current model was based on DDGS from just one ethanol plant. Actual DDGS flow properties will be different for each plant due to the host of factors mentioned above.

In addition to exploring physical properties to explain flowability, Dr. Muthu is looking into the surface chemistry and potential adhesion properties of DDGS. Staining of DDGS particles indicated a higher amount of surface layer protein compared with carbohydrate thickness in DDGS particles that had a lower flow function index (which indicated potential flow issues). The glass transition and sticky point temperatures of DDGS have also been analyzed. Stickiness of DDGS increased with an increase in moisture content, indicating flow problems resulting from moisture. A step toward understanding DDGS flow using intelligence-based modeling tools was attempted. Neural network modeling was successful in predicting the behavior of key flow properties of DDGS as a function of multiple environmental and storage variables.

Hope flows

The good news that this summary delivers to ASABE members and other engineers who design facilities and equipment for the new bioeconomy is that a bunch of really smart people are working on the flowability problem in all corners of the globe. Some are developing equipment that comminutes fibrous biomass raw materials into feedstocks with improved flow properties. Others are improving our understanding of the physical, mechanical, and surface chemistry properties that affect the flowability of biomass feedstocks. All of this work comes together to enable advanced modeling and mathematical solutions that inform the design of hoppers, mixers, piping, and material handling systems.

Someday soon, our engineering team at Forest Concepts may even design a hopper and feeder system that actually works on the first try.

ASABE Fellow and Past President Jim Dooley, Chief Technology Officer, Forest Concepts, LLC, Auburn, Wash., USA, jdooley@forestconcepts.com.
Few Americans can imagine waking before dawn, heart pounding, anxious about finding enough fuel to prepare the day’s meal for their family. This reality affects over two billion people in parts of Africa, Asia, and Latin America where cooking fuel, primarily wood, has become increasingly scarce. The people who forage for wood in rural areas are primarily women, and the cost can be twenty hours per week. In urban centers, some families spend more money buying charcoal for cooking than they spend on food. Environmental costs include soil erosion and desertification from the decreased rainfall associated with deforestation. Even worse, the smoke from cooking fires in unventilated dwellings results in a staggering health cost: the World Health Organization estimates that over four million people, mostly women and children, die prematurely each year from heart disease, stroke, pneumonia, emphysema, and lung cancer caused by indoor air pollution. That’s twice the combined annual mortality from HIV/AIDS and malaria. But there is an elegant alternative.

A brief history

Before the U.S. declared its independence from England, Swiss scientist Horace-Bénédict de Saussure was using a solar hot box to demonstrate the greenhouse effect and cook food. In the 19th century, astronomer and aviation pioneer Samuel Pierpont Langley, who also served as Secretary of the Smithsonian Institution, cooked on Mt. Whitney using solar energy. French mathematics teacher Augustin Mouchot, who demonstrated industrial applications for solar energy at the 1878 Universal Exhibition in Paris, provided the Foreign Legion with solar cookers. In the 20th century, Hungarian-American scientist and inventor Mária Telkes worked on solar energy at the Massachusetts Institute of Technology, and some of her designs were featured in Popular Science during the 1960s. Mass-produced variants of her design occasionally turn up at garage sales.

In the 1970s, Barbara Kerr, an inventor in Arizona, developed an inexpensive solar cooker made from cardboard boxes and later helped launch the non-profit organization now known as Solar Cookers International (SCI). SCI hosts a web site (www.solarcookers.org) with an encyclopedic collection of information about solar cooking projects, contact information for experts in 133 countries, project implementation guidelines, solar cooker designs and plans, news archives, and thousands of photos. SCI’s international conferences have been a catalyst for cooperation, and its monitored projects have been a source of sound data on adoption and use. And there are other organizations with similar goals, because solar cooking only makes sense: on most days, in most parts of the world, the energy required for a family to cook a meal arrives at their doorstep, emissions free, and at no cost!

A variety of designs

Sunlight is converted to heat when it is absorbed by a dark surface. There are three categories of solar cookers designed to perform this task: box-type, concentrating-type, and panel-type.

The well-insulated box-type solar cooker bakes like an oven. These designs have a clear plastic or glass lid, some have one or more flat mirrors, and most only require an adjustment to face the sun every hour or two. Some versions can hold multiple cooking vessels, and most have an effective cooking power in the range of 50 to 200 W. Because they cook slowly, similar to an electric Crock-Pot®, users can attend to other tasks while the sun does their cooking.

The high-power concentrating-type solar cooker is like a range top or grill. Most designs have a parabolic mirror focused on an uninsulated pot in which water can boil in as little as 20 minutes and oil can reach frying temperatures. A concentrating-type cooker requires more frequent adjustments to follow the sun, so the user must often stand in the sun to use it.
Panel-type solar cookers—the third category—typically have multiple flat reflective surfaces arranged around a cooking pot. The pot may also be enclosed in a clear container to reduce heat loss. This design is favored for refugee and disaster relief because panel-type cookers can be mass produced for as little as $5 each, although more durable designs are available at higher prices. More complicated systems involve some type of heat transfer fluid, and these designs are more common in South Asia. Solar cookers that even work at night will be introduced soon. Current research is focusing on devices that extend the cooking opportunity into the evening through heat storage, in many cases using phase-change salt solutions.

Today, there are hundreds of solar cooker designs all over the world. Several designs are mass-produced by the tens of thousands, and two designs each exceed half a million copies. Solar cookers are widely used in refugee camps and at disaster sites. The Delicias del Sol restaurant in Villaseca, Chile—an arid region where fuel wood is scarce—prepares all its meals with solar cookers. Large-scale commercial solar cookers are used to prepare thousands of meals a day at many ashrams and army bases in India, reducing the need for imported fossil fuels.

Solar cooking can also support new businesses. Because box-type solar cookers are capable of baking, they can be the foundation for women-owned micro- Enterprises, bringing baked goods to areas where such products were previously unavailable. With the lid ajar, box-type cookers can also dehydrate foods, thereby preserving perishable crops like fruit or fish for storage or for transport to distant markets.

Engineering colleges at some universities have used solar cooker design competitions as a “mini capstone” in first-year courses to introduce freshmen to the challenges of balancing competing performance measures such as cost, durability, and cooking speed. Students particularly enjoy working on a project that has the potential to meet basic human needs.

The future of solar cooking

Given the need, history, and potential, it’s surprising that solar cooking has not become ubiquitous. Is it because not everyone has access to a sunny spot, or because the sun fails to shine at night and on cloudy days? Is it because the entry cost and risk are prohibitive, even in places where cooking fuel is costly? Is it because the people who would most benefit are mostly poor? Advocates who once hoped that major development agencies would promote solar cooking now realize that direct sales can provide the shortest route to meeting a significant portion of the world’s domestic energy needs with clean, renewable solar energy. In any case, there is still plenty of engineering work to do if 2.6 billion people are to be connected with a device that’s appropriate for their varying cuisines, customs, and climates. There is also much work to do to facilitate people’s transition to cooking with solar energy, necessitating cooperation with social scientists.

Agricultural engineers are well prepared to understand the potential of solar cooking and contribute to the development of this technology, which is at the intersection of renewable energy and food preparation. Agricultural engineers are also well placed to collaborate with other disciplines to ensure that this task is done well. Since 2003, our Society has hosted a voluntary standard for solar cookers (S580.1: Testing and reporting solar cooker performance, available at www.asabe.org/media/200979/s580.1.pdf). To facilitate innovation and communication of this technology and address an important global issue, ASABE’s Board of Trustees recently made this standard available to the public at no cost.

It has been exciting to watch the solar cooking industry grow over the past 25 years, and to sense that even greater growth is at hand. Solar cooking has a bright future!

ASABE member Paul Funk, USDA-ARS Southwestern Cotton Ginning Research Laboratory, Mesilla Park, N.M., USA, paul.funk@ars.usda.gov.

Dr. Funk earned degrees in agricultural engineering at the University of Minnesota and the University of Arizona while conducting research on solar cooking. He worked on various designs, visited four continents, and participated in the development of the test standard.
The University of Wisconsin-River Falls (UW-River Falls) welcomed 22 students into its new agricultural engineering program in fall 2016. The new program was an outgrowth of the Northwest Wisconsin Engineering Consortium, a joint effort by UW-River Falls, UW-Eau Claire, and UW-Stout to bring a range of engineering programs to western and northern Wisconsin. This collaborative effort was a response to the many small and mid-size companies, as well as local operations of global corporations in northwestern Wisconsin, that have had a difficult time attracting and retaining graduates of engineering programs from outside the region. The Consortium campuses are taking a rational approach to adding new engineering programs, including offering a common first-year core curriculum that allows students to transfer freely between programs if they choose. Until the Consortium was established, the only UW campuses with engineering programs were clustered in the southern part of the state, 200 miles from the Consortium campuses.

UW-River Falls chose to add an agricultural engineering program to complement its long-standing, successful program in agricultural engineering technology. The two programs are housed in the College of Agriculture, Food and Environmental Sciences. The River Falls campus, with an enrollment of just under 6,000 students, is well known for its agriculture programs and is a destination for students in the region who are looking for these programs at a smaller campus.

A drawing card

Students in the new ag engineering program confirm that they were drawn to UW-River Falls because they had heard about our agriculture programs or they were specifically looking for an ag engineering program and preferred a smaller school. One concern was whether the new program at UW-River Falls would divert students from the other ag engineering program in Wisconsin, at UW-Madison. Both campuses were pleased to discover that did not happen. The Department of Biological Systems Engineering at UW-Madison enrolled its largest-ever freshmen class last fall, despite the new program at UW-River Falls.

The university showed its commitment to the new program by providing funds to renovate and upgrade laboratory spaces, purchase new equipment, and hire additional faculty. For a small campus, the department is fortunate to have nearly 20,000 ft² of laboratory space in the Agricultural Engineering Annex, which is connected to the larger Agricultural Sciences building. Over 4,500 ft², encompassing two laboratories and an additive manufacturing space, were renovated in summer 2016. Formal planning will start this spring to renovate a similar-size space in 2018.

