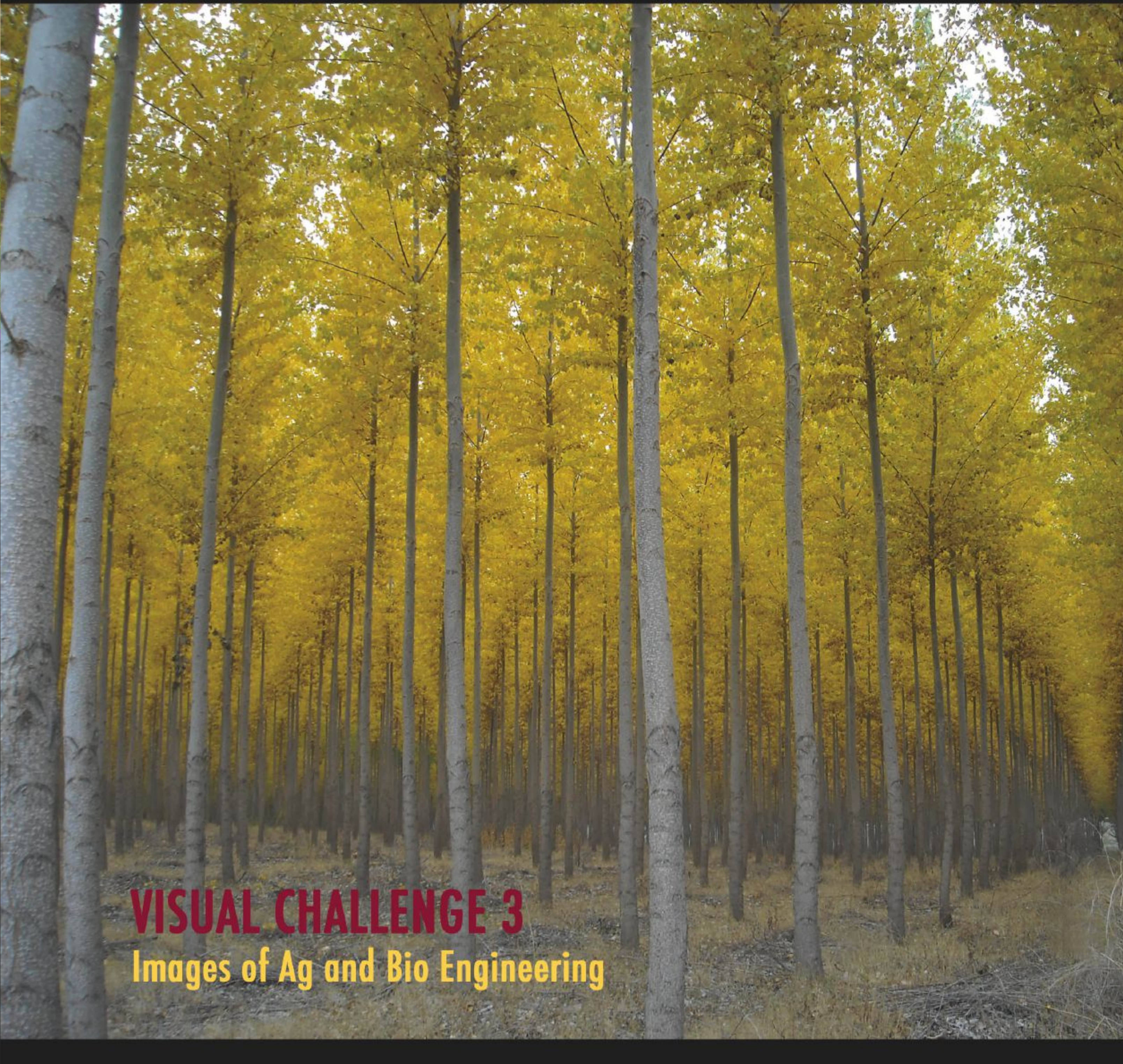
September/October 2013

RESOURCE

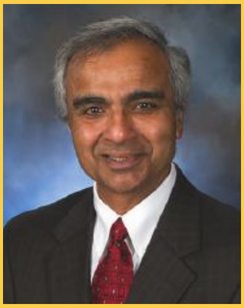
engineering and technology for a sustainable world



PUBLISHED BY ASABE – AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS

from the new President

The Value of Agricultural and Biological Engineering



What is the value of our profession?—a profession engaged in enhancing sustainable food, water, and energy systems for humanity? Perhaps it is an unfair question. We cannot assign a monetary value, but the "human" value of the profession is undeniably immense, as we help provide the essential needs of life.

