The Challenges and Opportunities of Global Agriculture

“Our profession understands that everything is connected, everything is changing, and most importantly, we are all in this together.”
I have taken great pride in my ASABE membership because of the valuable things members are doing to solve the resource challenges facing the world. As I have become friends with many of you over the years, my respect for your work and contributions to our profession has continued to grow. As President, I have been exposed to an even broader sector of our membership. I am never disappointed in the amount of engagement our members have in addressing the needs in their field, and I am continually impressed by our members’ commitment to our professional society. ASABE is exactly what its members want it to be. Where we are lacking, it is because we have not committed together to make the changes or improvements that are needed. Where we are strong, it is because members like you have fostered a vision to move us forward.

I was in a meeting recently with several members and had occasion to visit with a member from Vermont (a select group in that state, as there are only nine total). I asked how he came to join ASABE, and he explained that he had started working in agricultural consulting and eventually extension work. ASABE publications and ASABE Standards became important resources for him—to the point where he joined the Society. This member “recruited” by our literature did not just join ASABE. He got involved in the technical committees and committees serving our profession—a fully engaged member making a difference in our profession. What a great story! It reminded me again how valuable our products can be. Not only do they provide timely and solid information, they can also be used to market how relevant our Society is in meeting the needs of society at large. These publications did not happen overnight. They were the result of members working to expand the knowledge base of our profession.

That story is just one of many. Each of you has a story of how ASABE has impacted your career. As I challenged our members when I took this office, find ways to engage where you have influence—your section, your technical communities, and your networking communities. If ASABE is lacking in an area or needs to grow somewhere, consider working to put together a group of like-minded members interested in addressing the issue. ASABE will be what you want it to be.

It has been an honor serving you as President. See you in New Orleans!

Terry A. Howell Jr., P.E.
Terry.Howell@mckee.com
FEATURES

4 The Challenges and Opportunities of Global Agriculture
Marty Matlock, P.E.
Concluding a four-part series, the author explores the complexities of global food supply chains and the increasing importance of social responsibility in agriculture.

7 Community Development from Oklahoma to West Africa: The Work Continues
Katie Arroyo
Sierra Leone needs water and food security, even more so in the wake of the Ebola crisis. Recent Oklahoma State graduates are continuing the development work they began as students.

10 Variable-Rate Application and Swath Control Technology
Peter Ako Larbi
Technology improves the application of agricultural inputs by efficient control and precise distribution. The result is financial benefit with less environmental impact.

12 New Engineering in Grain Drying and Storage
Griffiths Atungulu
Microwave and infrared systems can provide drying and pre-drying treatments that reduce fungal infections while maintaining grain quality.

15 Using Ozone for Integrated Pest Management in Viticulture
Rumela Bhadra
The rapidly growing viticulture industry needs new IPM technologies, including treatment with ozonated water as an alternative to chemical pesticides.

18 China Pursues Precision Agriculture on a Grand Scale
Lalit Verma
China’s commitment to precision agriculture is shown by large modern farming operations and extensive programs in research, design, and development.

20 University of Kentucky Initiates a TSM Degree
Karin Pekarchik
The University of Kentucky’s new Technical Systems Management degree is meeting statewide needs for skilled graduates in agricultural, manufacturing, and construction.

UPDATE

24 Purdue leading research to improve water management on farms

25 Stem-bending sensor can predict yield in bioenergy crops

26 Vegetable study targets water saving in the Texas High Plains

27 On-line tool evaluates options for reducing odors from livestock operations

28 Inexpensive aerial imaging can target treatments where they are needed

DEPARTMENTS

2 From the President/Events Calendar

22 Focus on the Foundation: Fundraising Events at the 2015 AIM

23 Bioenergy Focus Day at AIM

29 Visual Challenge 5: Call for Entries

30 Professional Listings

31 Last Word: What Makes an ASABE Fellow?
Editor's note: This is the final article in a four-part series on the role of agricultural and biological engineers in sustainable agriculture. The first three articles appeared in the March/April 2014, May/June 2014, and May/June 2015 issues of Resource.

The three axioms of sustainability are (1) everything is connected, (2) everything is changing, and (3) we are all in this together. These axioms are especially apparent in our modern global agricultural supply chains. Supply chains are the networks of suppliers, technical support, producers, processors, consumers, and affiliated enterprises engaged in the delivery of a product to consumers. Globalization is the process of extending supply chains across national and geographic borders and is often associated with the expansion of branded food products into emerging markets. This expansion into developing economies is no accident; it is driven by demographic shifts in populations around the world (see graph). Our current population of approximately 7.2 billion will expand to over 10 billion in the next 40 years; these 3 billion additional people will live in emerging markets. They will be younger, more prosperous, and more connected than ever before. They are the growth market of the future for consumer packaged goods (CPG) companies.

Supply chain complexities
Agricultural companies engaged in managing food supply chains are among the largest and most complex companies in the world. Agricultural supply chains are increasingly complicated because of the breadth of products they encompass: fruits, vegetables, grains, animal products, and animal proteins. They are also complicated because of the depth of engagement of agricultural companies across every life cycle category: extraction, production, processing, transportation, distribution, consumption, and disposal. These companies are competing on a global scale for expanding markets, but they face real risks of disruptions due to competition for limited land, water, and crops.

In response to global market pressures, every sector of agricultural production has undergone some degree of horizontal and vertical integration, creating interconnected global networks of private and commercial branded products. Horizontal integration is the aggregation of products and brands within a supply chain category; vertical integration is the aggregation of products and services up and down the supply chain. The leading companies driving horizontal and vertical integration of agricultural supply chains include:

- **Cargill**, the world’s largest private company (estimated annual sales of $135 billion), with more than 152,000 employees in 67 countries, is engaged in every stage of agricultural supply chains.

- **Unilever**, the world’s largest CPG company (estimated annual sales of $59 billion annually), employs almost 175,000 globally and manages more than 400 brands, of which 14 have annual sales greater than $1 billion.

- **Tyson Foods**, one of the world’s largest animal protein companies (estimated annual sales of $38 billion annually), employs 124,000 people in more than 110 facilities globally, sourcing animals from more than 11,000 independently owned farms.

- **ConAgra**, the largest U.S. CPG company (estimated annual sales of $16 billion annually), employs 33,000 people and owns 47 private brands.

These four companies generate a quarter of a trillion dollars in sales each year, employ half a million people, and control two-thirds of food brands on the grocery shelf. Each of these companies is very concerned about global sustainability challenges, as indicated in their annual reports, and more importantly, in their corporate decision-making.
Dining on the biosphere

The impact of global-scale agricultural production systems on Earth’s biosphere is significant. Environmental key performance indicators such as soil erosion, water quality impairment, habitat loss, and biodiversity loss are getting worse. The rates of these changes are accelerating to the point that we are altering Earth’s surface at continental scales. The 2014 Living Planet Report from the World Wildlife Fund (wwf.panda.org) estimated that more than 50% of vertebrate life has been lost since 1970. We have destroyed half the vertebrates (measured in numbers and species) on Earth in two generations. This rate of decline is increasing, driven by habitat destruction, habitat alteration, and over-exploitation. In many parts of the world, if it moves, it’s meat. We are eating the biosphere upon which our prosperity depends.

We currently consume more than one and a half times the annual production capacity of Earth. We use more than 40% of Earth’s terrestrial surface for agricultural production (including pasture and grazing lands). The only remaining arable lands to expand production are tropical forests and wetlands. The only way we will meet the food needs of 10 billion people without irreversibly damaging the biosphere is through intensification of production on existing agricultural lands. The world’s leading environmental conservation organizations have joined with modern agricultural production organizations to create strategies to ensure that the drive for intensification does not have undesirable consequences.

Food and agriculture supply chain companies recognize that changes on the land will be driven by decisions made through these companies, not by governments or international super-governmental organizations. Finding alignment of values, interests, and priorities is key to creating global improvements at local levels. More than 20 years ago, John Elkington (volans.com) coined the term “triple bottom line” to express the business model for sustainability:

- **Financial performance**
- **Environmental performance**
- **Social justice performance**

The rationale for this framing is that the true cost of doing business includes managing risks across environmental and social domains. For most companies, this means increasing efficiency across the entire life cycle of their products, understanding supply chain risks, and creating demand for innovation throughout their organization.

Increasing supply chain efficiency is where most sustainability discussions begin within companies. Inefficiency is waste, and waste is loss: lost revenues, lost time, lost resources, and lost opportunities. The presumption has generally been that successful companies are those that have achieved some threshold of efficiency in order to be competitive. However, the data on life cycle process management do not support this assumption because many true costs of operation are distributed across operational management categories. Water costs provide an example of how costs can be hidden from facility managers and corporate planners. A food processing facility might pay as little as $0.75 per thousand gallons at the meter at the front of the processing plant, but it may pay as much as $15.00 per thousand gallons surcharge to the municipal wastewater treatment plant for disposal of that water. Decisions on capital expenditures for water conservation generally do not make economic sense at $0.75 per thousand gallons but may very well make economic sense at $15.75 per thousand gallons. This decision is still economic; it does not touch on the additional costs associated with risks from water scarcity or pollution impacts. Finding the masked inefficiencies in global companies that are horizontally and vertically integrated is daunting. This challenge requires process knowledge, life-cycle assessment, and systems thinking.