With the addition of a new faculty member in fall 2016, there are now five engineering faculty on staff, with plans to add another by fall 2018. The faculty members have expertise in agricultural engineering, mechanical engineering, civil and environmental engineering, bioprocess engineering, and biosystems engineering. Together, the faculty has more than 25 years of industry experience, ensuring that the new program will be industry relevant. There are no teaching or laboratory assistants; faculty members teach all the lecture and laboratory sessions, including laboratory sessions that take place at the university farm or in one of the three food processing pilot plants on campus.
Industry connections

Our successful program in agricultural engineering technology has prided itself on strong industry ties, bolstered by a long-standing internship program in the College of Agriculture, Food and Environmental Sciences. Industry support was key to getting approval for the new ag engineering program. This partnership will help ensure that the ag engineering program remains industry relevant. Oxbo International and GEA Process Engineering were among the industry advocates for the new program. Oxbo is a world leader in specialty harvest equipment for niche markets (olives, berries, coffee, peas, etc.) with a facility in Clear Lake, Wisconsin. GEA Group AG (the parent company of GEA Process Engineering) is headquartered in Germany and is one of the largest suppliers of process technology for the food industry. Their facility in Hudson, Wisconsin, focuses on membrane filtration and is the technology center for their global filtration business.

Accreditation on the horizon

Accreditation is important for engineering degrees, regardless of the field. Following the Accreditation Board for Engineering and Technology (ABET) process, accreditation will not be formally granted until our first class of students completes the ag engineering program and meets the degree requirements. The faculty members are working with accreditation coaches to help ensure that the new program will be granted ABET accreditation when those first students graduate in 2020. When this goal is met, UW-River Falls will be the 40th school in the U.S. to offer an ABET-accredited program in agricultural or biological engineering.

Realizing that there are synergies between engineering programs, UW-River Falls had originally requested permission to add both an agricultural engineering program and an environmental engineering program. Both programs would align well with our existing facilities, faculty expertise, and the curriculum of the agricultural engineering technology program. All three campuses in the Consortium requested multiple engineering programs, but in the end each campus was given permission to add a single program, with the option to request another program in the future if the first program is successful. With the success of our new ag engineering program, UW-River Falls intends to pursue a second engineering program as soon as possible.

Laura Walsh, Administrative Program Manager, College of Agriculture, Food and Environmental Sciences, UW-River Falls, Wis., USA, laura.walsh@uwrf.edu, www.uwrf.edu/cafes.

MEET MEMBERS OF THE INAUGURAL AGRICULTURAL ENGINEERING CLASS

Virginia Lee — Mequon, Wisconsin

“I knew some students who had gone to UW-River Falls, and I knew that I wanted a smaller school with an agriculture program. When I visited, I immediately loved the campus! I was in 4-H but didn’t grow up on a farm—but I’m not letting that keep me away from agriculture. My passion is fighting world hunger and thirst, and through our Intro to Engineering class, I’ve learned about local career opportunities connected to international work. In just these past few months, I’m more encouraged and more excited about my career choice."

Julia Rogers — St. Paul, Minnesota

“I was a bit familiar with UW-River Falls, but I chose to come here because of this program. I’m very interested in how food can be produced using fewer resources. In our Intro to Engineering class, we had to write a mock undergraduate research proposal. I submitted mine to one of the programs on campus, and it was funded! I’ll be working with one of the faculty on this project—small-scale aquaponics production."

Madison Schochenmaier — Waconia, Minnesota

“I like the mechanical side of agricultural engineering and working with machinery. I wanted a smaller school and found UW-River Falls through a Google search. So far, I’ve found the faculty easy to talk to. Because it’s a smaller program, I can get to know everyone, and I know people I can go to when I have questions. I’ve already been offered the opportunity to work as the student lab technician in the 3D printing lab."

Matthew Wech — Green Bay, Wisconsin

“I checked out other campuses, but knew I wanted a smaller school. There are few small schools that offer agricultural engineering. I like the smaller classes, getting to know the faculty, and being comfortable asking for their help. My particular interests are mechanical systems, biofuels, and energy.”
The Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss (PHLIL), housed at Kansas State University (KSU), is a research and education program aimed at improving food security by reducing post-harvest loss of seeds and staple crops, such as grains, oilseeds, and legumes. Feed the Future is the U.S. Government’s initiative for food security and ending global hunger in developing countries. PHLIL’s efforts are focused in four Feed the Future countries—Bangladesh, Ethiopia, Ghana, and Guatemala—as well as Afghanistan as a short-term engagement. The major goals include:

- Increase the understanding of post-harvest work in rural communities and develop technologies that are usable by all household members.
- Improve drying, handling, and storage technologies to reduce infestation by insects, mold, and fungus.
- Develop technologies with low acquisition costs and limited footprints that are sustainable and accessible to poor farmers.
- Develop creative tools that help non-literate farmers understand and implement the technologies developed as part of the project.
- Develop a standard protocol for conducting baseline surveys of mycotoxin contamination in agricultural products in different countries.
- Increase the quantity and quality of stored food to improve food safety and security for poor farmers.
- Develop strong partnerships with local NGOs to spread information about these technologies to farmers throughout the targeted regions.

The PHLIL team has a wide variety of partners—universities in the U.S. and other countries, governmental agencies including the USDA-ARS and USAID, private companies like John Deere and GrainPro, and non-profits like the ADM Institute for Prevention of Post-Harvest Loss at the University of Illinois and SHARE in Guatemala. The full list of the partnering institutions can be found on the PHLIL website (www.k-state.edu/phl). KSU houses the management for this international effort.

Sustainable, low-cost grain storage

After a crop is harvested, it must be stored. Pests cause post-harvest losses of 30% to 80% of staple crops and are a major threat to global food security. Some of the grain storage technologies being deployed in by the PHLIL program are ZeroFly® pesticide-impregnated bags, Purdue Improved Cowpea Storage (PICS) bags, and GrainPro® Super Bags. These bags have been proven to protect grain and eradicate common pests. Plans are for mass-scale adoption and sustainable production of these bags in the focus countries. Local grain storage vessels made of terracotta materials and converted plastic water storage tanks are also being tested and evaluated for each country depending on their availability, cost of production, and efficacy in suppressing insect spoilage of stored products for a significant period.

Bhadiraju Subramanyam of KSU (second from left) and Rizana Mahroof of South Carolina State University (far right) work with students Haile Alebachew (far left), Tesfaye Tadasse (center), and Ethiopian technical agent Dereje Ayalew Zewudie (second from right) to sieve insects from white maize at Bahir Dar University.
KSU Distinguished Professor Bhadriraju Subramanyam, whose specialty is stored grain and insect pests, has been heavily involved in Ethiopia, training students at Bahir Dar University and Mekelle University, and establishing curricula for reducing post-harvest losses. As lead scientist for PHLIL’s Ethiopia project, Dr. Bhadriraju has helped build the two universities’ entomology labs from scratch. After two years of careful training, students are ready to help local farmers with pest control and improved grain storage.

Efficient crop drying technology

Small-scale farmers who do not have proper crop storage facilities suffer the most losses. Traditional storage methods, such as woven baskets and clay pots, don’t prevent fungus and mold. The resulting mycotoxins can cause transitory illnesses, organ failure, immune system suppression, stunting of growth in young children, cancer, and death. Harvested grain is considered wet if the moisture content exceeds 13% by weight, and wet grain is an excellent food source for infestation. Reducing the moisture content reduces these risks and increases the storage life.

A great idea for drying grain in developing countries is the Solar Bubble Dryer, a polyethylene capsule powered by sunshine. Solar drying is economical and sustainable; however, lack of sunshine, high humidity, inconsistent temperatures, and longer drying times are challenges for small-scale farmers. To overcome these challenges, the PHLIL team in Ghana has developed a biomass hybrid solar dryer in which a biomass-fueled heater supplements the solar heat. The biomass fuel can be agricultural residue, wood waste, vegetable waste, or other combustible material. Tests are underway, and the results look promising. Up to five tons of maize can be dried within eight hours, reducing the moisture content from 25% to 12%. Future plans include gas-assisted solar dryers for improved efficiency. The team also built cost-effective plastic crop storage bins that were modified from common water bins. These bulk storage bins are being tested for resistance to mold and insect infestation in maize for up to 12 months.

Solar dryers and hybrid solar dryers are promising for countries like Ethiopia and Ghana, where there is ample sunshine. However, countries that are prone to monsoon rains, like Bangladesh, require non-solar options. To meet this need, team members in Bangladesh have developed a simple, low-cost solution. The STR dryer is composed of bamboo mats, a dryer with generator-compatible electric motors, and a combustible fuel source, such as rice hulls. An STR dryer can be assembled with simple tools and installed indoors, where it occupies very little space. In six hours, an STR dryer can reduce the moisture content in rice enough to allow safe storage for several months in tropical conditions. In the upcoming cropping season, women in four districts in Bangladesh will be given hands-on training with STR dryers.

Low-cost handheld moisture meters

Other PHLIL teams are training local staff in the four focus countries in the use of moisture meters. The Deere Foundation donated funds for the purchase of 40 handheld meters for measuring grain moisture on small farms, where crops often are harvested with high moisture content. These accurate, portable meters are an example of an on-the-shelf technology that can be applied immediately to reduce post-harvest losses for poor farmers in rural areas.
In Guatemala, the promoters of this program are representatives of our in-country partner organization, SHARE Guatemala. They live in designated Feed the Future areas and are responsible for collecting and submitting grain samples for analysis. Through training and systematic sample collection, the promoters and participant farmers become more aware of moisture management during storage.

**Mycotoxin detection and analysis**

PHLIL is actively engaged in detecting and identifying specific mycotoxins in post-harvest crops. Key toxins detected include aflatoxins, fumonisins, deoxynivalenol, ochratoxins, and trichothecenes (including T-2), which are measured with ELISA test kits donated by Romer Labs.

This effort is particularly important in war-torn Afghanistan, which once exported high-quality grapes, raisins, dried fruits, and tree nuts to international markets. Recently, receiving countries have rejected these high-value agricultural products because of fungal toxicities. Not coincidentally, many Afghans suffer from health problems that are possibly attributable to chronic exposure to mycotoxins.

In Afghanistan, wheat is a suspect food for mycotoxin contamination because it dominates the national diet, with per capita consumption topping 500 g per day. PHLIL has trained staff members of the Afghanistan Ministry of Agriculture, Irrigation, and Livestock in sample collection and detection of mycotoxins using commercially available test kits. The trainees honed their skills for six months and developed baseline profiles for wheat. Outcomes include a strong possibility for improved national health and safer agricultural exports.

**Empowering women and improving nutrition**

For women in Bangladesh, the real work begins after the rice is harvested. Women preserve, prepare, and serve their family’s food. However, unless it is dried and stored properly, freshly harvested rice will quickly become contaminated by fungi, including aflatoxins and fumonisins.