How well have we marketed our profession?—and should we be blowing our own horn? Why not? Who else will do it for us? In the food, water, energy, and sustainability challenges facing the world today, we are the most valuable players!

Our outreach to the global community of agricultural and biological engineers must be proactive and collaborative. Although food production is local, agriculture is an international enterprise, and ASABE must aspire to be international, not at the expense of domestic efforts, but in collaboration with our national programs.

ASABE is already highly respected around the world, and there is a keen desire to affiliate with our Society. We should embrace this confidence in ASABE and expand our global influence and membership through global collaborations, ASABE-led global summits, web-conferencing, virtual discussions on critical issues related to water, land, food, air, energy, sustainability, and economics—and all other opportunities that are available to us. I realize that this is ambitious, but the momentum is strong. Now is the time for us to get going.

ASABE must commit to developing a strategic position that will promote our profession worldwide with a stronger, more unified stance—affirming our expertise and our importance in sustainably providing the essential needs of life.

ASABE is engaged in helping to provide the essential needs of all humanity—nutritious food, abundant water, clean air, renewable energy, and economic opportunity—all sustainably produced in a healthy environment. That is a worthy endeavor, and ours is a worthy profession.

I am honored and humbled to be your next president, and I am looking forward to working with the Society's membership.

Lalit R. Verma
lverma@uark.edu

events calendar

ASABE CONFERENCES AND INTERNATIONAL MEETINGS

To receive more information about ASABE conferences and meetings, call ASABE at (800) 371-2723 or e-mail mtgs@asabe.org.

2014

Feb. 10-12 — **Agricultural Equipment Technology Conference.** Seelbach Hilton, Louisville, Kentucky, USA.

April 7-11 — **Evapotranspiration: Challenges in Measurement and Modeling from Leaf to the Landscape Scale and Beyond.** Raleigh, North Carolina, USA.

July 13-16 — **ASABE Annual International Meeting.** Montreal, Quebec, Canada.

2015

July 26-29 — **ASABE Annual International Meeting.** New Orleans, Louisiana, USA.

ASABE ENDORSED EVENTS

2013

Oct. 21-24 — **NIAE International Conference.** University of Uyo, Akwa Ibom State, Nigeria.

Nov. 3-7 — **8th CIGR Section VI International Symposium on "Advanced Food Processing and Quality Management."** South China University of Technology, Guangzhou, China.

2014

July 16-18 — **4th International Symposium on Soil Water Measurement, Using Capacitance, Impedance, and Time Domain Transmission.** Macdonald Campus of McGill University, Montreal, Canada.

RESOURCE

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ON THE COVER

VISUAL CHALLENGE
Pacific Albus trees: 10,440 ha of autumn yellow.
Photo by **Nabil Mohamed**
Broadman Tree Farm
GreenWood Resources, Inc.
Hermiston, Ore., USA

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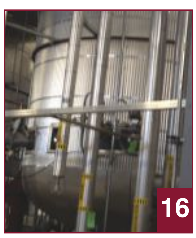