Risk averse and beyond

Reducing risks is where most sustainability initiatives engage with environmental and social issues. Compliance with environmental regulations is no longer recognized as adequate environmental risk management; regulations represent just the baseline of acceptable practices. Companies must now manage the reputation of their brands through proactive control over their supply chains to ensure that their products, processes, and practices are not associated with environmental damage. This means that companies must know where the materials used to make their products come from, how they are grown/produced/processed, and how their supplier companies address environmental issues. Companies can no longer employ a “do no harm” environmental ethic; they must adopt a “make things better” environmental ethic. Understanding potential reputational risks requires understanding the impacts from all facets of a company’s activities and many facets of its suppliers’ activities. This requires expertise in risk assessment associated with geochemical processes, landscape ecology, and social and political equity.

Similarly, social responsibility within companies requires much more than compliance with safety, payroll, and welfare laws and regulations. Social sustainability issues within supply chains such as child labor, equitable pay, environmental justice, and worker safety must be managed and reported across the entire supply chain. A company that sources raw materials from an enterprise that engages in unethical labor practices will assume significant reputational risks. Child labor is a particularly vexing challenge. Globally, 60% of child labor (more than 98 million boys and girls ages 5 to 17) occurs in agricultural production. Agriculture is one of humanity’s most dangerous enterprises; risks to the health and welfare of children anywhere in a supply chain translate directly to reputational risks to companies.

Five years ago, companies that use chocolate in their supply chain were rocked by allegations that they were supporting child slave labor through participation in the cocoa trade from Côte d’Ivoire and Ghana. Many private brands were linked directly to alleged child trafficking practices for cultivation, harvesting, and processing of cocoa pods. In
Companies can no longer employ a “do no harm” environmental ethic; they must adopt a “make things better” environmental ethic.

response, Cargill developed the Cocoa Promise, committing to making “a tangible difference to farmer productivity and increasing their income and improving livelihoods for generations to come.” Cargill has implemented programs in farmer training to increase productivity and profitability, community support to increase access to education and healthcare, and farm development to improve smallholder cocoa tree health and genetics.

As of 2014, Cargill has trained more than 115,000 farmers in good agricultural practices, established more than 2,500 Farmer Field Schools around the world, and provided almost 34,000 children in producer communities with improved access to education. In 2014, more than 50,000 cocoa producers, mostly small landholders (2 to 3 ha) in Côte d’Ivoire alone were certified as sustainable growers. These producers are not Cargill employees; they are suppliers of raw materials in the chocolate supply chain. Cargill recognized that if they were going to be able to sell products made with cocoa, they had a responsibility to create a sustainable product from farm to table. This translation of risk across supply chains to CPG brands is driving sustainability initiatives around the world.

Imagine the cocoa story multiplied by 100 (the number of primary ingredients that each CPG manages) and you get a sense of the challenge facing agricultural companies around the world. Palm oil plantations are destroying critical rainforest habitat for orangutans and other key species; beef production in Brazil is damaging the Pantanal wetland ecosystem and accelerating Amazonian deforestation; cotton irrigation in Asia is reported to be a major driver of water scarcity in many regions. These examples illustrate the complexity and diversity of the supply chain challenges faced by global agricultural CPG companies. And these are just the challenges supported by some level of scientific data; companies also have to fend off a swarm of non-scientific reputational assaults from advocacy groups that exist solely to make unfounded accusations loud enough to achieve their ideological goals. For example, these organizations insist, without evidence, that genetically modified foods (GMOs) are bad for your health and the environment, or that the only sustainable production strategy for animals is free-range, pasture-fed, or cage-free. Agricultural production companies must either respond to these non-scientific allegations with science-based sustainability metrics or capitulate to reputational extortion.

The clarity of our role

The role of biological, biosystems, bioprocess, and agricultural (bio/ag) engineers in managing complex supply chains should be clear. Our profession is well positioned to address the challenges of global product safety, security, and stability through integrated geographic information systems (GIS) traceability, transportation logistics, and data management technologies. Food safety technologies have been a hallmark of bio/ag engineering for decades. For example, our profession is developing and deploying real-time sensors, indicators, and sentinels for bacterial contamination. Most important, bio/ag engineering has a 50-year history of assessing and mitigating environmental risks associated with production agriculture, starting with soil and water, and more recently assessing the design and sustainability of ecosystem services.

The challenges for our profession’s leadership is to guide undergraduate and graduate programs to prepare engineers who have the breadth of systems knowledge to understand the interconnected continuum of global supply chains and the depth of process knowledge to effectively address very specific challenges in agricultural food systems. No single professional can meet all of these challenges; teams of professionals across technology specializations are necessary to create integrated solutions to global problems. These teams will need leaders who understand how the processes fit together. These leaders must have an understanding of the processes that drive the triple bottom line: environmental, economic, and social systems.

As Executive Director for Sustainability at the University of Arkansas, I am responsible for administering our Sustainability Minor, open to all students across disciplines, to provide this global systems framework. I have seen students from bio/ag engineering engage in project leadership with amazing competence and effectiveness, which they attribute to the interdisciplinary nature of bio/ag engineering degree programs. We have the opportunity to define our profession as the leader in sustainable agricultural systems thinking, design, and management for the next century. Our profession understands that everything is connected, everything is changing, and most importantly, we are all in this together.

ASABE member Marty Matlock, P.E., Professor, Department of Biological Engineering, and Executive Director, Office for Sustainability, University of Arkansas, Fayetteville, USA, mmatlock@uark.edu.
Community Development from Oklahoma to West Africa: The Work Continues

Katie Arroyo

Editor's note: An article in the May/June 2012 Resource described Oklahoma State University’s student-led projects supporting sustainable solutions to food and water insecurity in Sierra Leone. This article provides an update on the continuing efforts.

Although some of Sierra Leone’s urban residents have access to “safe” well water, less than half the population can access potable drinking water, and people in rural areas typically drink water from polluted sources. According to the World Bank, as of 2012, 58% of Sierra Leone’s rural population and 18% of its urban population did not have access to improved water sources. In addition, every year brings six months of dry season and six months of monsoon season, with midday temperatures reaching 95°F and up to 80% humidity at all times. During the dry season, rural residents mostly eat imported bread and rice for three or four months because the land is too dry to grow food.

Food insecurity reached critical levels last year as the Ebola crisis spread throughout the country. As of May 30, 2015, Sierra Leone has accounted for 8,617 cases of Ebola, with 3,545 confirmed deaths. Freetown, Sierra Leone’s capital, became completely cut off due to issues with Ebola, and those not affected directly by the disease were affected indirectly through economic inflation, civil unrest, work shortages, stress from superstitions, and general misunderstandings about how the disease is transmitted. The rural residents with whom the OSU group works lack infrastructure connecting them to major trade hubs. Because goods must be transported from urban areas to rural open-air markets, rural residents pay higher prices than their urban counterparts. Ebola made this situation much worse, resulting in widespread hunger due to inflated prices for imported staples such as rice, flour, and petroleum. According to a 2011 World Food Programme publication, “Food insecurity … is a threat and impact multiplier for violent conflict.”

Despite the challenges created by the Ebola crisis, several OSU students featured in the previous article have led additional projects, both while in college and since graduation. This is really a story about how a small investment by determined, caring students and local communities goes a long way. It is also a story about the perseverance of Sierra Leone’s people.

ASABE member Jesi Lay conducted rainwater harvesting research for ten months during Fulbright studies in 2012-2013. Lay had previously received just over $2,000 in scholarships and stipends to offset the cost of two prior trips. In June 2014, she returned to Sierra Leone to check on the rainwater har-

Jesi Lay with sample collection bottles.
vesting system constructed as part of her research at the Mokonde Primary School, and she verified that all system components continue to be operational.

At about the same time, Richard Moore established an agricultural consulting business (International Agricultural Consultants LLC) and attracted venture capital, enabling him to move to the rural city of Kissy Town, Sierra Leone, about five miles east of Freetown. There he employed local residents, as well as several young students from the Freetown orphanage that the OSU group previously worked with, to develop a mango and pineapple farm that supplies a local Italian-owned juice company. He also raised chickens and developed a successful retail egg business.

Moore uses the operation as a vehicle to teach young people the science of agriculture along with principles of business and personal responsibility. He pays the tuition for several students to study agronomy at Njala University and focuses on providing guidance, planning, and startup capital to local entrepreneurs. He currently consults with five small businesses, ranging from boutiques to well drillers, as well as services that are either operating or about to launch. During the past six months, Moore has also worked as a professional water well drilling consultant, training teams and businesses throughout Ghana, Uganda, Rwanda, and Sierra Leone.

Liberty Galvin continues to run Gondwana International LLC, which raises funds to support Sierra Leone projects. Since 2012, the business has provided over $2,000 in student scholarships and funding for tools and supplies. Galvin anticipates providing up to $1,000 in scholarships to OSU students.
participating in future projects over the next year and may hire a student intern to support the business. She previously received about $7,000 in grants, scholarships, and stipends to help pay for three prior trips to Sierra Leone.

In 2013, after graduating from OSU, Galvin moved to Bonganema, Sierra Leone, on her own volition for nine months. She continued Lay’s rainwater harvesting work and successfully coordinated with locals and Njala University to install a rainwater harvesting system at a second primary school. Galvin plans to return soon to check on the system and to assist local entrepreneurs with starting renewable energy businesses for charging electric devices such as cell phones.