Current drying practices have changed little for thousands of years. The rice is spread on a flat surface and left to dry. The rice is turned once or twice a day with a rake, or sometimes by women simply shuffling their feet through the piles. A big improvement in this age-old process has been to use a tarp or a concrete pad under the crop. Still, drying may require several days, and the rice does not dry uniformly. And while an improved drying space (with a tarp or concrete pad) can help, renting such spaces requires a large share of the family’s limited funds. Reducing the time and money that women must spend on drying rice will allow them to use those resources elsewhere. Simple technology, such as low-cost rice dryers and effective storage methods, can greatly improve their quality of life.

**Scaling up with international partners**

PHLIL is committed to reducing post-harvest loss of staple crops, such as maize, in Ghana. To achieve this goal, PHLIL collaborated with the USDA and private companies, including Vestergaard Frandsen (in Switzerland), John Deere, and GrainPro, for initial lab-scale studies. For expansion and mass-scale adoption of the resulting technologies, Ghana signed Memoranda of Understanding with national and international agricultural organizations, including the Ghana Agriculture Technology Transfer project (ATT), Africa RISING, and SPRING. ATT has expressed interest in constructing three solar dryers for use with warehouse trials in Ghana and will purchase USDA moisture meters.
Africa RISING and SPRING will help the Ghana team collect mycotoxin baseline data. Additional pest infestation data from the warehouses and on-farm storages will be collected by ATT and SPRING. Large-scale adoption of ZeroFly storage bags (made by Vestergaard Frandsen) will be a collaborative process between the PHLIL team in Ghana and ATT, Africa RISING, and SPRING. The Ghana team has also received a $40,000 grant from the USDA Scientific Cooperation Research Program to build a biomass hybrid solar dryer. The Adventist Development and Relief Agency (ADRA) in Ghana is scaling up as well.

These kinds of collaborations are hugely beneficial for mitigating post-harvest loss. The ongoing work builds on the expertise of international agricultural programs as well as local stakeholders, local farmers, and local private industries. A surprising outcome from these collaborations was discovering how important the new technologies were to the Ghana Poultry Project (GPP), which needs grain dryers and moisture meters for quality control of its maize-based chicken feed. The new technologies allow GPP to meet the demands of important clients, such as Kentucky Fried Chicken, which now purchases about $2 million of poultry per year from GPP. Similar happy surprises are occurring across the focus countries.

ASABE member Rumela Bhadra, Research Associate, Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, USA, rumelabhadra31@gmail.com. Dr. Bhadra works under a joint collaboration of KSU’s Department of Biological and Agricultural Engineering and the USDA-ARS Center for Grain and Animal Health Research in Manhattan, Kansas. Dr. Bhadra served as the program coordinator for KSU’s Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss from October 2015 to October 2016. For current updates and information about the Innovation Lab, visit www.k-state.edu/phl. For more information on the Feed the Future Initiative, visit www.feedthefuture.gov.
Mowed fields and trimmed hedgerows are vital for planting, growing, and harvesting crops and for keeping our roads clear of encroaching vegetation. Crop gathering and storage are just as important, and our responsibility as standards developers is to provide safe machines with ergonomic designs. Consideration must therefore be given to:

- Global standards and legislative requirements.
- The safety aspects of complex machinery.
- The long-term challenges of conservation and sustainability.

ISO standards development

Standards take time to develop and years to publish. The ISO/TC 23/SC 7 group that I was privileged to steer from 2008 through 2016 has diligently worked to produce a suite of standards that will enhance the safety of new machinery. By testing in several countries, thrown-object hazards, material behavior, guarding strength and longevity, and cycle times have all been explored in the production of several standards.

The main challenges for mowers have been to (1) increase blade quality, (2) reach global parity for thrown-object testing, and (3) encompass the various sizes of machinery while taking into account the many different agricultural situations all over the world. Thrown-object testing criteria have also been applied to the road-edge mowing and highway maintenance sector.

A series of ISO standards has now reached publication (see sidebar). For pick-up balers, it was time to reduce hazards and increase safe working practices. As different bale sizes emerge and as the risk of unauthorized use appeared to be increasing, a gap in the series of requirements became obvious, and a new standard, published in 2016, was developed for bale wrapping.

Management and team building

To address the issue of thrown objects with mowers, it was necessary to pull together specific global expertise. The problem affects machines used in all countries, with many different-size machines and varied landscapes. Even the experts had little experience with standards and were typically company-oriented. Fortunately, over a period of time, the specialists came together and undertook the challenge of combining machine and safety expertise for the creation and publication of standards.

We involved testing facilities at several manufacturing bases in the U.S., Italy, Germany, and the U.K. to examine the evolving test criteria. A series of tests was conducted to replicate varying local conditions. We encouraged manufacturers to buy into the process with support for engineers, test rigs, and research. The manufacturers responded by implementing sponsorships and providing meeting facilities. Mutual enhancement of safety was the overarching goal.

Following up the mower successes, the baler issues were tackled through a similar process, but with different experts. The management of testing and research was undertaken—this time in the Netherlands and Germany, as well as in Italy, the U.K., and the U.S. again. Smaller ad-hoc groups were given research tasks for issues such as emergency stops, bale chamber guarding, and remote tractor stopping controls. A series of requirements aligned to essential health and safety legislation emerged from the work.

It was encouraging to watch the team grow. Confidence was the driver, ensuring that the team jelled, and this was enhanced through mutual respect and understanding. Because the equipment is large and appropriate locations are hard to come by, logistics were definitely a difficulty. Fortunately, management of the process was simplified by the group’s dedicated focus on the life-important issues. The enthusiasm of the participants has been remarkable. Today, the mower and baler groups are both continuing to work on further safety improvements.
Standards for mowers

Several mower fatalities had been recorded in North America, South America, Asia, and in the European community, so it was important to identify causes after gathering many statistics. A thrown-object test was needed so that new designs and innovations could include protection of the tractor operator as well as bystanders. Objects thrown at a velocity of more than 200 kph were identified as the main cause of fatalities. Development of better containment was entrusted to working groups. They developed a test for blade breakup under duress, and another for thrown objects.

Approval of the European version of the standard required four independent consultant assessments for machinery and one for noise. Each consultant wanted something different as they all tried to bring the standards into line with the varying European directives. More robust mechanical testing to validate the practical requirements managed to overcome these pressures. Semi-parallel committees, ISO/TC 23/SC 13 for domestic mowers and CEN/TC 151 for road maintenance machines, are now using the basis of the thrown-object test in their respective standards.

Standards for balers

Several issues were identified with balers when accident statistics were examined. The technical aspects included entanglement with bales of different sizes and shapes, and clearing of blockages. After a fatality occurred on a satellite arm bale wrapper, a U.K. court ordered the development of a standard that would deter a similar death from occurring again. Therefore, our team developed a new standard.

Machines were identified, and it was clear that everyone had matters to solve. Although balers are specific to harvesting and conservation, it was appropriate to introduce some tractor experts to help with the interface associated with the baler and wrapper. Testing for the development of machine safety included enhanced guarding for the feeding elements, automatic starting, feeding of twine, changing of blades, and integral pick-up. Tests were also developed for the rotating wrapping satellite arms. Although traveling at a modest 30 rpm, these were seen to cause head injuries to operators.

The results so far

Success may be seen from the reduction in fatalities and accident statistics recorded since the introduction of the more stringent safety measures listed in the sidebar. With the newly designed machines (on the market progressively since 2012), mower and baler related fatalities have dropped significantly, from around 20 per year to only one known. We await quantitative statistics from various global bodies, but preliminary indicators are promising. For example, before 2012, the U.K. recorded an average of four fatalities a year that were attributed to the machines in question, but only one fatality has been recorded in the last three years.

We continuously strive to reduce accidents. Challenges remain, but with good research, communication, and project management, the goal to provide safe machines for operators and bystanders is being achieved.

Another major success, in addition to the reduction in fatalities, is new awareness in the farming community of the need for education and training. When new products and methods emerge, some countries are now actively encouraging workshops that alert their farming communities to health and safety issues. Manufacturers are providing more information at the point of sale. New machines, based on new standards, are making a difference and ergonomically supporting productivity.

ASABE member Eur Ing Keith J. Hawken, Technical and Standards Director, Agricultural Engineers Association, Hampton, Peterborough, U.K., standardsfe@aea.uk.com.

This work has been funded by the agricultural industry in conjunction with the Agricultural Engineers Association in the U.K. The author wishes to acknowledge the International Standards Organization and the British Standards Institute for their support, and in particular ASABE member John R. Fisher from the Alamo Group, Seguin, Tex., USA. As a group, we also wish to express our gratitude and appreciation to all the project partners for their contributions during the development of the various ideas and concepts presented here.

Over the last few years, the following safety standards have been introduced by the various working groups within ISO/TC 23/SC 7:


Upcoming safety standard:
Members of the Agricultural Engineers Association (AEA) contribute to the standards and legislation process by shaping documentation and ensuring that engineering solutions are workable for industry. Heading up this function is Keith Hawken. Keith is a chartered engineer through IAgrE and the Engineering Council program. He progressed to Eur Ing status in 2008, which complemented the university and practical background he gained during his time with the Robert Bosch group. In 2016, Keith earned a doctorate in the U.S. with a concentration in mechanical engineering.

Keith has worked in industry for 43 years, completing two apprenticeships (tool maker/fitter and jig & tool design draftsman) while with Qualcast in Derby. His family had over 270 years of service with the mower company, and Keith also spent time at ATCO, as well Bosch, before joining AEA in 2000. “Standards have been a key focus of member interest since AEA was founded back in 1875,” Keith said. “In fact, BSI (British Standards Institute, the U.K. national standards body) was formed in 1901, and the two have complemented each other ever since. But the remit has grown wider over the last 50 years. Standards are not mandatory but are a great way to achieve conformity in respect of legislation.”

Over time, British national standards have gradually disappeared to become European standards, so that everyone can follow the same requirements, although the BS numbering still appears. The goal has always been to achieve global parity, and that is why you still see standards numbered BS EN ISO for use worldwide. AEA and its members contribute immensely to standards production on behalf of industry. Once an internal agreement is reached, the views of consumer groups, testing institutes, related associations, government departments, and other contributors are considered until consensus is achieved, and this is taken forward as the U.K. view. On behalf of industry, AEA holds external secretariats for five national committees, which includes addressing document control, collating comments, and uploading new work onto the BSI website, as well as balloting procedures for the U.K.