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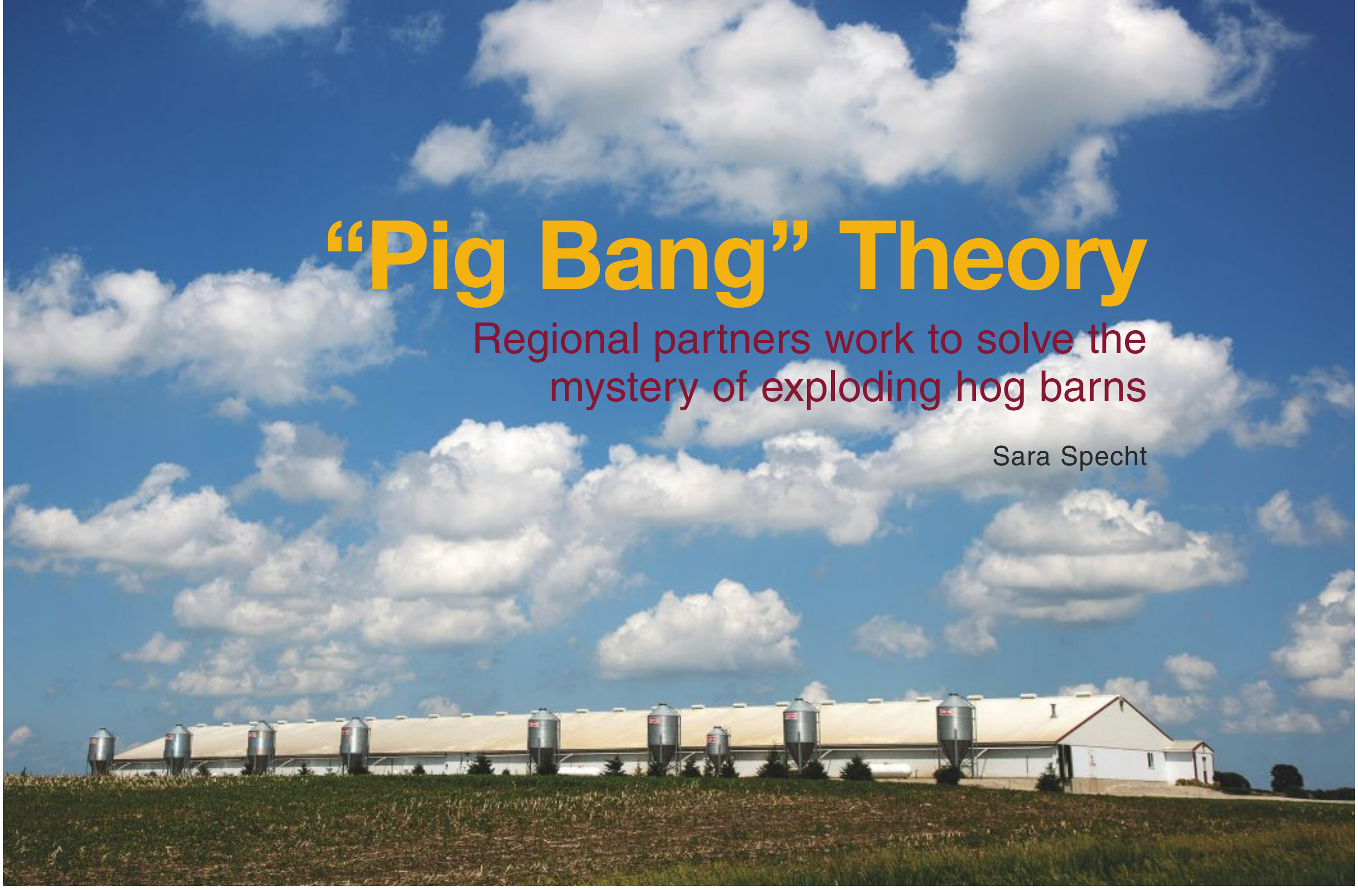


“Pig Bang” Theory

Regional partners work to solve the mystery of exploding hog barns

Sara Specht

It began like any other phone call for an Extension engineer. A farmer with a problem, albeit an odd one: Some kind of foam was suddenly bubbling up through the slats in the floor of his hog barn. How should he deal with it?

There were more calls in the following weeks—more foam, from a few inches deep to four feet deep, even threatening to suffocate livestock. Then came reports of flash fires, and explosions, all related to this mystery foam rising from manure pits. **ASABE members Larry Jacobson and Chuck Clanton**, both professors in the Department of Bioproducts and Biosystems Engineering (BBE) at the University of Minnesota, visited the afflicted farms and began surveying other Minnesota pork producers. It seemed like a straightforward problem that they would be able to resolve quickly.

That was in the summer of 2009. Three years later, Jacobson, Clanton, and colleagues from several Midwest universities joined forces to try to answer the question that once seemed so simple: What is causing hazardous foam in manure pits in the region’s hog barns?

ASABE members Larry Jacobson (left) and Chuck Clanton have been working to educate farmers about the risks of deep-pit foaming since 2009. ***Photo by David Hansen.***

An explosive situation

“This foaming is something that we’d only heard about very sporadically in the past,” said Jacobson, an Extension engineer. “Then in the summer of 2009, we started hearing from farmers who were noticing this foam on the floors of their barns. It was pretty alarming for them, and they wanted to try to knock it down.”

Most hog barns in the upper Midwest use deep-pit manure storage throughout the year. The storage system consists of 2.4 m (8 ft) deep pits beneath the slatted floors. The pits preserve nutrients in the manure, which is pumped out in the fall and used as fertilizer on harvested agricultural fields. The pits also have become popular with neighbors, since they keep swine manure out of sight.