Galvin spent long hours with locals during extended stretches of food and water scarcity, and she observed firsthand how some people became desperate while others used wisdom to solve problems for the greater good. She also noted a population gap between ages 20 to 40, resulting from a generation lost to the civil war that ended in 2002. Consequently, the young people and orphans are dependent on foreign aid because they cannot help themselves, and those over age 40 are considered elderly.

A government authority approached Galvin about replicating the rainwater harvesting systems in the northwest part of the country, and she and Lay have also been asked to develop an instruction manual explaining how to build the systems. The manual will be published by Njala University Press.

Less than a year after Galvin returned to Oklahoma, the Ebola crisis reached record levels in Sierra Leone. With her personal network and knowledge of the local infrastructure challenges, she created a crowdfunding campaign, called The Rice Bag Challenge, to help overcome food insecurity in rural Bonganema, where she worked in 2013. The campaign exceeded its goal, raising over $2,600 to fund food aid to every house and even to schoolteachers living outside of the village. The Rice Bag Challenge sustained over 300 people for three months while their own rice crops were maturing.

The work continues, and those who labor are seeing the fruits of their efforts in a world where need abounds. Fortunately, there is no deficit of inspiration. Stay tuned for another update!

Katie Arroyo, OSU alumna and International Trade Specialist, Florida Small Business Development Center (FSBDC), University of North Florida, Jacksonville, USA, k.arroyo@unf.edu.

Further reading


Agricultural application equipment—such as grain planters, boom sprayers, and fertilizer spreaders—applies production inputs continuously to a limited area while in motion. This instantaneous rectangular coverage area that sweeps along with the equipment is known as the swath. Generally, the swath width is determined by the number of discharge points and the distance between any two adjacent discharge points. The number of discharge points usually corresponds to the number of crop rows that the equipment can span while traveling across the field. In most conventional equipment, the swath width is fixed for a given application, and a constant application rate is set for the input being applied. However, constant application rates are not efficient due to variations in the soil and crop conditions within the field.

Variable-rate application

Naturally, most agricultural fields are characterized by significant variability in soil conditions and crop characteristics. With conventional application, this variability can lead to excess inputs applied at some locations and insufficient amounts at other locations. In addition, agricultural inputs are expensive, and inefficient application increases the farmer’s production costs, impacts the environment, and poses possible health risks even beyond the application site. These concerns have influenced the development of precision technology that allows a more responsible way of applying agricultural inputs. By using less input, due to more efficient application and more precise distribution, farmers can realize financial benefits with less impact on the environment and human health.

Precision agriculture acknowledges the variability in the field and uses that information to the farmer’s advantage by varying the application based on site-specific need, a practice known as variable-rate application. Automated variable-rate application is made possible by a decision support system (a computer program) that performs highly computational decisions based on information about the current location, and then passes commands to the delivery components in order to implement the treatment. The information about the current location may come from on-the-go crop and soil sensors or from previously created GIS (geographic information system) or GPS (global positioning system) maps. Variable-rate application of production inputs, such as water, nutrients, and pesticides, minimizes waste, increases productivity, and promotes environmental sustainability. Thus, precision agriculture aims to optimize returns on inputs while preserving resources.
Swath control technology

New technologies are being developed to achieve variable-rate application, and they are available on new equipment and can be installed on older equipment. One such technology is swath control technology, which controls individual output components, such as nozzles, or groups of outputs, such as sprayer boom sections, based on real-time sensor data or GPS maps.

One example is the GPS-based Section Control (formerly Swath Control) developed by John Deere for field sprayers. With this technology, individual boom sections and nozzles are controlled by turning them on and off automatically based on a GPS coverage map. By delivering the input only when and where needed, the application is highly efficient. An updated GPS map is created as the sprayer travels through the field. Section Control can also be used with John Deere’s AutoTrac hands-free assisted steering to reduce overlap and eliminate skips in the field, thus achieving even greater efficiency.

Another example is Raven’s OmniRow planter control system. This system features a fully integrated design with real-time kinematic (RTK) sub-inch positioning accuracy. With this technology, precise seeding rates can be maintained for individual rows or sections. For best performance, the OmniRow works in tandem with Raven’s Envizio Pro II field computer and Slingshot RTK online service. This configuration provides variable-rate seeding, automatic on-off planter control, and real-time seed monitoring while eliminating skips, doubles, and overplants.

Looking ahead

While swath control technology automatically turns inputs on and off to avoid application to unwanted locations, the best efficiencies are achieved by adjusting the inputs within a range of values. For example, in variable-rate application based on a GPS map, individual nozzles can be adjusted to deliver different flow rates to different zones, in addition to observing no-spray zones. Using highly reliable sensors to obtain real-time data in place of GPS maps may further increase the flexibility of this technology. Some of these advances are already featured on newer larger equipment.

Technological improvements are continually needed to perfect each generation of agricultural equipment. Just as important, though, is the need to scale down this sophisticated technology, so that it can be accessible and affordable not only for farmers in advanced countries but also for farmers in developing countries.

ASABE member Peter Ako Larbi, Assistant Professor of Agricultural Systems Technology, College of Agriculture and Technology, Arkansas State University, Jonesboro, USA, and Division of Agriculture, University of Arkansas, Fayetteville, USA, plarbi@astate.edu.
Grains are normally harvested at a moisture content (MC) higher than the level required for safe storage. In order to reduce the MC to a safe storage level, some producers use low-temperature, natural air, in-bin drying systems. These in-bin drying systems generally maintain grain quality, but the associated slow air movement and occasional stagnation of the drying zone can result in differences in quality among the grain layers.

Recently introduced drying technology based on the equilibrium moisture content (EMC), also known as “cabling and sensing technology,” for use in on-farm drying systems retains the advantages of low-temperature, in-bin drying of grain with potential to maintain consistent grain quality. This new technology uses sensors that measure ambient air conditions and monitor the MC and temperature of the grain throughout the bin. With the new cabling and sensing technology, operation of the drying fans depends on the EMC conditions of the drying air and the MC of the grain. The drying fans are operated only under certain conditions of drying air temperature and relative humidity to avoid over-drying or re-wetting of the grain. The MC trend of the grain during drying can be accessed at any time and from any location via the internet, which makes monitoring the grain much easier.

While the new cabling and sensing technology appears very promising for managing grain drying, its ultimate success depends on (1) accurate EMC data to establish fan run time and air flowrate; (2) accurately assessing grain quality, especially in the upper layers where the grain remains at high MC for a longer time; and (3) providing efficient supplemental heating to speed up grain drying when the weather conditions do not allow complete and timely drying with ambient air.
Our team recently conducted a field study to determine the vertical and spatial variations in the quality of rice that had been dried and stored using the new cabling and sensing technology. This study produced the following observations:

- Rice samples from different layers within the bin exhibited variations in the standard quality indices, including milled rice yield (MRY), head rice yield (HRY), rice color, and pasting properties.
- There were some variations in the quality indices for rice between the center and perimeter of the bin, but the differences were not significant.
- In some drying scenarios, rice in the top layers and at the center of the bin had slightly elevated microbial populations compared with rice in the bottom layers and at the bin perimeter.

The findings provided justification to develop better drying and storage strategies to maintain the uniformity and quality of the grain throughout the bin.

Of greatest concern for most cereal grain consumers is potential contamination with mycotoxins, particularly aflatoxin, which is highly toxic even at doses as low as 20 ppb. Compared to grains such as corn, the problems of mycotoxin in rice have not been common. The capabilities of the new cabling and sensing technology to allow monitoring of grain MC and temperature, and the automated fan control accord on-farm, in-bin drying of grains a new paradigm to combat and protect in-bin dried grains from mycotoxin contamination after harvest.

Various strategies are used to control this risk before harvest, including:

- Selective breeding to advance the development of varieties resistant to mycotoxin-producing fungi.
- Proper cultural practices, such as choice of planting and harvest dates, tillage practices, crop rotation, plant population, irrigation, and sanitation.
- Applying crop protection chemicals or biological controls to mitigate mycotoxin contamination.

However, the spores of some pathogenic fungi such as Aspergillus flavus are prevalent in the air, making the fungus a common contaminant of grain in the field. The spores of such fungi are very heat tolerant and may
survive the convective heating used in conventional grain drying. When such spores encounter favorable conditions of equilibrium relative humidity, they may be activated, and their growth increases the risk of mycotoxin contamination. As a public health concern, survival of harmful fungi must be minimized.

The best way to control mycotoxins is to prevent their formation. Our team is working on in-bin grain modeling and simulations to identify and optimize suitable on-farm, in-bin grain drying and storage strategies that retard mold growth on grain, thereby reducing chances of mycotoxin development, and the development of auxiliary drying systems that can be used on the farm to dry grain as well as decontaminate grain of harmful fungi. The accompanying photos show our recently built, pilot-scale system for continuous infrared (IR) heating of grain to achieve rapid drying and inactivation of microbes. The single-zone system uses catalytic IR emitters powered by either natural gas or propane and has a modular design to allow adjustment of process parameters, including belt speed, IR intensity, belt vibration intensity, air circulation within the drying zone, and gap size between the product and the emitters. This new IR heating system has been tested for corn drying and has shown promising results.