Beyond this, AEA and its member representatives also hold secretariats for the European standards committees (CEN) for mowers, hedge trimmers, all-terrain vehicles, side-by-side vehicles, etc., and three convenorships for working groups on subjects such as PTO shafts, accident statistics, chainsaws, brush cutters, lawn mowers, hedge trimmers, and other garden-related products, which are all important for maintaining the influence of U.K. industry.

In July 2016, ASABE member Keith Hawken (with his wife Lesley) received his doctorate in mechanical engineering and was one of eight recipients of the Order of the Engineer, presented by ASABE Fellow and Past President Bob Gustafson.
AEA is also a member of the Machinery Directive working group in Brussels, where decisions are made on the validity of standards within the legislative process. “This has been a real challenge,” said Keith, “As member states normally allow only government representatives to participate. But over the years, the knowledge and expertise of AEA have gradually become vital, acknowledged, recognized, and we have helped shape legislation with some common sense approaches.”

Keith recalled when he was first invited to attend. “We were not allowed to speak, but now the 60-strong membership, from all EU countries, listens to the issues that we address. In particular, the fatal accident story is much improved from when we first started, as the member states have begun to understand how complex the machinery is, and how we are dealing with this using safe designs that are prompted by work in the standards area.”

“These issues take time,” Keith said, “And much goes on in the background as we continue our quest to prevent fatalities. Now we are down to 1% of U.K. fatalities for which machine design may be a contributory factor, and we will spend an enormous amount of time and energy to reduce this even further. Mainland Europe is a different story, although many fatalities there are due to a lack of training and education. We are trying to address this with our new statistical reporting standard, which will help identify trends and areas that need to be looked at.”

Internationally, AEA has gained respect in the global standards effort. In particular, ISO (International Standards Organization) and IEC (International Electrotechnical Commission) are vital areas of interest. AEA holds secretariats for knapsack sprayers, vocabulary standards, sprayer closed transfer systems, baler and bale wrapper safety, harvesting and conservation machinery, manual forestry equipment, chainsaw and brush cutter vocabulary, as well as symbols and pictograms.

AEA members also hold various working group convenorships. After a maximum nine-year stint, Keith will shortly conclude his chairmanship of the ISO/TC 23/SC 7 testing committee, which looks after combine harvesters, foragers, mowers, balers, and thrown objects. He is also chairman of ISO/TC 23/SC 17, which looks after chainsaws, pole pruners, brush cutters, and forestry machinery, for which AEA hosted an international meeting in September 2016 that welcomed representatives from 14 countries to work through the next series of documents that will become standards.

Over 100 committees are tracked by AEA members, including interfaces with legislation and regulation. AEA sits on the Agricultural Tractors Working Group in Brussels and has contributed to new legislation on type approval. Importantly, much of the standards wording is now included in the legislation, and the ability to change is much easier than under the constraints of the E.U. trilogy of parliament, council, and commission in the past. “AEA punches above its weight in all forums,” said Keith, “And the results are for all to see, particularly the ISO and IEC initiatives, which help manufacturers sell their products globally.”

Keith’s former work as a homologation/type approval engineer involved compliance with many different regulations in different countries. “It was a nightmare trying to shore up a specification to meet various markets, but today this is much easier, and I believe it will still be fine even after we are on the periphery of the E.U.” In the last few years, a couple of European countries did not allow machines to be placed on the market despite all the certificates of conformity (European wide) to the recognized standard. “In some cases,” said Keith, “the job will not be any harder if we are out of the E.U. or in it!”

“The key is to know your product, the people involved, and how to use experience within the constraints of the system,” said Keith. “The success of the machines that are available today is due to the safety of their designs, coupled with diligent sustained testing. But we strive for more, always.”

AEA core concerns include tractors, towed implements, sprayers, ATVs, material handlers, outdoor power equipment, member research and input, development of standards, and member confidentiality. Legislation is also an active area, and AEA is working on tractor/trailer schemes, emission regulation, machine safety, and market surveillance, as well as broader issues such as overhead power line safety.

AEA works closely with other associations in Europe, including its equivalents in other countries (VDMA in Germany, AXEMA in France, and FederUnacoma in Italy) and is a member of the European Committee on Agricultural Machinery (CEMA), the European Garden Machinery Industry Association (EGMF), the European Association of the All-Terrain Vehicle Industry (ATVEA), and other groups in association with ISO and IEC.
The many challenges of rural development, environmental sustainability, and energy independence will continue to be a national priority regardless of the pressing political urgency of the day. To tackle these challenges, institutions such as the State University of New York College of Environmental Science and Forestry (SUNY ESF) have drawn support from the U.S. Department of Energy and other partners to research and facilitate the commercialization of shrub willow and other woody biomass crops.

Research on woody biomass crops for renewable energy and environmental applications has been prolific and revealed that these crops can be converted into different forms of renewable energy and environmentally friendly products that offset the use of non-renewable fossil fuels.

Co-firing harvested wood chips with other fuel sources, called gasification, can produce heat and electricity from direct combustion. Fossil fuel energy is still required to produce biomass crops. However, for every unit of fossil fuel energy used, about 15 units of renewable electricity are produced, or about 30 units of renewable heat and electricity through cogeneration.

Wood pellets, liquid biofuels, biodegradable plastics, and other green products can also be produced from woody biomass. In addition to the environmental benefits, the end uses of woody biomass provide local and regional economic benefits, including income for landowners and jobs in the local community, when these crops are converted into renewable energy and products.

The production cycle for shrub willow is relatively straightforward. After site preparation and planting with a special willow planter, the plants are cut to ground level, called coppicing, when they become dormant after the first growing season. Coppicing encourages vigorous growth and more stems per plant. Willow can grow up to ten feet in a single growing season, and a well-established root system helps the plant grow back quickly. After that, the crop can be harvested once every three to four years. A mature crop is 15 to 20 feet tall with stems that are one to two inches in diameter. Maintenance is drastically reduced after the crop is established, and each harvest yields about 25 to 30 wet tons per acre.

Harvesting shrub willow is the most expensive operation in the biomass production cycle. Research suggests that it accounts for about 30% of costs over the +20-year life cycle of the crop. In the past, willow harvesting operations had problems with equipment durability, chip size, and other technical details, adding even more cost to the equation.

CNH Industrial participates in studies of renewable energy crops and the equipment needed to produce and harvest them. The company’s innovation team has been working with willow, along with other biomass crops such as eucalyptus, in south Florida and Brazil, and with poplar in Europe and the U.S. Northwest, where poplar is also used for pulp. The company has also partnered with Iowa State University and Penn State University on miscanthus, and with Penn State on corn stover.

In addition, for more than 13 years, CNH Industrial has partnered with SUNY ESF to research and optimize the logistics of transporting biomass materials. SUNY ESF’s research played an integral role in the development of the New Holland 130FB coppice header. The header has been tested with the New Holland FR Series forage harvester to improve the logistics related to the transport of woody biomass.
This system efficiently cuts and chips one double row of willow in one pass, and the willow chips are blown into collection vehicles, such as trucks or dump wagons. This one-step process reduces costs and helps producers harvest willow and other short-rotation woody crops for biomass applications faster and more efficiently, while expanding the use of their expensive harvest equipment. This makes it a mutually beneficial arrangement that will strengthen the supply of renewable energy feedstocks into the future.

As institutions and companies develop more useful and innovative equipment for perennial biomass crop producers, they help to develop opportunities to lower delivery costs for willow and other short-rotation woody crops and make bioenergy crops more profitable. Soon enough, these economies of scale will deliver benefits that address the ongoing challenges of rural development, environmental sustainability, and energy independence.

ASABE member Doug Otto, P.E., Special Projects Manager, New Holland Agriculture, New Holland, Pa., USA, doug.otto@newholland.com.
When you win the bid on an item in a silent auction, you usually make a single-purchase donation to the charity or foundation holding the sale. However last summer, a unique item in the Foundation Silent Auction at the 2016 Annual International Meeting in Orlando gave doubly.

The item was a load of fresh potatoes, offered by Walther Farms of Three Rivers, Michigan, as a Bid to Give donation. The winning bidders, rather than hauling home literally a ton of high-quality produce, specified a food bank of their choice, and Walther Farms provided delivery—free of charge. The ASABE Foundation got a major donation via the Silent Auction, and two food banks each received 2,000 pounds of potatoes to help feed families in need.

That’s right, two tons of potatoes were sold at the Silent Auction: one ton to ASABE member Mike Hirschi and his wife Debbie, and another ton to ASABE Fellow, Past President, and Foundation President Bob Gustafson and his wife Yvonne. The Hirschi’s potatoes were donated to the Eastern Illinois Food Bank (EIFB) in Urbana, Illinois, and the Gustafson’s potatoes were donated to the Mid-Ohio Food Bank in Grove City, Ohio.

Mike Hirschi was on hand for the delivery to EIFB on November 14, 2016. The 2,000 pounds of potatoes filled two pallets, and the staff at EIFB unloaded the spuds with a lift truck. Because the potatoes were already packaged in ten-pound bags (thanks again to Walther Farms!), they could be readily distributed, and 200 families in east-central Illinois received a special Thanksgiving dinner staple. Another 200 families in central Ohio received similar ten-pound bags—all because of a generous Silent Auction donation.

The Silent Auction is a wonderful way to support your Foundation while helping others. Please consider how you can contribute to the auction in Spokane this July. If you are interested in donating, including Bid to Give items, contact Sarah or Joann at foundation@asabe.org or 269-429-0300 for more information. When you attend the AIM, be sure to stop by the auction display and bid on the many donations—handcrafted items, custom jewelry, educational toys, weekend getaways, and Bids to Give that can multiply the impact. Last year, the Silent Auction and various raffles raised over $7,000 for the Foundation KEYS Fund. And that’s not small potatoes!
At the July 2016 Annual International Meeting in Orlando, Florida, thirteen new ASABE Fellows were recognized. Election to Fellow is one of the highest distinctions an ASABE member can achieve, and those elected often say that this recognition by their peers is one of the most significant experiences of their career.

ASABE’s Constitution establishes that “a Fellow shall be a member of unusual professional distinction, with outstanding and extraordinary qualifications and experience in, or related to, the field of agricultural, food, or biological engineering. A Fellow shall have had 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 shall have honorary status, to which members of distinction may be elected, but for which they may not apply. Admission shall be only after a minimum of 20 years as an active Member-Engineer or Member of ASABE.”

As in previous issues of Resource, here we shine the spotlight on the final three of the thirteen new ASABE Fellows who were elected in 2016.