Rather than pumping out the pits early and then having to find alternative cropland for the manure, several farmers tried to knock the foam down by agitating the pits or spraying the foam with water. This was when the real trouble started. When they examined the foam, Jacobson and Clanton discovered that it acts like a sponge over the manure, collecting the methane gas produced in the pit. Analysis by a researcher at Iowa State University showed that the foam consisted of nearly 60 percent methane.

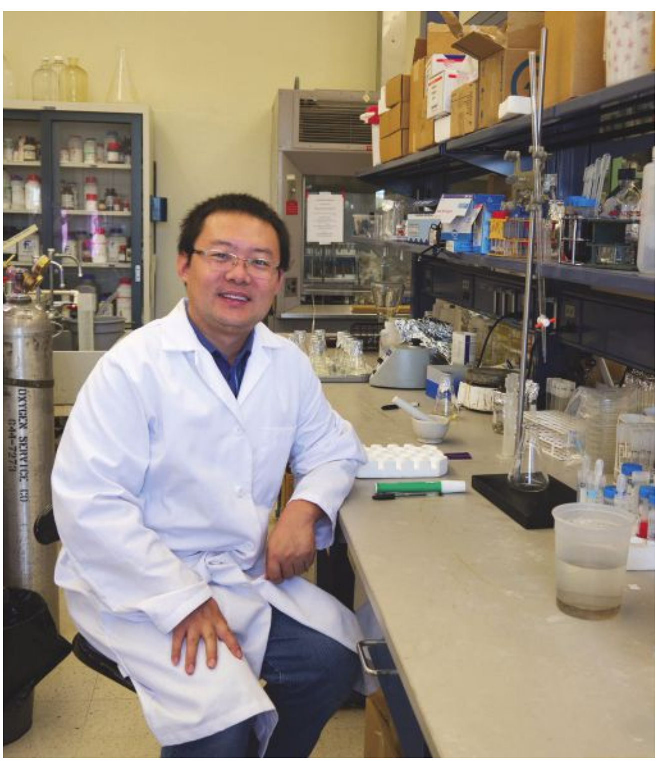
“It was a methane tank on top of the manure,” Jacobson said. “When the farmers started to agitate the foam, the bubbles released all this methane in a matter of minutes into the barn. At that point, all it needed was a spark—a pilot light, a motor starting, a welding torch, a light switch, or a cigarette. The lesser problem would be a flash fire, a whoosh of blue flame. But the worst-case scenario is an explosion.”

As recently as September 2011, the foam caused about a half-dozen explosions in the upper Midwest, where this phenomenon is centered. One explosion destroyed a barn on a farm in northern Iowa, killing 1,500 pigs and severely burning the worker involved.

Jacobson and Clanton and their team spent much of that first year in the field using a grant from the Minnesota Agricultural Experiment Station Rapid Response Fund, examining both foaming and non-foaming pits, as well as surveying farmers throughout southern Minnesota. Their results showed a frustrating lack of connection between the problem sites. At that time, about 25 percent of the farmers they contacted had some issue with foaming pits, but nothing appeared to be a common tie among them. Even on a farm with a double-wide barn consisting of two rooms and two pits beside each other, sharing a single wall, it was common to find foaming in one pit and none in the other.

"We heard from one producer with three barns that one is foaming and the other two aren't," Clanton said. "We tried to identify the differences, but it was the same pigs, the same feed, the same genetics, management, and building. Everything was the same."

"We thought, maybe naively, that we would find some obvious commonality," Jacobson said. "Maybe we would do some simple lab analysis and something would jump out at us, allowing us to trace it back to a cause. But that didn't happen."



Bo Hu is analyzing the varying effects of DDGS on pig manure and foaming, but the process is difficult, with the wide variety of types and quality of DDGS available to farmers. *Photo by Martha Enzler.*

An explosion on a farm in Iowa leveled the building, *above*, killing 1,500 hogs and severely burning a farm worker, *below*.

Burning through theories

By the summer of 2010, instances of pit foaming had begun to spread beyond southern Minnesota and northern Iowa, and without a clear connection between cases, the team needed a closer look at the foam. They brought BBE scientist Bo Hu on board to analyze their field samples at a microbial level.

On a basic level, three things must be present for a liquid to foam: gas, surfactant, and stabilizer. Methane gas is present in all manure pits, and the filamentous bacteria might serve as a stabilizer—something that keeps the bubbles from bursting. Hu decided to look at a possible surfactant—soap-like chemicals that initiate bubbles—in this case, long-chain fatty acids.