Single-pass grain drying while simultaneously maintaining grain quality may also be possible with microwave heating. Microwave energy is typically associated with volumetric heating of agricultural products. In collaboration with microwave equipment manufacturers, our team is developing treatment methods that use microwave technology for drying and decontamination of agricultural products. These methods may allow one-pass drying with reduced MC and temperature gradients within individual grain kernels, thereby preventing cracking, which is especially important for rice kernels, and may also inactivate harmful microbes during storage.

When optimized, the new IR and microwave technologies will provide grain quality comparable to that of conventional drying systems. In addition, with the minimal cost of retrofitting at the front end of conventional dryers, the new technologies may find applications as auxiliary drying and/or pre-drying systems in both on-farm and commercial grain drying facilities.

**ASABE member Griffiths Atungulu**, Assistant Professor, Department of Food Science, University of Arkansas, Fayetteville, USA, atungulu@uark.edu.

Griffiths Atungulu (left) and Stephen Rogers of AMTek Microwaves examine rice dried in a pilot-scale microwave system at the University of Arkansas Department of Food Science.

The microwave system reduces the risk of mycotoxin contamination.
The common grape, *Vitis vinifera*, is native to the Mediterranean region, central Europe, and southwestern Asia—from Morocco and Portugal to southern Germany and northern Iran. There are currently 5,000 to 10,000 known varieties of *Vitis vinifera*, although only a small proportion are of commercial significance for wine (about 500 to 1,000 known subtypes), including the popular Cabernet Sauvignon, Chardonnay, Merlot, Pinot Noir, and Riesling. California’s Central Valley is the main grape-growing region in the U.S., and there has been dramatic growth in the wine industry throughout the Midwest. However, while the Central Valley has ideal climate conditions for growing *vinifera* varieties—including ample sunshine, dry and windy summers, mild winters, and gentle slopes—the Midwest is known for its long, cold winters and hot, humid summers. In the Midwest, vines often suffer bud and stalk injury during the harsh winters, and the humid summers can increase the risk of pest-related diseases.

Agronomists and horticulturists have developed several hybrid varieties that can thrive in Midwestern climate and soil conditions. Frontenac was developed in Minnesota, NY81.0315.17 was developed at Cornell University in upstate New York, and Orion was developed in Wisconsin. In the northeastern part of Kansas, where I live, there has been much recent interest in viticulture. The gentle slopes of the Flint Hills and sufficient windy days are two main advantages for growing grapes here, but the summer heat and humidity, as well as the harsh winters, create challenges. Norton and Vignoles, two varieties that tolerate the local conditions, are very popular in northeastern Kansas and Missouri.

Because the budding-to-harvest season is short in the Midwest and Northeast, grape vines are particularly vulnerable to pest problems. High humidity, cold spells, and varying environmental conditions can trigger outbreaks of fungi, insects, bacteria, and weeds. Pesticides have been used in agriculture since the beginning of the Industrial Revolution, when maximum crop yield was a necessity. However, for the last few decades, environmental concerns and pest resistances have compelled agricultural scientists and horticulturists to take a new approach to applying pesticides.

Integrated pest management (IPM) is a systematic method for applying pesticides with the intention of minimizing risks to the environment and the agricultural economy. IPM includes carefully planned application schedules, sanitization, and physical and biological controls whenever possible. In addition, in order to minimize pest resistance, IPM alters pesticide types and applies chemicals only when necessary.

**The advantages of ozone for IPM**

As part of the goal of replacing chemical pesticides whenever possible, a potential method for controlling blight in viticulture is spraying the vines with ozonated water. Ozone is believed to have broad-spectrum germicidal properties against viruses, bacteria, fungi, and protozoa. Just as important, none of these pests can develop resistance to ozone because ozone destroys organisms through oxidation—a chemical reaction that damages cellular membranes, degrades lipid molecules, and ruptures cell walls.

The use of ozone in bottled water was first regulated by the FDA in the 1950s. In 1982, ozone received “generally recognized as safe” status for bottled water, and labeling as a “food additive” was approved. In 1997, an expert panel approved using ozone technology as a potent antimicrobial treatment in a variety of food and beverage processing industries. Finally, in 2005, the USDA and FDA approved the use of ozone in the meat and poultry industry for ready-to-eat products with no labeling requirements.

According to research reported for other food industries, ozone treatment increased the shelf life of white fish by 50% for North Coast Seafood Co., and the combined effects of ozone and UV treatment by Kraft Foods, Inc., showed an 80% reduction in mold growth on seafood. Fungal development in blackberries was suppressed by 20% when stored at 2°C with 0.3 ppm ozone; the ozone treatment did not cause surface discoloration and increased the shelf life up to 12 days. When potatoes were stored at 6°C to 14°C with 93% to 97% relative humidity, adding ozone treatment extended the shelf life to six months. A three-log reduction of bacterial populations was reported when carrots were washed with ozone-treated water.

Ozone treatment has the following advantages over traditional pest control methods:

- Ozone is generated on-site at low concentrations and pressures, and then immediately used in the treatment
process. Hence, there are no concerns about safe storage and handling.

- Ozone has a short life span, measured in minutes, so any accidental release of ozone is not harmful. The ozone molecule (O₃) breaks down into stable oxygen (O₂) and does not form recalcitrant hydrocarbons, as pesticides do.
- Accidental exposure to high concentrations of ozone, which is very rare, can be treated, and complete recovery is possible within a day.
- No residues are left behind. Unlike chemical pesticides, ozonation does not require post-treatment washing to remove residues from food surfaces.
- Because of ozone’s effective mechanism, pests cannot develop resistance to ozone.
- When needed, ozone can be used to delay fruit ripening.
- Ozone is not a carcinogen.

Based on the above advantages, it is clear that ozone can be used safely and easily for treating pests, microbes, and fungal growth in food and beverage industries. Can ozone also be used for IPM in viticulture?

The use of ozone in viticulture

Ozone is already widely used in the wine industry for cleaning reactors, tank sanitation, and clean-in-place programs, and more applications of ozone in wine production will occur in the future due to ozone’s advantages over traditional germicidal agents. In viticulture, traditional pesticides have become unpopular in recent years because of their inherent risks. For example, copper fungicides, which are used to fight powdery mildew on grape vines, can produce foliage injury and toxicity. Ethyl mercaptan fungicides are effective for downy mildew, but they require a four-day re-entry warning after application. Mancozeb is the active agent in many other fungicides, but it cannot be applied for 66 days after harvest. All these chemical fungicides also have a reasonable chance of losing their effectiveness in coming years due increasing pest resistance.

At a recent Kansas Grape Growers Conference in Topeka, we discussed the benefits of spraying ozonated water as a pesticide treatment in Midwestern viticulture. With the suggestion that ozone is the only good pesticide, the discussion became heated. If ozone can be used in drinking water,
then surely it can be used in viticulture instead of chemical pesticides. Some growers have reservations about ozone because there is anecdotal evidence of leaf damage due to ozone application. However, the ozone concentrations used in pesticide treatment are very low, and the exposure of the vines to ozone lasts only a few seconds.

While ozone treatment has some advantages for IPM in viticulture, there are also some serious drawbacks. Primarily, there is a lack of scientific research on the effects of ozone in viticulture. Ozone’s ability to control common fungal diseases is not clearly documented, and the efficacy of using ozone to prevent different diseases could vary. For a variety of fungal and bacterial diseases, there are no data on the effects of ozone application. Furthermore, even when ozone is effective, the dosage requirements and scheduling for safe application in viticulture must be determined.

In a recent on-line discussion, Wayne Wilcox, director of Cornell University’s viticulture program, suggested that ozone treatment could provide effective control of powdery mildew growth, but only because ozone attacks powdery mildew on the surface of the plant. Ozone will not work for other fungal diseases such as downy mildew, black rot, and bitter rot—which are prevalent in humid climates—because those infections occur within the plant tissue. Wilcox expressed his skepticism about ozone treatment, and he agreed that scientific research is urgently needed to prove or disprove the usefulness of ozone for IPM in viticulture.

Considering the growing problem of pest resistance, earlier this year the USDA showed strong interest in approving GMO corn and soybean seeds that are resistant to 2,4-Dichlorophenoxyacetic acid. Better known as 2,4-D, this herbicide was an ingredient in Agent Orange, a powerful defoliant used during the Vietnam War that caused severe damage to human health and the environment. In the late 1970s, farmers noticed weed resistance to Roundup when using GMO seeds; hence, 2,4-D was introduced to combat this resistance.

However, this on-going chemical “arms race” is not a long-term solution. Environmentalists and researchers can agree that GMOs with resistance to 2,4-D will encourage farmers to use more herbicide, which will eventually lead to weeds with 2,4-D resistance, followed by the need for yet another pesticide to replace 2,4-D. Michael White of Iowa State University Extension added that 2,4-D, dicamba, and Roundup have also shown evidence of drifting off the target site. Therefore, based on pest resistance, evidence of drift, and our need to protect the environment, we must develop non-chemical technologies for IPM in viticulture, and in agriculture generally.