Ruihong Zhang, Professor, Department of Biological and Agricultural Engineering, University of California-Davis, is honored for her outstanding contributions to bioenvironmental engineering in the areas of waste conversion, bioenergy, and biofuel production. Zhang has led the development of high-solids anaerobic digestion (HSAD) technology that reduces the burden on landfills while capturing biogas for energy and nutrients for fertilizer. CleanWorld has commercialized the new technology, and UC Davis has established a renewable energy facility to treat all organic waste produced on campus.

Thomas R. Way, USDA-ARS National Soil Dynamics Laboratory, Auburn, Alabama, is honored for outstanding research on traction performance, soil compaction, agricultural sustainability, and agricultural equipment development. Way’s work on soil dynamics has had significant and lasting impacts on industry developments. He led the first quantitative study describing the direction of the major principal stress in soil as it is traversed by tractor tires. He was also first to publish work that describes the soil beneath a tractor drive tire as undergoing plastic flow.

Xiuzhi Susan Sun, Distinguished Professor, Biomaterials Lab, Kansas State University, is honored for her work in the conversion of biorenewable feedstocks into high-performance chemicals and polymers for biobased adhesives, plastics, coatings, and medical devices. Sun’s research has had significant impacts on the biobased-products industry by applying fundamental research to practical applications and reducing dependence on fossil fuels. She is a pioneer in developing new applications of biobased materials, and her work has been applied commercially.

Meet the Fellows

Honoring the Newly Elected
Moisture meter will help prevent grain losses

In Brief: In developing countries, grains are often stored in bags, not silos, and high moisture can lead to mold growth in stored grain. Current moisture tests can be costly and impractical for some farmers, so USDA-ARS and university scientists have developed a simple, inexpensive moisture meter.

Many farmers in developing regions of the world have no low-cost way to reliably assess the moisture level of their stored grain. Too much moisture can lead to spoilage, insect infestation, and growth of molds like *Aspergillus*, which often renders grain unfit for consumption. A team of USDA-ARS and Kansas State University (KSU) researchers has been addressing the problem over the past year, helping subsistence farmers prevent postharvest grain losses of up to 30%.

In underdeveloped countries like Ghana, grains like maize are stored in large bags rather than in bins or silos, as in the U.S. ASABE member Paul Armstrong of the USDA-ARS and his KSU colleagues have developed a handheld device that they hope will provide farmers with a fast, low-cost way of checking their grain bags. “The meter works by measuring the relative humidity and temperature within the grain to estimate the moisture content,” said Armstrong, who is with the USDA-ARS Center for Grain and Animal Health Research in Manhattan, Kansas. “It is a fairly old concept, but it can be made more practical with modern, inexpensive sensors.”

The device is known as the post-harvest loss (PHL) moisture meter, and it costs about $75 to make. It is designed so that farmers can build it, or have it built, using off-the-shelf parts and without sophisticated manufacturing equipment. It features a probe that’s inserted directly into a bag of grain to check the moisture level. After about six minutes, a reading appears on a small display window. “Determining whether the grain moisture is low enough for storage is critical for avoiding mold and reducing insect damage,” said James Campbell, who leads research at the USDA-ARS Stored Product Insect and Engineering Research Unit, where Armstrong developed and initially tested the device.

Armstrong got involved when KSU requested his help with a U.S. Agency for International Development (USAID) project called the Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss [Editor’s note: See page 12 for more information on the Feed the Future Innovation Lab]. The objectives include finding ways to reduce hunger, poverty, and malnutrition in impoverished countries. The USDA-ARS is also partnering with USAID in its Feed the Future efforts to address world food security.
As part of the project, the PHL moisture meter is being evaluated by grain farmers in Ethiopia, Guatemala, and Bangladesh, as well as at four sites in maize-producing regions of Ghana. In the Ghana trials, the moisture meter performed well compared to two other devices that are commonly used in modern grain production systems and that can cost hundreds to thousands of dollars. A description of the device and trial results will be submitted for publication in *Applied Engineering in Agriculture*.

With feedback from farmers, Armstrong and his colleagues are making refinements, including extending the battery life, shortening the measurement time, adding smart phone connectivity, and reducing the cost. Part of this effort is being funded through a USDA-ARS Innovation Fund grant.

For more information, contact Jan Suszkiw, Acting Supervisory Editor and Public Affairs Specialist, USDA-ARS, Beltsville, Md., USA, Jan.Suszkiw@ars.usda.gov.

**Land-use planning is more efficient with targeted tools**

In Brief: When communities look to address water quality issues such as nutrient pollution, an assortment of computer models can help them simulate scenarios to solve their problems. But how do local officials and watershed planners know which models best address their needs, and which models consider cost as part of the solution?

When watershed planners want additional information for making decisions about nutrient management and land use, they want to do it as expeditiously as possible. “With the data that we have available, we must work economically and quickly, and we must have confidence in the results,” said ASABE member Bernard Engel, head of Purdue University’s Department of Agricultural and Biological Engineering.

With funding from Illinois-Indiana Sea Grant, Engel and his team analyzed various modeling tools to assess their value in addressing community land use and water concerns. “Models vary greatly in terms of the required data inputs, the level of expertise needed to use them, and what exactly they model or simulate. Because of that variation, each model has its own strengths and weaknesses,” said Engel. The researchers compared model performances to observed data sets, which allowed them to make recommendations on when to use certain models and what to expect from them.

Engel’s team is hoping to push for the models about which they feel most confident to become more accessible to stakeholders. Some models are already available in more comprehensive decision support tools, such as *Tipping Points and Indicators*. *Tipping Points and Indicators* is a complex web-based program that uses data to help community planners understand how close a watershed is to ecological thresholds related to a range of water issues, and what the watershed will look like if land use patterns continue on the same course. Based on the results, communities can develop an action plan that includes customized steps to improve current conditions.

Engel’s team spends most of its time developing and improving computer-based land use models. One of their additions to *Tipping Points and Indicators* is a tool to analyze the impacts of land use changes due to urbanization and the construction of green infrastructure, such as rain barrels, porous pavement, and green roofs. This tool was incorporated when decision makers in Peoria, Illinois, signed up to use *Tipping Points and Indicators* to develop a green infrastructure plan to address the city’s stormwater issues.

Engel’s assessment project has helped inform what direction the team is heading. For example, they plan to explore ideas to improve modeling speed and cost-effectiveness. “If the models are faster, they will be more accessible for people, and more useful,” said Engel.

For more information, contact Irene Miles, Coordinator of Strategic Communication, University of Illinois, Urbana, USA, miles@illinois.edu.

*Illinois-Indiana Sea Grant is a part of University of Illinois Extension and Purdue University Extension.*
Breeding resilience into plants

In Brief: Researchers at the University of California-Davis are accelerating crop breeding to keep pace with variable weather and a changing climate.

Variable weather is creating extreme challenges for crop breeding in California. How do researchers develop crops that will thrive under certain conditions when they can no longer predict what those conditions will be? “That’s the question we’re all asking,” said Charlie Brummer, professor and director of the UC Davis Plant Breeding Center. “Our weather patterns are changing fast, affecting everything from soil composition to what to expect in terms of weeds, diseases, and pests. It can take ten years to develop a new crop variety, even more for perennial plants. So we have to extrapolate what the future will bring—very, very quickly.”

Changes have already begun, according to Allen Van Deynze, director of research at the UC Davis Seed Biotechnology Center. A spike in insects and the viruses they transmit is threatening vegetable crops in California and beyond. “An extra four to six weeks of heat can produce another generation of aphids and wipe out an entire crop,” Van Deynze explained. “The insects are multiplying very fast.”

Extreme variations in local weather pose a greater challenge than long-term climate change. If growers know that the weather will trend hotter, they can plan accordingly. However, the wild swings—longer droughts and more intense floods—are trickier. “The insects, weeds, and other pests that thrive in more humid settings are different from those that we find during droughts,” Brummer said. “We’re working to breed crops that can adapt to all those conditions.”

Plant breeders at UC Davis help develop new cultivars of the nearly 400 fruits, vegetables, nuts, grains, and ornamentals grown year-round in California’s diverse environments. To create a winning variety, breeders cross plants with desired traits and select the best offspring over multiple generations. That is essentially how humans have been improving crops since the dawn of agriculture.

In recent years, breeding has become faster and smarter, thanks to rapid improvements in DNA sequencing and the computer power needed to analyze genetic data. Some plant traits, such as flavor and size, are determined by many genes acting together. Other traits, such as resistance to a disease, may be regulated by a single gene. Breeders can now identify genes that influence some traits at the molecular level, so they can select plants at the seed or seedling stage based on their DNA sequence rather than wait for traits to express themselves as the plants mature. That speeds up the process. “We have the tools to respond quickly to disease and other threats,” Van Deynze said. “We’re hoping to reduce the time it takes to breed for disease resistance from eight years to two or three years.”

To accelerate breeding, genotyping is only part of the equation. Breeders also need phenotyping, which means measuring traits as plants grow in the field. “Molecular tools help us find genes of interest for some traits, but we don’t really know what we have for other traits until we grow plants in the field,” Brummer explained. “While trying to solve one problem, we can’t overlook yield or flavor. For those traits, we have to phenotype to find out which traits are best.” Current methods of phenotyping are slow and labor-intensive and have
not kept pace with genotyping. Breeders use measuring tapes and their own taste buds to assess yield and fruit quality.

Phenotyping has become the bottleneck in plant breeding, but a solution may be at hand. New smart machines and sensor-based technologies can automate the measurement of large numbers of plants. **ASABE member David Slaughter**, professor in the Department of Biological and Agricultural Engineering at UC Davis, has developed a rapid, in-field phenotyping system with high-tech cameras that creates three-dimensional models of each plant as it grows in the field. “It can measure critical components, like plant architecture and volume, leaf area and number, and even leaf temperature, which helps breeders determine growth patterns and whether plants are suffering from heat or water stress,” Slaughter explained.

Slaughter’s tractor-pulled system can currently measure three plants per second, or 10,800 plants per hour. “That’s revolutionary,” Brummer said. “Breeding is a numbers game. The more plants we can look at, the better our chances of finding plants that are truly exceptional.” Sensor technology can also provide the big-picture data that breeders need to develop crops that can thrive in an uncertain future.

“We need to look at both phenotyping and genotyping, and tie them together with crop management strategies to optimize the performance of new cultivars,” Brummer said. “Done correctly, we will be able to create new cultivars more efficiently and rapidly today, so they can perform well in the production environments of tomorrow.”

For more information, contact Diane Nelson, senior writer, UC Davis College of Agricultural and Environmental Sciences, denelson@ucdavis.edu.