The most likely source of an increase in fatty acids in pig manure is the addition of distiller's dry grains with solubles (DDGS) into the livestock's diet, which may cause incomplete digestion of oils. DDGS is a byproduct of corn processing for ethanol that is added to most swine feed. DDGS has shown nutritional value for pigs, but Hu thinks that the high levels of unsaturated fatty acids in DDGS may be part of the foaming equation. Identifying how big an issue this is will be a challenge, since the quality and quantity of DDGS varies widely by refinery, season, and farmer.

"From a dietary standpoint, the pig can only metabolize about half of the fatty acids in DDGS, so it all goes back to how much you put into the diet," said Clanton. "But this is the

***Left*, foam erupts from a manure pit rising through slats in a barn in southern Minnesota.**

***Right,* samples from the field were collected and distributed to research partners in the region.**

Photos courtesy of Chuck Clanton.

frustration we're running into. We're dealing with a pit where manure's accumulated over a year, in a building where two groups of pigs have turned over, and with diets changing weekly. In a 2,400-head building, it's hard to pinpoint which pigs, or which diet."

A coordinated attack

Something that will help narrow down the likely causes of foaming are the numerous samples that the team will collect and exchange with their new research partners at Iowa State University, the University of Illinois, and the University of Nebraska in a multiyear project funded by the Iowa Pork Producers Association. The group of scientists has established protocols for collecting and sharing field samples to build a foundation for coordinated research.

While each organization focuses on different aspects of the problem, the Minnesota team will continue its outreach with producers and survey analysis. The researchers also plan to continue their work to refine feed and DDGS sources, targeting specific conditions that generate foam. In 2011, Hu hit a landmark in the research by producing foaming manure in the lab, providing a key diagnostic resource.

One of their goals, he said, is to come up with a tool that farmers can use to assess the likelihood of foaming from a formulated diet. However, the long-term solution to preventing foaming is to trace it back to its source. "What started out like a routine Extension phone call has led to a real CSI mystery type of thing," Jacobson said. "What's causing this thing, and how can we fix it?"

Sara Specht, writer and graphic designer, College of Food, Agricultural, and Natural Resource Sciences, University of Minnesota, St. Paul, USA, sspecht@umn.edu.

"The most likely source of an increase in fatty acids in pig manure is the addition of distiller's dry grains with solubles (DDGS) into livestock's diet, which may cause incomplete digestion of oils. But identifying how big an issue it is will be a challenge, since the quality and quantity of DDGS varies widely by refinery, season, and farmer." ***Photo by Tom Campbell.***

"Poop foam" or "noxious goop" crept up on this barn and buckled the structure. Fortunately, it did not level the barn or cause injury or loss of life.

In the news ...

Photo by Scott Bauer, courtesy of USDA-ARS.

According to University of Minnesota researchers, in the past five years, about 30 to 40 "manure foam" flash fires and blasts have been reported. The fires and explosions have been occurring at manure pits where farmers store pig waste. A bubbling layer of foam—sometimes several feet high—mysteriously builds up at the surface of the manure, releasing a high concentration of volatile methane gas. All it takes is a tiny spark—from a running motor, for example—for disaster to strike.

Incidences of spontaneous manure foaming have increased significantly since the phenomenon started cropping up at factory-scale hog farms in the upper Midwest. Explosions have killed thousands of pigs, costing farmers millions of dollars.

"No human deaths have been reported during these events, but workers have been injured after being blown by a blast or exposed to intense heat," University of Minnesota researchers said in a report last year.

In April of this year, says **ASABE member Chuck Clanton**, a flash fire from foaming manure in south-central Minnesota burned the inside of a building and plastic water and feed lines. There were also three flash fires at upper Midwest farms last fall, Clanton told MSN News.

"The flash fires are more of a blue flame moving across the manure surface from one end of the building to the other that sometimes gets hot enough to melt or burn plastic pipes and warp the sheet metal," Clanton said.

ASABE member Larry Jacobson told *Mother Jones* magazine that about a quarter of operations in the hog-heavy regions of Minnesota, Illinois, and Iowa are experiencing foam. He said that "the number may be higher, because some operators might not know that they have it."

Researchers still aren't sure what's causing the manure foaming. Perhaps it's connected to the hogs' diet? It's become an increasingly popular practice among farmers to mix swine feed with dried distiller's grains, a byproduct of corn processing for ethanol, in part to cut down on the cost of feeding pigs. Researchers say distiller's grains contain high levels of fatty acids that pass through the pigs' digestive system and help form bubbles in the manure foam.