Vast scientific knowledge is available for cereal grains in the U.S. Midwest regarding crop growth and stored-product handling, but this is yet not the case for viticulture. Ag and bio engineers should be proactive about researching IPM alternatives in viticulture. Growers interested in viticulture need access to that knowledge, and novel IPM technologies that succeed in viticulture can also be used in cereal grains. Pest resistance and pesticide drift are serious problems for growers—and for anyone concerned about the environment. Pest-resistant GMOs will buy us some time, but fresh thinking and better treatment alternatives are needed.

ASABE member Rumela Bhadra, Research Associate, Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, USA, rumelabhadra31@gmail.com. The author invites reader comments related to this article.

Further reading
China Pursues Precision Agriculture on a Grand Scale

Lalit Verma

In a field of sorghum, demonstration of tractors and field machines for seeding, chemical application, and harvesting at Red Star Farm in Heilongjiang Province.

Feeding the future is taken seriously in China, as the ASABE delegation witnessed during the Second International Summit on Precision Agriculture (ISTPA 2014) in Beijing. The opening session provided specific viewpoints on precision agriculture (PA) from the host, Maohua Wang, and invited presenters from the U.S., the U.K., Germany, Belgium, Greece, Taiwan, Japan, and South Korea. Topics covered included:

- Innovative development of strategies for PA
- Precision management for both conservation and profitability
- PA in the U.K.
- PA in agricultural and biological engineering for a sustainable world—how is PA being redefined?
- ISOBUS in European PA
- “From precision to decision” in modern agriculture
- Plant sensing for PA and phenotyping
- Aptasensors for rapid detection of pathogens in agriculture
- Impedance sensors for soil water content
- Quality inspection of seedlings and fruits using chlorophyll fluorescence imaging
- Systems informatics and analysis for the agricultural supply chain
- Vehicle robotics
- The future of PA: designing for farms of tomorrow
- Precision livestock farming and dairy farming.

Not only were the myriad of topics and presentations current and intriguing, they also pointed out the advances that are being pursued in the academic, private, and public sectors.

On the road to PA

The second day of the summit took us to northeastern China, first to Harbin, the capital city of Heilongjiang Province, to visit the Heilongjiang Academy of Agricultural Mechanical Engineering and Science, followed by a bus ride to the Hongxing Farm in Beian City. This state-owned farming system in the Heilongjiang reclamation area is a colossal operation, with 113 farms totaling 1.28 million ha (3.16 million acres, covering 51 counties) and 1.7 million workers. About 21 million tons of grain are produced per year, and 98% of the operation is mechanized. In fact, there are about 87,000 tractors, 35,000 combines, 90,000 rice transplanters and related implements, 85 aircraft, and 63 airports, with 200,000 ha (494,211 acres) treated aerially with fertilizers and pesticides.

Attendees of ISTPA 2014 in Beijing, representing the U.S., the U.K., Germany, Belgium, Greece, Japan, Korea, Taiwan, as well as many universities, research institutes, and companies in China.
The PA initiative in China began in 2000, when a Chinese delegation visited U.S. manufacturers, including John Deere and Case IH. China began importing U.S. machinery in 2001, and the concept of PA gained acceptance at the farm level just a couple of years later. Auto-guidance of tractors was the most accepted technology, as it increased efficiency by about 40% due to the higher precision. At the Hongxing Farm, all tractors larger than 200 hp now have auto-guidance.

In Heilongjiang Province, about 25% of the farmland is managed according to PA, which has resulted in greater yields and productivity. John Deere’s GreenStar system, which depends on ground-level correction (GLC), is used. GLC has a 30 km radial coverage, and a network of GLC stations is being planned. This is just the beginning of the PA wave. Further improvements will include soil sampling and mapping, variable-rate application technology, and auto-guidance of all equipment. Yield monitors will help in identifying yield differences within and among fields, as one sample per hectare is insufficient for precision fertilizer applications. An increase in arable land will also contribute to yield increase, as the yield per unit of land has not increased yet.

A bottleneck appears to be the implementation of variable-rate technology in the field. Other elements that are still lacking include: field-scale comparisons of PA with the best practices of conventional farming, soil conservation and management practices, an organized schedule of projects to pursue from field experiments to commercial scale, life cycle analyses, agronomy-based inputs, as well as systems analyses, robotics, and optimization.

The Heilongjiang Province Agricultural Machinery Engineering Research Institute in Harbin is one of the entities providing technology for the China PA initiative. Others include the China National Research Center of Intelligent Equipment for Agriculture (NRCIEA), the China National Engineering Research Center for Information Technology in Agriculture (NERCITA), the National Research Center of Intelligent Equipment for Agriculture, the Chinese Academy of Agricultural Mechanization Sciences, and agricultural universities throughout China. China’s investments in the PA initiative are impressive, and they are bearing fruit. At the same time, targeted technical conferences and R&D programs at universities and institutes are ongoing.

NERCITA was established in 2001 and now has approximately 300 researchers in its 100,000 ft² facility. NERCITA has also established a 167 ha field site for PA research and demonstrations near Beijing. It has developed large-scale intelligent agricultural implements, a GPS base station, a monitoring station for soil conditions, greenhouse control systems, and a platform for precision fertilization and pesticide application testing—as well as other technologies that are now widely used in China. NRCIEA was established in 2009 to conduct research and development in intelligent agricultural equipment and to establish a digital design and testing platform. Alone, these two entities—charged with providing research, design, development, and manufacturing support for intelligent mechanization—demonstrate the level of commitment to PA in China.

The First International Conference on Smart Agriculture Innovative Development (ICSaid 2014) followed ISTPA 2014 during the 18th World Congress of CIGR in Beijing. The CIGR Congress was an impressive showing by our Chinese hosts. The events also allowed ASABE leadership and academic administrators to interact with their counterparts and tour the facilities at China Agricultural University. These interactions richly contributed to ASABE’s Global Engagement Initiative and reinforced the global importance of our profession.

Feeding the world in 2050 will greatly depend on the successful adaptation of PA technologies. However, systems that are successful on a large-scale in the developed world will need to be modified using appropriate technologies for application in developing regions that have more constrained resources. The PA initiative in China is a case in which abundant resources—natural, financial, and intellectual—are readily available. Other developing regions do not necessarily have such wealth and will need outside assistance to improve their productivity while sustaining their environment.

That’s where we come in. Agricultural and biological engineering is essential for producing more food with the least inputs, and providing this food to the people who need it most. Feeding the future is the grand challenge, and ASABE and our profession have a central role in meeting this challenge.

**ASABE Fellow and Past President Lait Verma**, Professor and Head, Department of Biological and Agricultural Engineering, University of Arkansas, Fayetteville, USA, lverma@uark.edu.
Starting a technical degree program similar to many of our sister institutions was an idea that floated around the University of Kentucky’s Department of Biosystems and Agricultural Engineering for years, and it began to take shape during the tenure of former department chair and ASABE Fellow Scott Shearer. Because of a possible new budget model at the university, the timing finally seemed right to launch the new degree, which would fulfill a need in Kentucky for highly skilled graduates who were prepared for technical jobs in the agricultural, manufacturing, and construction sectors. Our alumni reinforced the concept that a non-engineering-based program, with a different skill set than that of an engineer—one with more hands-on training—was needed.

I became interested in the new program, and about two years ago I had the idea that we could incorporate German-style skills training into the program. I received approval from Nancy Cox, dean of the College of Agriculture, Food, and Environment, to speak to the German Embassy about their “Skills Initiative.” Subsequent conversations with Mark Tomkins of the Chicago German Chamber of Commerce and feedback from our alumni influenced the shape of the program.

The new degree program, Technical Systems Management (TSM), marries business and technical theory with skills, where the skills-based portion is reinforced through actual jobs the students hold during the semester, and an online portion that emphasizes the “soft” skills we expect the students to learn that semester. What we call “work-based learning” (WBL)—similar to a cooperative learning experience or internship—is only one part of the education, but it provides a bridge between student knowledge and industry expectations. In our version, the WBL component (100 hours, two credits each semester for a minimum of four semesters) is supported with an online course (one credit) designed to promote critical thinking and increase soft skills.

Extended WBL is rarely found in similar four-year technical programs and is often optional in engineering programs, as is the case at the University of Kentucky. Much of the TSM program has been designed around WBL, including courses and academic-industry partnerships, so that students have the advantage of gaining practical, theoretical, and managerial skills. TSM students also get an early opportunity to develop a relationship with employers, with a view toward a potential job offer at graduation.

After completing TSM 101 (Introduction to TSM) and TSM 102 (Introduction to Work-Based Learning) in their first year, students work 100 hours each semester while completing the following courses:

- TSM 201 WBL 1: Fundamentals of WBL
- TSM 202 WBL 2: Training Management and Leadership – Part 1
- TSM 301 WBL 3: Understanding the Technical Work Environment
- TSM 302 WBL 4: Training Management and Leadership – Part 2
- TSM 401 WBL 5: Conflict Management
- TSM 402 WBL 6: Capstone

Some of the foundation for this curriculum resulted from meetings that current department chair and ASABE member Sue Nokes and I had with Mark Tomkins, as well as with Josh Benton, Executive Director for Workforce Development in the Kentucky Cabinet for Economic Development. After more planning, our internal team—Sue Nokes, ASABE member Alicia Modenbach, Donnie Stamper, and I—began developing the program, and our first students—two juniors and three freshmen—enrolled in fall 2014.