---

**Yeast is good for a lot more than bread**

In Brief: A research team led by **ASABE member Xueyang Feng**, assistant professor of biological systems engineering at Virginia Tech, developed a way to make versatile alcohols from yeast, a discovery that could lead to environmentally friendly ways to manufacture a wide range of products that have historically been made from petroleum.

Feng’s team discovered that a compartment in yeast cells can be used to produce fatty alcohols within the cell itself. “Theoretically, these alcohols could be used to supplement the biofuels industry in a more sustainable way,” said Jiayuan Sheng, a post-doctoral associate in Feng’s lab. “These fatty alcohols are sometimes derived from petroleum, so using yeast would eliminate the need for fossil fuels. In the meantime, there are immediate applications for industries that use fatty alcohols in their products.”

The discovery has myriad applications. Fatty alcohols are used in a wide variety of products, from detergent to ice cream, and are value-added chemicals that generate $3 billion annually. In 2006, more than 1.3 million tons of fatty alcohols were used in consumer products. The most common products that incorporate fatty alcohols are cosmetics, lubricants, detergents, and food items that use them as thickeners or emulsifiers.

To make medium-chain fatty alcohols, Feng’s team hijacked a pathway in a compartment in the yeast cell. Most eukaryotic cells, or cells containing a nucleus and organelles, are made up of various microorganisms, including peroxisomes, that are located outside the nucleus in the cytoplasm. Peroxisomes contain enzymes that oxidize certain molecules normally found in a cell, such as fatty and amino acids, and are responsible for turning hydrogen peroxide into water and oxygen. Using a compartmentalized organelle like the peroxisome as a staging ground was what set this study apart from previous work.

The team found that medium-chain fatty alcohols could be produced in yeast by targeted expression of fatty acyl-CoA reductase, or TaFAR, in the peroxisome of *Saccharomyces cerevisiae*. “We’re the first to develop this method of using the compartment within yeast cells to create medium-chain alcohols from yeast,” Feng said. Feng and Sheng have shown that yeast can do much more than make bread rise.

For more information, contact Zeke Barlow, VT Office of Communications and Marketing, College of Agriculture and Life Sciences, zekabarlow@vt.edu.
Funding the Future of ASABE

The Young Professionals Community (YPC) strives to keep our young professionals aware of, engaged, and active in the business of the Society. Our efforts are dually focused on retaining current members and welcoming new, young engineers within our industry to an active professional membership. To help us with some of our “bigger picture” projects, especially during the past five years, we occasionally enjoy the assistance of Initiative Funding from the Board of Trustees (BOT).

Dollars and cents add value

The BOT Initiative Fund began distribution of funds in 1999. This Fund offers seed money for new events, activities, and other projects that add value to the Society and its members but may not be initially self-sustaining. Any group within the Society can submit an Initiative Fund proposal, and the use of the funds must support current Society objectives for that year. Details regarding the Initiative Fund are available at www.asabe.org/about-us/governance/initiative-fund.aspx.

In 2012, the YPC received funding to develop materials for membership development. With those funds and the help of an outside editor, we collected footage at the AIM in Dallas and put together a short video to advertise the benefits of ASABE membership. Haven’t seen the video? Check it out on the ASABE website: www.asabe.org/join. Funding for another video project was granted in 2015. This video, scheduled for completion by the 2017 AIM, will focus on the importance of standards and promote the involvement of the Society’s young professionals in the development process.

Dollars and a sense for needs

In 2013, ASABE participated in the McKinley Advisors’ membership engagement benchmarking study alongside other professional societies. Among the trends indicated by the study, two stood out with the YPC:

1. Low conversion rates from students to young professionals were common in many professional societies.
2. Regular meeting attendance was the most successful tool in facilitating membership engagement and commitment.

In response to those findings, the YPC applied for Initiative Funding to address both of these areas. The funds that were awarded allowed us to grant travel scholarships to the AIM for first-time young professional attendees. Funding was also applied toward our efforts to reach out to graduating ABE seniors—to recommend and remind them of the benefits of active membership once they begin their careers. Thanks in large part to assistance from headquarters’ staff, this project is still active and will remain active.

Other aspects of the YPC mission include providing a social body that offers networking opportunities for the members of the community as well as exploring issues facing young professionals, and providing guidance and solutions. The YPC News & Notes column in the March/April issue of Resource highlighted the foundation and activities of the Graduate Student Involvement (GSI) committee within the YPC. Most GSI committee work is made possible because of the Initiative Fund. Thanks to this funding, networking and career development activities for current and potential graduate students have been a continued success and should be able to sustain themselves in the future. For example, Initiative Funding made possible the YPC-sponsored Childcare Lounge at the 2016 AIM in Orlando. Providing an area where parents can care for their young children during the course of each day’s events makes it easier for members to attend the meeting and remain involved. This opportunity is being pursued again for the 2017 AIM in Spokane.

These are just a few of the areas where the YPC has recently focused its efforts on membership development and involvement. While some of these projects have been short-term, others can and will be sustained for years to come.

Is there another area where we should focus our time and efforts? Let us know! Perhaps, with the help of our own funds or the Initiative Fund, we can turn your idea into a reality.

ASABE member Shane Williams, YPC Executive Committee Chair, Design Engineer, Kuhn North America, Inc., Brodhead, Wisc., USA, shane.williams@kuhn.com.
Your personal/company consultant business card could appear here. For information on rates ($95 and up) visit www.asabe.org/Advertise or contact Sandy Rutter, 269-932-7004, rutter@asabe.org.
Over the last three and a half years, my wife Valerie and I have found ourselves in a new and exciting place in our careers, thanks in large part to the recent global interest in agricultural technology. Our story takes us from quiet wine-and-hazelnut-producing Yamhill County in western Oregon to where we live now—the astoundingly fertile Columbia Basin, which includes parts of Oregon, Washington, and Idaho.

Val and I are not farmers or food producers, nor are we engineers or biologists. In fact, we struggle to keep our houseplants alive. We are marketeers—producers of clever catch phrases and growers of the client’s bottom line. Until a few years ago, we had little to do with agriculture beyond designing labels for some of our regional wineries and restaurants. Our marketing agency was born from our passion for telling stories that needed telling.

Yamhill County lies in the lush rural valley between Portland and the Pacific Coast and has a rich history of high-value agriculture. In the early 1800s, Oregon Trail pioneers were attracted to the region because of its high-quality soils and mild climate. Generations later, farming is still a primary economic force in the region, and today the land is covered with vineyards, hazelnut orchards, and berries, as well as hay, winter wheat, and a large variety of ornamentals. Yamhill County is one of the most diverse agricultural zones in the U.S., growing well over 200 specialty crops.

In 2013, we were contracted by the county government to assess the economic development that was taking place in the region and come up with a strategy for moving forward. The dominance of agriculture in the area and increased interest in high-tech solutions for rote operations have made Yamhill County and the surrounding region a prime location for developing and testing ag tech innovations.

During our one-year contract with the county, we took a deep dive into the rapidly evolving world of digital farming tools. Robotics, data management, EM mapping, precision irrigation, unmanned systems, crop yield, and soil science became our topics of conversation over dinner. We began attending regional technology forums, farm shows, and sector-specific events like the AUVSI Cascade Chapter’s Robot Rodeo. Photographs of new products—Yamaha’s RMAX helicopter, John Deere’s automated tractor, and even Google Glass–covered our office corkboards. At the AUVSI event, we met a new friend and mentor, Young Kim, CEO of Digital Harvest in Pendleton, Oregon. His company is committed to solving some of the most complex and persistent problems that growers encounter. After several meetings, Young encouraged us to start organizing farm technology events of our own.

We hosted a small one-day event where ag tech innovators met with local farmers, business owners, and county commissioners to gauge the level of interest in the idea of collaboration. The attendees were all highly supportive. Inspired by those results, we moved quickly to organize our first Precision Farming Expo in the spring of 2014. We rented out the Evergreen Air and Space Museum in McMinnville, Oregon, and invited a select group of speakers and commercial exhibitors.

John Deere’s chief roboticist Stewart Moorehead, autonomous vehicle guru Mel Torrie of ASI, ASABE member and Gold Medal winner Ken Giles of UC Davis, and...
Susan Lambert, the founder of DN2K, all came to share their knowledge, insights, and new technologies for farming. But the attendees were equally important, and we knew that it was essential to have farmers and crop consultants participate. They were the people who knew what was needed in agriculture, and their involvement was key. The data collected from the attendee list showed us that we had a sold-out crowd of primarily growers.

In 2015, we moved the Expo to Salem, Oregon, to make more room for the increasing number of speakers, exhibitors, and participants that the event attracted. The 2016 Expo included the fields of spectroscopy and space-based agronomy. Our initial theme was: “Providing Clarity to Farmers.” That continues to be our motto.

Along the way, we have learned and adapted to new circumstances. When Oregon became a UAS center, Val and I moved our agency east to Pendleton to work with the test range there. Together with the city and the range, we created the Oregon UAS FutureFarm project as a digital agriculture proving ground for the development of interconnected agricultural systems.

The FutureFarm’s mission is to recruit both domestic and international companies to take advantage of the great agricultural diversity found within the range’s 14,000 square miles, the drone-friendly atmosphere, and the forward-thinking growers. Under the FutureFarm umbrella, we also organized a Drone Demo Day, where growers could study a variety of drones in operation and evaluate their respective advantages. Last December, thirty dedicated men and women attended a weeklong commercial drone pilot course held in Pendleton.

We decided to join ASABE because so many of the ag tech innovators and researchers whom we admire are also members. When we learned that we could become members despite not being engineers ourselves, we jumped at the chance. We did not know about Resource magazine when we joined, but reading it has been an added bonus.

Agricultural and biological engineers, irrigation experts, drone developers, automation pioneers, soil scientists, viticulturists, biologists, data crunchers, futurists, and farmers have become both our teachers and our friends. We have learned much about farming, and we have profound respect for the hard-working men and women who tend the Earth.

Labor shortages, climate change, sustainability, transparency, trade, and compliance are all challenges—increasingly so each season—that farmers and food producers face. However, our experiences of the last four years have encouraged us that together we can meet the nutritional needs of an ever-increasing population by continuing to connect, share knowledge, and work collaboratively toward solutions.

The FutureFarm project is now gaining the notice of foreign governments. We have been approached by several countries and provinces to share our methods, strategies, and best practices. An international grassroots FutureFarm initiative is conceivable.