TSM has been approved as a minor in the University’s College of Agriculture, Food, and Environment and is under consideration at the university level. Until full approval as a major is obtained, TSM will be offered as a BS degree through the Individualized Program in Agriculture in the College of Agriculture, Food, and Environment. As far as we know, it is the only four-year program of its kind in Kentucky.
and, as such, can serve as a strong model for the development of similar STEAM-focused technical programs in Kentucky and beyond (STEAM is STEM + Agriculture, or STEM + Art). From those first five students in fall 2014, enrollment has increased to ten for spring 2015. Meanwhile, our advertising for the program has been modest—one ad last year and promotion at events such as the National Farm Machinery Show and FFA Convention.

So far, we have contacted more than 30 local companies and community partners about the TSM program, and all of them have given us overwhelmingly positive feedback. Once industry partners understand the concept, they like the idea of working with students and shaping their early work experiences. I teach TSM 102 (Introduction to Work-Based Learning), which is a professional development course in which students visit a new work site each week (13 to 15 work sites as the semester allows) to gain an understanding of different work situations and employment opportunities. Last semester we visited companies that showed early support for the program, including Alltech, Keeneland, Smucker’s, Farmers Feed Mill, and 3M. These site visits give employers a chance to meet the students for the first time and gauge their level of interest and knowledge. Industry partners are crucial to the success of the program. By involving them in the process, we hope to secure continuing support for WBL and the TSM program.

The design of the program is still flexible. For example, requiring six semesters of WBL may not be necessary as the program grows; we can scale it back if needed. We are also looking forward to the tipping point in public awareness—that is, when the program’s reputation attracts employers to our graduates because the TSM degree is a proven fit for employers’ needs.

So far, the results are promising. Here’s a typical testimonial from a prospective employer: “Students obtaining a TSM degree are ideal candidates for Archer Daniels Midland Company’s Ag Services Operations Management Program. Our Ag Services Operations Management interns and trainees have the opportunity to challenge themselves and develop their skills at one of ADM’s many locations in a hands-on work environment,” says Rebecca Crowl of ADM Ag Services.

Karin Pekarchik, Distance Learning Trainer and Extension Associate Senior, Department of Biosystems and Agricultural Engineering, University of Kentucky, Lexington, USA, karin.pekarchik@uky.edu.

**UK’s First TSM Student**

**Stefan Fink, TSM Senior**

**Technical Systems Management/Agricultural Economics Double Major**

“During my first semester in the Technical Systems Management program, I did my work-based learning experience in UK’s Engineering Design Center. I was supervised and instructed by Dr. George Day, a research specialist in controlled environment systems engineering, and my co-worker was Shelby Grinnan, the second TSM student. I worked an average of eight hours per week with heavy instruction during the first half of the semester, and I worked more independently on a project during the second part of the semester. Shelby and I went through safety training for laboratories, and we also discussed our goals and expectations for the shop experience individually with Dr. Day. This allowed him to direct his teaching to our interests and needs.

“After learning and practicing the basics of the shop equipment, we started our project—to build a sheep-feeding wagon, often referred to as the “war wagon.” It was neat to be part of a research project and to help build it. We got to use all the skills we learned in the shop to construct the wagon, and we worked with ordering and purchasing the materials and supplies for it as well. The project gave me something to look forward to when going to the shop every day and something to take pride in here at UK.

Shelby Grinnan and Stefan Fink, now both seniors in the University of Kentucky’s College of Agriculture, Food, and Environment, were the first two students in the new Technical Systems Management program. As their work-based learning project, they designed and built a sheep-feeding wagon to be used for rotational grazing.

“My entire shop experience taught me how to communicate in a shop environment, work well in a group, be more precise and accurate, fabricate with machine tools, and weld. Working with Shelby was a great teamwork experience. Dr. Day worked with us in a slow, thorough, and positive pace throughout the semester. He discussed every detail and explained our lessons to us very clearly while making it fun, interesting, and safe. The experience allowed me to learn outside of the classroom and build relationships with others that will benefit my career in the future.”
We need you! The primary annual fundraising events for the Foundation are held during the Annual International Meeting, this year in New Orleans. And there is something for everyone! You can support the Foundation by participating in these events (think scholarships!), have fun, and enjoy networking, too. All 2015 proceeds go to the KEYS fund to support student development and humanitarian outreach.

**ASABE Foundation Silent Auction**  
**Sunday, July 26, through Tuesday, July 28**
Bid on all the great items donated by ASABE supporters to assist the work of the Foundation. To see the available auction items, scan the QR code or go to www.asabe.org/foundation/activities.aspx for a link to the catalog. Stop by the Marriott Exhibit Hall often, as bidding changes often!

**Gale Holloway Memorial Golf Outing**  
**Sunday, July 26, 8:30 a.m. tee time, $100**
Whether you are a beginner or a pro, the Gale Holloway Memorial Golf Outing is for you. If you’re unable to play, consider sponsoring a colleague or student! The gorgeous Audubon Park Golf Course, managed by the Audubon Nature Institute, is about six miles from the Marriott. Travel time is 20 minutes, and the Pro Shop will have clubs for rent.

**Foundation Portrait Studio**  
**Monday, July 27, and Tuesday, July 28, Donation**
Improve your personal brand with a portrait photo, perfect for social media networking, web directories, awards, or research publications. The Foundation is offering professional headshots on Monday and Tuesday mornings in the Foundation area of the Exhibit Hall. Smile for the camera!

**ASABE Foundation Dinner**  
**Mardi Gras World and Grand Oaks Mansion**  
**Tuesday, July 28, 6:30 to 10:00 p.m., $125 includes transportation, reception, and dinner**
What is New Orleans without Mardi Gras? Get a behind-the-scenes look at Mardi Gras floats, followed by dinner at the magnificent Grand Oaks Mansion, New Orleans’ only indoor antebellum mansion replica. After dinner, enjoy relaxed conversation with friends on the porch or take a stroll along the river under the moss-draped oaks. Register early for this popular event.

**ASABE Foundation Display**
Be sure to stop by the Foundation display in the Exhibit Hall. Learn more about the Foundation and the programs the KEYS fund supports. Meet members who have contributed to the profession and supported the Foundation so it can work for ASABE. Membership dollars are changing lives!

See you in New Orleans at the Foundation events!

ASABE member Jodie Wehrspann, Senior editor, Farm Industry News, Minneapolis, Minn., USA, jodie.wehrspann@penton.com.

ASABE member and Foundation Development Committee Chair Sylvia Schonauer, P.E., Principal Engineer, Advanced Innovation, W. K. Kellogg Institute, Battle Creek, Mich., USA, sylvia.schonauer@kellogg.com.

© Johan63 | Dreamstime.com; © Karlien Duplessis | Dreamstime.com; © Andres Rodriquez | Dreamstime.com; Grand Oaks Mansion photo courtesy of Mardi Gras World.
ASABE Annual International Meeting
New Orleans - July 26-29

MONDAY
Opening Session & Keynote Address
Please welcome Dr. Margaret Zeigler, Executive Director of the Global Harvest Initiative to give the 2015 Keynote Address.
8:00AM in the 3rd Floor Grand Ballroom
Join us for this exciting talk and more to kick off the 2015 Meeting.

MONDAY
Soil & Water Day
10:00AM-4:15PM
3rd Floor Grand Ballroom

TUESDAY
Bioenergy Focus Day
8:00AM-4:00PM
3rd Floor Grand Ballroom

NRES DISTINGUISHED SCHOLAR SERIES SPEAKER:
PROF. ANDREA RINALDO ON ECOHYDROLOGY
Join the top experts in the Ecohydrology field in this New Distinguished Scholar series, brought to you by the NRES Technical Community and ASABE Initiative Funding.

NATURAL RESOURCES AND ENVIRONMENTAL SYSTEMS DISTINGUISHED LECTURE SERIES
2:30PM-4:15PM

NRES POSTER SESSION & RECEPTION
4:00PM-6:00PM

TUESDAY STUDENT PIZZA LUNCH
TUESDAY 12:00PM-2:30PM
Tips and advice for students from successful researchers including Prof. Rinaldo.

Panel:
ENVIRONMENT-ENERGY NEXUS AND POLICY ISSUES
Discussions around policy, environmental, social, and economic opportunities in the bioenergy sector.

Panel:
INDUSTRY-CENTRIC PANEL
Focus on challenges and opportunities in scaling up existing bioenergy technologies to commercial scales.

POSTER SESSION
Bioenergy related posters from all technical communities of ASABE

Visit www.ASABEmeetings.org • Follow us on Twitter @ASABE_meetings #ASABE2015
Purdue leading research to improve water management on farms

In Brief: A Purdue University researcher is heading a $5 million federally funded project examining the economic and environmental benefits and costs of storing water on farms so that crops can use it when needed and to reduce loss of nutrients into waterways.

A SABE member Jane Frankenberger, professor of agricultural and biological engineering, is directing the five-year research project addressing the issues of farm nutrients draining from fields, causing problems downstream, and the need for water in the late summer to irrigate sometimes parched crops. “Both of these problems are expected to get more pressing with climate change,” Frankenberger said. “This research will collect data now that will help farmers make better decisions in the future.” The research is funded by the USDA National Institute of Food and Agriculture.

Other universities participating in the research project, titled “Managing water for increased resiliency of drained agricultural landscapes,” are Iowa State University, North Dakota State University, Ohio State University, University of Missouri, North Carolina State University, South Dakota State University, and the University of Minnesota, as well as the USDA Agricultural Research Service.

The objective is to advance three innovative practices that can address the problems of crop loss due to the increased likelihood of summer drought and the degradation of water quality from drained farmland:

Drainage water management: This practice conserves water by raising the drainage outlet using a water control structure, thereby retaining water in the soil profile when drainage is not needed.

Saturated buffers: This practice stores water within the soil by diverting tile water into laterals that raise the water table and slow outflow. Early results indicate that buffers can be effective in removing nitrate from tile drain water before it is discharged into surface waters.

Capture and use: With this system, subsurface drainage water is diverted into on-farm reservoirs, or ponds, where it is stored until it is needed to irrigate crops.

The researchers say that each of these practices has been evaluated at scattered fields across the region, but the findings have not yet been brought together and made into tools to improve decision-making.

Drained lands comprise about 25% of U.S. cropland, some of it among the most productive in the world. Depending on the weather in any year, this land can get too much water from rain and snow or not enough water during drought. Many scientists believe that such conditions will intensify with climate change.

The project will integrate research and education to develop new understanding, tools, and strategies to increase the resiliency of drained agricultural land. Extension and education programs will extend the strategies and tools to agricultural producers, the drainage industry, watershed managers, agencies, and policy makers. They also will help to educate the next generation of engineers and scientists in designing drainage systems that include storage in the landscape.

Other Purdue researchers working on the project are Laura Bowling, associate professor of agronomy; SABE member Bernard Engel, professor and head of the Department of Agricultural and Biological Engineering; SABE member Eileen Kladivko, professor of agronomy; and Linda Prokopy, associate professor of natural resource social science.

A video clip of Jane Frankenberger explaining the research, is available at https://www.youtube.com/watch?v=ynOVY0BeFI.

For more information, contact Keith Robinson, Coordinator of News and Public Affairs, Department of Agricultural Communication, Purdue University, West Lafayette, Ind., USA, robins89@purdue.edu.

Top photo courtesy of USDA NRCS.
Stem-bending sensor can predict yield in bioenergy crops

In Brief: A “look-ahead” sensor that converts the bending load of napiergrass to a measure of yield was one of four yield-sensing approaches developed by University of Illinois (U of I) researchers. The study was conducted in Florida and funded by the Energy Biosciences Institute.

Napiergrass, also known as elephant grass, resembles sugarcane in stature and in methods of propagation. The grass is emerging as a candidate bioenergy crop, but few studies are available on napiergrass yield sensing, a technology that could play an important role in implementing precision agriculture and reducing harvest costs. ASABE member Alan Hansen, professor in the U of I Department of Agricultural and Biological Engineering, and ASABE member Sunil Mathanker, postdoctoral researcher in the department, worked with colleagues from John Deere and BP Biofuels to field test four yield-sensing approaches and document their correlation to napiergrass yield.

In this study, a stem-bending yield sensor was developed to fit a John Deere 3522 sugarcane billet harvester. Four load cells were fitted between two parallel pipes to form a push bar. The push bar was installed between the crop dividers about 1.2 m above the ground and 1.5 m ahead of the basecutter. The study also investigated the hydraulic pressures of the basecutter, chopper, and elevator drives as indicators of yield. Three pressure sensors were fitted to the inlets of the hydraulic motors operating the basecutter, chopper, and elevator on the John Deere harvester.

The sensor that measured stem-bending force was the most accurate among the four methods tested. “What’s particularly good about this sensor,” said Hansen, “is that we’re able to measure yield at the point of entry. This is somewhat unique. In combine harvesters, yield is monitored at a point much farther along in the flow of material, where the grain is about to enter the tank at the top of the combine. The delay between when the grain comes in and when it reaches the point of measurement creates a potential for error, which requires an estimate in relation to the time lag. So having this look-ahead sensor right up front is of significant value.”

While the look-ahead sensor showed the best correlation with yield, Mathanker said there are still issues, such as crop lodging, harvester speed, and the ability of critical components to respond to sudden changes in ground speed, that pose a challenge for this sensing approach. Varietal characteristics, harvest time, moisture content of the stems, soil conditions, sensor height, and physical properties of the stems can also influence the bending force on the push bar.

Among the three hydraulic pressure-sensing approaches, the chopper pressure showed the highest correlation with yield. A reasonable correlation was found between the basecutter pressure and yield, although it was expected that the basecutter pressure would depend on cutting height in addition to yield. Chopper and elevator pressures were less affected by factors other than yield compared to basecutter pressure.

“Based on the results of this study,” Mathanker said, “the stem-bending yield sensor showed potential for real-time napiergrass yield prediction. It can also be used to control operating parameters of the harvester, such as travel speed, and generate yield maps for precision agriculture. We believe this force-sensing approach can be extended to other thick-stemmed crops as well.”

Hansen and Mathanker published their findings in Computers and Electronics in Agriculture (doi: 10.1016/j.compag.2015.01.007). Co-authors of the article are ASABE members Hao Gan, Jason Buss, and John Larsen.

For more information, contact Leanne Lucas, News Writer, Agricultural Engineering Sciences, Urbana, Ill., USA, llucas@illinois.edu.
Vegetable study targets water saving in the Texas High Plains

In Brief: Vegetable production is not new in the Texas High Plains, but it is being re-examined in a Texas A&M AgriLife Research study to see if it might offer a water-saving alternative for some cereal grain production.

Everybody knows we are generally short of water in the Texas High Plains and can no longer meet 100% of all crop water needs,” said ASABE member Thomas Marek, senior research engineer for irrigation water conservation and management at AgriLife Research in Amarillo. “We grow a tremendous amount of corn for the cattle industry, and we know from our regional water plan that corn production is going to have to be reduced in the future.”

Marek said production changes, preferably to higher-value crops such as certain types of vegetables, might be a partial solution to sustaining future profitability for Texas High Plains producers, particularly those facing water shortages in the northwestern area.

“Water is the largest input factor for economically feasible crop production, so numerous water management strategies have been proposed by the region’s water planning committee, the Panhandle Water Planning Group,” he said. “One of the strategies being considered is crop changes to reduce irrigation water use.”

“While water use for vegetables may not be less per acre than that of some currently produced cereal grains, less overall regional acreage may be required to maintain or even increase the existing profit level for producers,” Marek said.

Marek conducted a relatively small demonstration in 2014 with several categories of vegetables at AgriLife Research’s James Bush Farm north of Bushland, Texas. The USDA-ARS Ogallala Aquifer Program, AgriLife Research, and the USDA National Institute of Food and Agriculture supported this study. Marek said they grew higher-value runner-type vegetables such as squash, zucchini, cucumbers, as well as peppers, onions, melons, tomatoes, black-eyed peas, and okra. “We have a pretty definite range of what we are evaluating at this point,” he said, “and the potential has been promising to date.”

All vegetables were grown with a single irrigation level targeted at high evapotranspiration (ET). A weather station, which is part of the Texas High Plains Evapotranspiration Network, was located near the plots and was used to compute daily reference ET to determine what the actual water demand was.

Plots were planted on May 29 and again on June 10. This was later than desired, but scheduling conflicts prevented earlier operations. Irrigation was applied using surface-flow systems. Because the total plot area was relatively small, Marek said irrigation efficiencies were very high, and the total amount of irrigation applied from planting to harvest was 17.46 in. The in-season rainfall in 2014 was 12.61 in.

Each vegetable was planted on a bedded, two-row, 20 ft long plot. The row spacing was 30 in. Vegetables were hand-harvested on a two to three day picking schedule. Data on plant count, harvested fruit number, total harvested weight per picking, and water use were recorded for each harvest event.

Several findings were determined from the first round of the study: earlier planting would help increase yield output per plant, and plant establishment with transplants needed to be augmented with protective wind cylinders due to early-season high winds in 2014. “We had local folks driving by the field and asking, ‘What are all those white things out there in the field, and what are y’all doing?’ so I knew the community was paying attention,” Marek said.
Marek indicated that they would also need to look at the heat unit requirements to be sure vegetables can be routinely produced. In addition, more research is needed regarding water use and management within the region before adequate assessment can be made for vegetables as a viable water-saving alternative to current cereal grain production.

A demonstration is planned again for 2015 and will be complemented with related projects in the Texas A&M AgriLife cropping system program involving other AgriLife Research scientists and Texas A&M AgriLife Extension Service specialists. “The results so far have been promising,” Marek said, “We can produce vegetables. What’s needed ultimately is to develop a market structure. We will also continue to determine the production aspects and water-use efficiency of various vegetables and determine what is most efficient over time.”

For more information contact, Kay Ledbetter, Associate Editor and Communication Specialist, Texas AgriLife Research and Texas AgriLife Extension Service, Amarillo, USA, sklledbetter@ag.tamu.edu.

On-line tool evaluates options for reducing odors from livestock operations

In Brief: A team of Iowa State University Extension and Outreach specialists has developed an online tool to help livestock and poultry producers compare odor mitigation techniques that could be useful on their farms.