As we prepare for our seventh ag tech event in less than four years, this Last Word in Resource has given us the perfect opportunity to reflect on our unexpected journey. Frankly, it has been a lot of fun. Our new path has taken us to french fry plants, spectroscopy labs, grain elevators, and drone factories, and we’ve met many smart and dedicated people.

ASABE member Jeff Lorton, Director, Duke Joseph Agency, Pendleton, Ore., USA, jeff@dukejoseph.com.

For more information about the 2017 FutureFarm Expo, visit www.futurefarm.tech.

Views expressed are solely those of the author and do not necessarily represent the views of ASABE.
Registration Is Open!

Visit [www.asabemeetings.org](http://www.asabemeetings.org) for information on meeting registration, housing and travel, technical program, cultural and technical tour options, and volunteer opportunities.

**Meeting Highlights**
More than 1,000 technical and poster presentations; Specialty sessions with invited speakers, panel and round-table discussions; Professional development hours/credits; Networking opportunities; Career fair; Silent auction to benefit the ASABE Foundation

**Meeting Location**
The meeting will be held at the Spokane Convention Center, 334 West Spokane Falls Blvd, Spokane, Washington 99201

**Meeting Accommodations**
The 2017 ASABE Annual International Meeting hotels are the Davenport Grand and the Doubletree by Hilton. Both hotels are connected directly to the convention center. To make your reservation visit [www.asabemeetings.org](http://www.asabemeetings.org) and select ACCOMMODATIONS to view hotel rates and procedures to register directly with the hotel of your choice.

Early Bird Registration Discounts End June 9th

[www.asabemeetings.org](http://www.asabemeetings.org)

**Exhibit and Sponsorship Opportunities are Still Available**
Visit [www.asabemeetings.org/sponsors](http://www.asabemeetings.org/sponsors) for more information
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. 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.
Registered Engineers

Gayle C. Baker, P.E.
Maurer-Stutz, Inc.
3116 N. Dries Lane, Suite 100
Peoria, IL 61604
309-693-7615
gcbaker@mstutz.com
www.mstutz.com
Planning and design services for livestock production facilities and soil and water conservation practices. Livestock experience includes beef, dairy, swine, horses and poultry facilities. Experience includes site development, feasibility studies, manure handling/storage/treatment, permitting, nutrient management, equipment/material specification, construction observation, land treatment and soil stabilization, edge of field nutrient reduction practices, and constructed wetlands. NRCS project experience.
Initial date of registration 1981; KS
Available full-time; Domestic and International

Ivan Droessler, P.E.
ISG
1725 N. Lake Avenue
PO Box 458
Storm Lake, IA 50588
712-732-7745
cell: 712-299-1487
ivan.droessler@is-grp.com
www.is-grp.com
ISG specializes in agricultural drainage, wastewater, waste management and facilities. Our innovative drainage projects serve as industry models. Through well-engineered and designed systems and facilities including feedlots and sow buildings, our ag clients experience expedited environmental approvals, enhanced production, minimized maintenance and repair costs, and a reduced environmental impact.
Initial date of registration 1990; IA
Available full-time; Domestic

Bradley J. Bond, P.E.
Project Manager, Curry-Wille & Associates Consulting Engineers, P.C.
425 S. 2nd Street / PO Box 1732
Ames, IA 50010, USA
515-232-9078
bbond@curryville.com
www.curryville.com
Engineering consultant for various livestock facility designs, manure handling/treatment/storage, vegetative treatment systems for open lot runoff, livestock permitting, research facilities, secondary containment for fertilizer & pesticides, grain handling & storage, and general agricultural consultation. Services include design, facility planning, site selection, site layout, programing, and design for agricultural and commercial sites.
Initial date of registration 2014; IA, TX
Available full-time; Domestic and International

William A. Cook, P.E., L.S.
Neosho Engineering & Technology
20475 Uddall Road
Stark, KS 66775, USA
620-754-3500
Boundary surveying, topographic surveying, construction staking, land use planning, preliminary planning for water control structures, real estate development, and community planning.
Initial date of registration 1981; KS
Available full-time; Domestic

Terry L. Feldmann, P.E.
Maurer-Stutz, Inc.
3116 N. Dries Lane, Suite 100
Peoria, IL 61604, USA
309-693-7615
fax: 309-693-7616
tfeldmann@mstutz.com
Consulting, evaluation, planning, and design services for livestock and poultry production facilities including expansion, site development, feasibility studies, renovation, ventilation and heating, environmental monitoring, product development, field research, manure handling/storage/treatment, permitting, nutrient management, odor assessments, equipment/material specifications and earthwork quantities. Expert witness testimony. Experience includes horses, swine, dairy, turkeys, broilers, and beef cattle facilities.
Initial date of registration 1998; IL, IN, AR, WI
Available full-time; Domestic and International

John A. George, P.E.
Agricultural Engineering Associates, Inc.
1000 Promontory, PO Box 4
Uniontown, KS 66779, USA
800-499-5893
fax: 620-756-4600
john@agengineering.com
www.agengineering.com
AEA provides experienced (40 years), leading edge services to US and International Clients on production and research livestock and poultry facilities and associated environmental systems, permitting, crop production, and renewable energy systems to maximize efficiency, profitability, and environmental compliance. Primary services include complete facility design, environmental permitting, and construction management.
Initial date of registration 1974; KS, AL, AR, CO, GA, IL, IN, IA, MO, MI, MT, NE, NM, NY, NC, OH, OK, OR, PA, SD, TX, WA, WI, WY
Available full-time; Domestic and International

Ted A. Gribble, P.E.
Five-G Consulting
6355 Lamar Road
Reno, TX 75462, USA
903-783-9995
fax: 903-784-2317
eng@fiveg.com
www.fiveg.com
Consulting and engineering for livestock facilities. Specialize in dairy and food processing waste systems. Experience worldwide in all climates.
Initial date of registration 1998; OR, NE, HI, NY, PA, TX, UT, NC
Available full-time; Domestic and International

Dale M. Gumz, CSP, P.E.
Inductive Engineering
10805 230th Street
Cadott, WI 54727-5406, USA
715-289-4721
dgumz@centurytel.net
www.inductiveengineering.net
Engineering consultant for agriculture, construction, consumer products, and specialty machines. Forensic and safety services include: accident reconstruction, safety responsibilities, human factors, manufacturing processes, mechanical and electrical, occupational safety, product liability, product and machine design analysis. Experience includes a farm background and safety and design engineering since 1970, manufacturing, safety, and forensic engineering. NCEES, CSP.
Initial date of registration 1975; IL, IA, MO, WI
Available full-time; Domestic and International

Larry R. Johnson, P.E.
Oakwood Engineering LLC
W7975 Oakwood Lane
Fort Atkinson, WI 53538, USA
920-650-3371
ljohnsonwi@gmail.com
Consulting services for agricultural and construction equipment. Services include product safety program development, safety evaluation of equipment and product documentation, and expert witness litigation support. Litigation experience in personal injury, product performance, contracts, trade dress, patent and trademark issues. Over 30 years experience in operations and engineering management.
Initial date of registration 1974; MI, WI
Available part-time; Domestic and International

GUIDE TO CONSULTANTS
Registered Engineers

Joseph G. “Jake” Martin III, P.E.
JGMII, Inc.,
Consulting Agricultural Engineers
6024 S.W. 89th Terrace
Gainesville, FL 32608, USA
352-371-4655
jake@dairydesign.com
www.dairydesign.com

Consulting engineering services for complete dairy facility evaluation, layout, and design. Services provided include: site selection and evaluation; preliminary dairy facility layouts; dairy expansion evaluation; layout and design of milking centers, animal housing facilities, animal working areas, feed centers and youngstock facilities. Complete animal waste management system evaluation, layout and design.

Initial date of registration 1984; LA,GA, FL, KS, AZ, IA, VA, TX, KY, OH, SC, NC, TN
Available full-time; Domestic and International

Jason E. Olmstead, P.E.
MSA Professional Services, Inc.
2117 State Street, Suite 200
Bettendorf, IA 52722, USA
563-424-3703
jolmstead@msa-ps.com
www.msa-ps.com

Consulting, evaluation, planning, and design services for livestock and poultry production facilities including expansion, site development, feasibility studies, renovation, ventilation and heating, environmental monitoring, product development, construction observation, manure handling/storage/treatment, permitting, nutrient management, equipment/material specifications and earthwork quantities. NRCS project experience. Experience includes beef, dairy, swine, horses, and poultry facilities.

Initial date of registration 2010; IL, IA, MO, NE, AZ, HI, WV
Available full-time; Domestic and International

Frank C. Mercurio, P.E.
KLA Environmental Services, Inc.
1303 Vucca Street
Scott City, KS 67871
785-823-0097
fmercurio@klaenviro.com
www.klaenviro.com

Engineering and environmental consulting services for agricultural, rural and water resources clients. Livestock feeding facility design including grading plans, waste management systems, nutrient management plans and permit applications. Water resources planning, dam and reservoir design. Specialty services include water right development, whole-pond seepage testing, and phosphorus reduction in wastewater.

Initial date of registration 1985; KS, CO, OK
Available full-time; Domestic

James M. Miller, P.E., Ph.D.
J M Miller Engineering, Inc.
2392 Fuller Ct.
Ann Arbor, MI 48105, USA
734-662-6822
miller@millerengineering.com
www.millerengineering.com

Agricultural, Chemical, Mechanical, & Forensic Engineers. Expertise Areas: Hay/Grain Harvesting & Storage; Dairy & Food Processing; Tractors & Implements; Guarding/Entanglement; Ingress, Egress, Slips, Trips, and Falls; Chemical Application & Exposures; Warnings, Labeling, & Instruction Manuals; Irrigation, Hydroelectric, & Wind; OSHA, GIS, RCRA, CWA, and other Compliance.

Initial date of registration 1968 OH, 1999 ID
Available full-time; Domestic

John Osarenren, Ph.D., P.E.
Integrated Agriculture and Industrial Consultancy
2421 Gunther Avenue
Bronx, NY 10469, USA
info@integratedconsulting.org
www.integratedconsulting.org

Establishing Engineering Framework, design, prototype build, testing and maintenance for various Industries of the Future and Future city development. Work done in Agricultural and Industrial, food production, processing, specialty machines, test machines, instrumentation, measurement and tooling for prototypes, manufacturing and maintenance. Condition monitoring measurement and data acquisition services in all phases of a project. Mentoring, Educating and Tutoring students. Integrating Urban Agriculture into city landscape and policy-making programs. Volunteer services for state and national future city competitions.