The Air Management Practices Assessment Tool, AMPAT for short, is web-based and available at no charge at www.agronext.iastate.edu/ampat. “The website was developed to help livestock and poultry producers identify practices to reduce odors and emissions of gases and dust caused by animal production,” said Angie Rieck-Hinz, an ISU Extension field agronomist and member of the project team. “The database lists options for three core sources of odor and emissions—animal housing, manure storage and handling, and land application.” Other members of the team include ASABE members Jay Harmon, Steven Hoff, and Dan Andersen, professors of agricultural and biosystems engineering at Iowa State.

Producers can select a specific mitigation practice and learn more about its effectiveness and relative cost by using AMPAT in conjunction with the National Air Quality Site Assessment Tool (http://naqsat.tamu.edu/) to identify opportunities to make changes, find best practices for improving air quality, and evaluate their effectiveness.

To evaluate practices on AMPAT, the producer selects one of the three core odor sources. Each category provides access to resources that are specific to a particular pollutant. Once a pollutant is selected, a variety of resources are listed. The resources include research-based publications on recommended practices, the pros and cons of using a recommended practice, and short videos. Additional information and related links also are provided.

“Our goal was to develop a tool that is easy to use and provides relevant information for livestock producers across the state,” Harmon said. “AMPAT helps producers see which technologies have the highest impact.”

For quick reference, AMPAT uses a colored-coded listing of the technologies available to address pollutants. Green indicates that the selected technology has a high impact on that particular pollutant; yellow and red indicate medium and low impact, respectively. No color indicates that there is insufficient data available to classify the effectiveness.

“For example, if producers are concerned about a potential odor problem from animal housing, they can scan down the list under the ‘odor’ heading. From the list, they will find that ‘siting,’ ‘scrubbers,’ ‘urine/feces segregation’ and ‘biofilters’ have green bars, meaning they have high impact on odors. With that information, the producers can then investigate options for implementing those technologies and evaluate their selection based on relative cost, or they can investigate all four options.”

“It’s not uncommon for producers to identify best practices and implement them in their operations,” he said. “Producers want to be good neighbors, and this tool helps them to achieve that goal.”

For more information, contact Dana Woolley, Communications Specialist, Departments of Agricultural and Biosystems Engineering and Aerospace Engineering, Iowa State University, Ames, USA, dwoolley@iastate.edu.

The AMPAT website shows a colored-coded listing of technologies available to mitigate odors and pollutants.
Inexpensive aerial imaging can target treatments where they are needed

In Brief: ASABE member Chenghai Yang, an agricultural engineer with the USDA, has developed a practical, cost-effective approach for taking aerial images of cotton fields that are detailed enough to show patches of large fields in need of special attention.

Small aircraft have been used for years to survey fields and treat crops for pest infestations, plant diseases, and other problems. But Yang, who is with the USDA Agricultural Research Service in College Station, Texas, began evaluating whether aerial imagery could spot problem areas within cotton fields when growers started using a new fungicide to control cotton root rot. Root rot infections are usually limited to just 20% to 30% of a field. But many growers treat entire fields, thereby wasting a fungicide that costs about $50 an acre.

Working with Texas A&M AgriLife scientists, Yang mounted two digital cameras on the underside of a small airplane, equipped them with GPS, and took images of cotton fields to see whether they could identify areas with cotton root rot. One camera took standard color images, and the other camera was filtered to capture images in near infrared. Yang tested the system for two years with about 40 flights at altitudes ranging from 1,000 to 10,000 ft on sunny and cloudy days.

Yang’s results show that the equipment could detect the presence, location, and disease progression of cotton root rot, as well as invasive weeds and areas affected by drought stress. The dual-camera system costs about $6,000, but Yang says that a $1,500 system with a single camera will also suffice. The camera can be attached to the bottom of an aircraft with minimal modifications. Fees for aerial surveys should be more than offset by reduced pesticide costs, and fewer chemicals will get into the soil and waterways, he says.

For more information contact, Dennis O’Brien, Public Affairs Specialist, USDA-ARS, dennis.obrien@ars.usda.gov.
AGRICULTURAL AND BIOLOGICAL ENGINEERING

Visual Challenge 5

ENTRY DEADLINE: September 30, 2015

To call attention to and celebrate the visual aspects of agricultural and biological engineering, Resource announces the Fifth Agricultural and Biological Engineering Visual Challenge.

The theme is visual communication of agricultural and biological engineering, and the Challenge is open to all—members, non-members, engineers, and non-engineers. To participate, submit one or more entries in any or all of three categories: photographs/captured images, illustrations/drawings, and informational/explanatory graphics.

Engineers have a unique responsibility to communicate technical concepts to a larger audience. Traditionally, that is done with words and numbers. Increasingly, however, communication in images makes statements without words. Visual imagination combined with technical skill can produce astonishing—and deeply informative—images.

We urge you to participate!

The Visual Challenge is an opportunity to be creative and to show those outside the ABE field: “This is what we do.” Use your entry to convey the beauty and meaning of your work, your research developments, and your Technical Community. All entries should be original work.

Submit your entry as an e-mail attachment in jpg format (300 dpi or higher) to Sue Mitrovich, Resource managing editor (mitro@asabe.org). Enter “Visual Challenge” in the subject line, and include your full name, professional affiliation, contact information, and a title with a brief description of your entry in your message. If necessary, include a source credit and an assurance that permission has been granted to submit, and possibly reprint, the entry. Multiple entries are welcome.

The winning entries will be selected by Resource staff and published in the January/February 2016 issue.
What Makes an ASABE Fellow?

Carol Flautt

Election to Fellow is one of the highest distinctions an ASABE member can achieve. Members who have been elected to Fellow often say it is one of the most significant experiences of their career. Recognition by peers carries an honor that is unmatched. So what is the process?

Characteristics of a Fellow

The ASABE 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. Graduation from a professional agricultural engineering curriculum (or its engineering equivalent) shall be considered equal to four years of active practice. 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.”

Nomination and election to Fellow follow rules prescribed by the Board of Trustees: “The number of candidates elected to the Grade of Fellow each year shall not exceed 0.2 percent (2/10 of 1.0 percent) of total ASABE membership in the grades of Member-Engineer or Member at the end of the immediate preceding calendar year.” The instructions for submitting a Fellow nomination can be found on the ASABE website (www.asabe.org/FellowNominationInstructions).

To nominate an ASABE member for Fellow

The initiating sponsor provides ASABE Headquarters with the following nomination information by April 15 for possible election and presentation the following calendar year:

- The Fellows Nomination Form, completed and converted to a PDF file, should be submitted as an e-mail attachment to the ASABE Awards Administrator. The maximum length of the completed nomination form is four pages.
- The Nomination Form should be accompanied by a minimum of six letters of support prepared by Fellows or members of ASABE. The nominator cannot be one of the individuals submitting a letter of support.

A maximum of eight letters of support may be submitted, but only six must satisfy the ASABE membership requirement. The letters may be sent with the Nomination Form or sent separately in a PDF file to the attention of the ASABE Awards Administrator. Each letter of support needs to include the writer’s name, work affiliation, address, phone number, e-mail address, and ASABE member number.

The letters of support are to be prepared by those who are representative of the profession insofar as technical interest, geographic area, occupation, and professional responsibility are concerned. The letters should relate the letter writer’s personal knowledge and evaluation of the nominee’s achievements, recognitions, and professional activities. Letters are limited to two pages.

Generally, a letter of support summarizes personal knowledge about the nominee, focusing on the unique contributions that the nominee has made to the profession. Usually included are thoughts and comments about the nominee’s personality, work ethic, and teamwork skills.

The nominator will be notified by ASABE Headquarters after the nominee has been recommended by the M-131 Fellows Screening Committee and elected to Fellow by the Board of Trustees. If the nominee is not selected in the first year of consideration, the Fellows Screening Committee will consider the nomination for two additional years.

The newly elected Fellows are given special recognition at the Fellows Ceremony and Reception held during the Annual International Meeting (AIM). News release information and publicity are issued following the AIM.

The list of active and living elected Fellows of the Society is published in the annual ASABE Member Roster and is posted on the ASABE Fellows web page (www.asabe.org/DirectoryOfFellows).

Soon, a listing of all ASAE/ASABE members who have been elected to Fellow will be included on the ASABE Fellows web page. However, there is missing information concerning members elected to Fellow prior to 1965. If you know of members who were elected to Fellow and are not included in the listing, we would greatly appreciate your providing this information, along with the year they were elected.

If you have any questions, please contact me at flautt@asabe.org, and I will be delighted to provide further information.

Carol Flautt. ASABE Awards Administrator, St. Joseph, Mich., USA, flautt@asabe.org.
NEW!

HOBO RX3000 Weather Station

The HOBO RX3000 is a research-grade data logging weather station that combines greater measurement flexibility and an on-board LCD display in a rugged, easy-to-deploy package.

- Cloud-based data access
- Plug-and-play Smart Sensors
- LCD display for easy field deployment
- Alarm notifications via text, email
- Rugged double-weatherproof enclosure

Get your next-generation Weather Monitoring Station now!

Starting at $899 USD

onsetcomp.com/rx3

Easy Deployment

On-board LCD display confirms logger operation before you leave the site.

Plug-and-Play

The RX3000 eliminates the need for programming or complicated wiring.

24/7 Data Access

 Transmit data to HOBOlink – Onset’s cloud-based software platform.

To learn more call 1-866-460-9160, or go online:

onsetcomp.com/rx3