Initial date of registration 2010; NY
Available full-time; Domestic

Russell A. Persyn, P.E., Ph.D., CFM
RESPEC
3824 Jet Drive
Rapid City, SD 57703
605-394-6400
cell: 210-213-2297
russell.persyn@respec.com
www.respec.com

RESPEC is a client-focused consulting firm that has provided innovative solutions for more than 45 years. Our scientists and engineers are experts in water development and management, including irrigation water management, monitoring data collection and analysis, decision-support system development, and hydrologic and hydraulic modeling in rural and urban watersheds.

Initial date of registration Dec 2004; TX, IA, SD
Available full-time; Domestic

Jonathan C. Popp, P.E.
Popp Engineering, Inc.
2710 Ford Street
Ames, IA 50010, USA
515-232-6118
joppp@poppengineeringinc.com
www.poppengineeringinc.com

Professional engineering and project management services are provided to the seed and related agricultural industries. These services encompass renovation and new construction, specializing in air systems, dust control, and seed drying systems. All phases of projects from problem analysis and design to equipment procurement and construction management are provided to clients.

Initial date of registration 1993; IA, IL, MN, MO, NE, ND
Available full-time; Domestic

Brian L. Roy, P.E.
Royal Consulting Services, Inc.
211 West Warren Avenue
Longwood, FL 32750, USA
407-831-3095
fax: 407-831-5095
RoyBL@royalconsulting.com
www.royalconsulting.com

The Professional Engineers and Certified General Contractors at Royal Consulting Services, Inc. (RCS) provide consulting, engineering, and construction management services, specializing in water resources, environmental, agricultural, and civil projects throughout the World. RCS provides turn-key services including conceptualization, permitting, design, cost estimating construction management, operation, and site certification.

Initial date of registration 1992; FL, GA, PA, NY, NC, TX, LA
Available full-time; Domestic and International

Fred B. Semke, P.E.
Semke Forensic
154 Hughes Lane
St. Charles, MO 63301, USA
636-896-9995
cell: 314-603-6382
fax: 636-896-9695
fsemke@semke.com
www.semke.com


Initial date of registration 1998; MO, ID, IL, AR, KY, KS, OK, IA, AL
Available full-time; Domestic and International
Registered Engineers

Russ Stammer, P.E.
Veenstra & Kimm, Inc.
2746 Superior Drive NW, Suite 210
Rochester, MN 55901
507-282-5000
rstammer@v-k.net
Consulting engineering services for agricultural waste handling and storage, manure and nutrient management, food processing waste and wastewater treatment, egg production wastewater treatment, odor control, biofiltration, planning, design, construction observation, construction management, permitting, site design, drainage, stream stabilization, flood repairs, spray irrigation design, and structure design. NRCS project experience, TSP.
Initial date of registration 1985; IA, MN, NE, WI, SD
Available full-time; Domestic and International

Jerry L. Wille, P.E.
President, Curry-Wille & Associates Consulting Engineers, P.C.
425 S. 2nd Street / PO Box 1732
Ames, IA 50010, USA
515-232-9078
jville@currywille.com
www.currywille.com
Consultation on agricultural research/experiment stations, commercial and private facilities housing livestock and poultry or storing grain and seed. Services include designs, plans, and specifications for the general, structural, mechanical, and electrical portions of the projects, including site development, utilities, and waste handling.
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

Daniel Berges
Sustainable Environmental Consultants
2318 21st Road
Frankfort, KS 66427, USA
515-207-0201
dberges@sustainableenviro.com
www.sustainableenviro.com
Livestock waste management consulting for beef, dairy, swine, and poultry facilities specifically engineering services, agronomy, and regulatory compliance. Common projects include engineering plans for livestock waste control systems, lagoon permeability testing, nutrient management plan development, soil & water sampling, and waste sampling.
Available full-time; Domestic

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
716-852-1444 ext 111
njb7@cornell.edu
www.ilr.cornell.edu/healthsafety
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.
Available part-time

Industrial & Environmental Concepts Covers & Liners
IEC
2190 Heywood Ave.
Lakeville, MN
952-829-0731
anderson@ieccovers.com
IEC is a turn-key provider of covers & liners. We design, fabricate & install covers & liners on wastewater basins for large dairy & hog producers in addition to industrial and municipal projects. Anaerobic covers are our specialty. We work closely with engineers & clients using tanks and lagoons for projects involving energy, biosolids, rainwater or process treatment.

John Lawrence, Ph.D.
KSU Bulk Solids Innovation Center
607 N Front St
Salina, Kansas, USA
785-404-4918
fax: 785-404-6497
jlawren@ksu.edu
www.bulk-solids.k-state.edu
Material flow property testing to measure flowability, bulk density, particle size analysis, pneumatic conveying testing for degradation, blockage, finding optimum pick-up velocity, design of pneumatic conveying system, troubleshooting, design of hopper, chute and feeders, elbow testing, testing of moisture sorption characteristics of bulk solids, equilibrium moisture contents of grains.
Available full-time; Domestic
Professional Service Cards

CURRY-WILLE & ASSOCIATES
CONSULTING ENGINEERS P.C.

Animal and Livestock Facility Design
Feed and Grain Processing and Storage
Fertilizer/Pesticide Containment Design
TSP/Manure Handling Design
Agricultural Research Facilities

AMES, IA
515-232-9078
WWW.CURRYWILLE.COM

INDUCTIVE ENGINEERING
DALE GUMZ, P.E., C.S.P.
10805 230th Street
Cadott, WI 54727-5406
• Accident Reconstruction
• Mechanical & Electrical
• Safety Responsibilities
• Product & Machine Design
715-289-4721
dgumz@centrytel.net
www.inductiveengineering.net

MILLER ENGINEERING
James M. Miller, PE, PhD: President
Idaho: Boise - Twin Falls
888-206-0394
rwill@millengineering.com
www.millengineering.com

Michigan: Ann Arbor
734.892.0622

Agricultural, Chemical, Mechanical, & Forensic Engineers.
Expertise Areas:
Hay / Grain Harvesting & Storage; Dairy & Food Processing; Tractors & Implements; Grazing / Entanglement/Ingress, Egress, Slips, Trips, and Falls; Chemical Application & Exposures; Warnings, Labeling, & Instruction Manuals; Irrigation, Hydroelectric, & Wind.
OSHA, GHS, EURA, CWA, and other Compliance.

KEEP MOVING FORWARD
RCI Engineering LLC
Randy Clark
RClark@RCEngineering.com
208 River Knoll Drive • Mayville, WI 53050
www.RCEngineering.com

Industrial & Environmental Concepts, Inc.
21320 Heywood Avenue
Lakeville, MN 55044
Office: 952-829-0731
Fax: 952-829-9770
Cell: 952-240-0254

website: ieccovers.com
e-mail: anderson@iecovers.com

Daniel Berger
Agricultural Engineer
765.207.0201
dberger@sustainableenviro.com

Environmental Compliance Management
Turf Management & Agronomic Consulting
Feces Control • Soil Amendments
Compost • Mulch
Certified Filtertek • Manufacturer

SEC
Sustainable Enviro
2319 21st Road
Frankfort, KY 40601
sustainableenviro.com

MAURER-STUTZ
ENGINEERS SURVEYORS
mstutz.com

Comprehensive Engineering Services
Civil • Structural • Transportation
Water • Wastewater • Agricultural
GIS • Surveying

309.692.7615
5110 N. Driscoll Lane, Suite 100
Peoria, IL 61604

765.272.6228
5836 W. Riga Road
Muscle, IN 47364

Your personal/company consultant business card could appear here. For information on rates ($95 and up) visit www.asabe.org/GuideToConsultantsinfo or contact Sandy Rutter, 269-932-7004, rutter@asabe.org.
WHAT A CONSULTING ENGINEER CAN DO FOR YOU

Because of their broad educational background, consulting agricultural engineers are a source of information on a wide variety of topics and can provide help with diverse technical problems. The design and management services agricultural engineers provide can be invaluable to small businesses without their own engineering departments, to agricultural producers and similar enterprises, and to large businesses or governmental agencies that want to supplement their in-house engineering departments. Consultants also can provide service to lending institutions, law firms, local units of government and planning boards, or to individuals that need expert witnesses or technical analysis.

What is a Consulting Engineer?
A consulting engineer is an independent contractor retained to work on a project-by-project basis. A consulting engineer may work alone or as a member of a consulting firm. Consulting engineers can provide a high level of technical expertise, direct personal service, and highly technical advice. Many consulting engineers are licensed professional engineers in their state of residence and must qualify to obtain licensure in other states where they practice or provide services.

What Expertise Does a Consulting Agricultural Engineer Have?
Agricultural engineers have a diverse educational background that makes them knowledgeable about many subjects; additionally, they usually focus their expertise on one of the following areas:

- Applied Sciences & Engineering
- Machinery Systems
- Education, Outreach & Professional Development
- Natural Resources & Environmental Systems
- Energy Systems
- Plant, Animal & Facility Systems
- Ergonomics Safety & Health
- Processing Systems
- Information Technology, Sensors & Control Systems

For more information, please visit www.asabe.org/GuideToConsultantsInfo
ADVERTISE IN THE GUIDE TO CONSULTANTS

Inexpensive: $90 (current listing rate—other options available)

Easy: Contact Sandy Rutter at 269-932-7004 or email GuideToConsultants@asabe.org or return the form on www.asabe.org/GuideToConsultantsInfo

This stand-alone print directory is mailed along with our May/June issue of Resource magazine. It is also posted on the ASABE website for approximately 12 months and distributed when ASABE receives queries regarding consultants. It may also be distributed at other events. Search Google for “agricultural engineering consultant” or “biological engineering consultant” and see “Why Hire A Consultant”.

More Advertising Opportunities: www.asabe.org/ADVERTISE

Interested in ASABE Membership? www.asabe.org/JOIN

CODE OF ETHICS OF ENGINEERS

The Fundamental Code of Principles
Engineers uphold and advance the integrity, honor and dignity of the engineering profession by:
I. using their knowledge and skill for the enhancement of human welfare;
II. being honest and impartial, and serving with fidelity the public, their employers and clients;
III. striving to increase the competence and prestige of the engineering profession; and
IV. supporting the professional and technical societies of their disciplines.

The Fundamental Canons
1. Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties.
2. Engineers shall perform services only in the areas of their competence.
3. Engineers shall issue public statements only in an objective and truthful manner.
4. Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest.
5. Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.
6. Engineers shall act in such a manner as to uphold and enhance the honor, integrity and dignity of the profession.
7. Engineers shall continue their professional development throughout their careers and shall provide opportunities for the professional development of those engineers under their supervision.