In the meantime, scientists are recommending that pig farmers add monensin, an antibiotic widely used to make cows gain weight, to the pig manure pits to control foaming. Monensin decreases the amount of acetic acid, a precursor for methane buildup.

Clanton said the use of monensin is only a Band-Aid until scientists can pinpoint the root cause of the manure foaming.

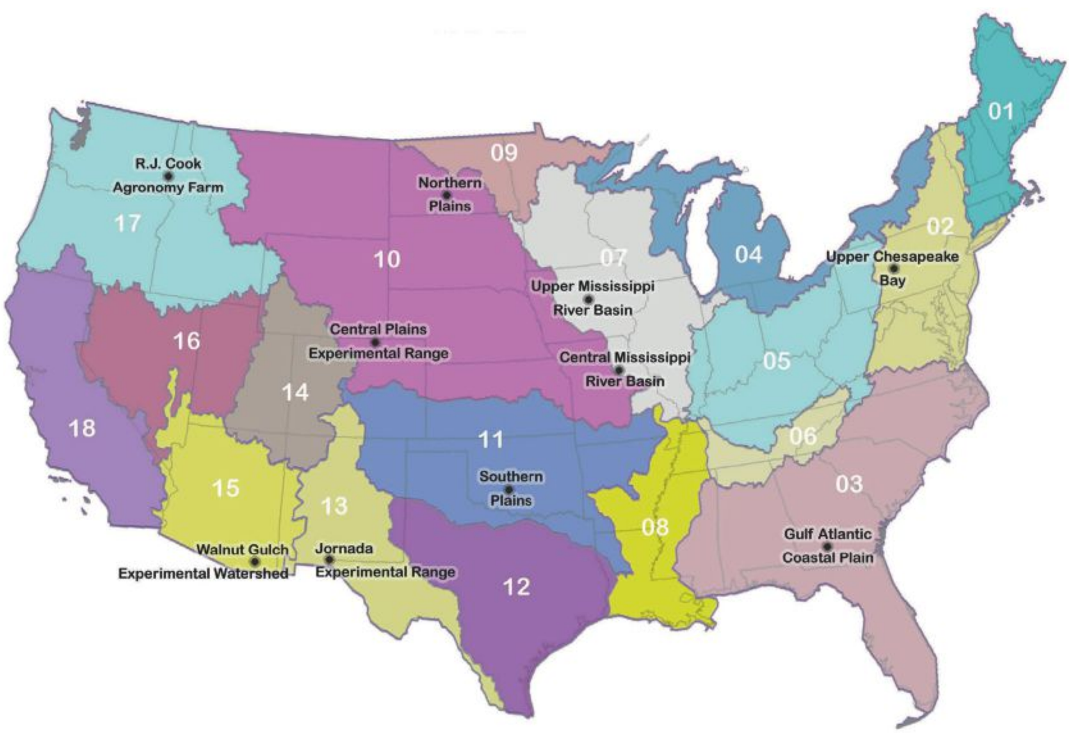
Angela Kent, an associate professor in the Department of Natural Resources and Environmental Sciences at the University of Illinois, told *Mother Jones* that scientists "are in the midst of a large multi-institution investigation focused on finding the cause of this very serious problem."

Establishing a Long-Term Agro-Ecosystem Research (LTAR) Network

Mark R. Walbridge and Steven R. Shafer

On September 10, 2012, the USDA Agricultural Research Service (ARS) formally announced the establishment of a long-term agro-ecosystem research (LTAR) network—consolidated from existing experimental watersheds, rangelands, and farms—to address large-scale, multi-year research, environmental management, and technology transfer for the nation's agricultural ecosystems.

Driving this decision were the challenges facing agriculture in the 21st century: to provide enough food, feed, fiber, and fuel for a global population of nine billion by 2050 without depleting natural resources or further degrading the environment, and in light of climate changes that could alter the global patterns of temperature and precipitation on which global food production depends. The ARS realized that an LTAR network could help agriculture meet these challenges. In addition, recent reports have identified the need for transformative changes to existing production systems to optimize productivity across a highly complex landscape. The United Nations FAO has estimated that less than three-fourths of the 70 percent increase in food production needed by 2050 will have to come from the "sustainable intensification" of lands already under cultivation. An LTAR network will provide the infrastructure needed to develop and test these transformative production systems under varying eco-climatic conditions.



Initial LTAR sites in relation to major drainage basins (HUC-2 watersheds) of the continental United States.

Other factors in the decision included frequent calls for the creation of an LTAR network, the current U.S. fiscal climate (with little chance of appropriations to establish a network of new sites), and the significant ARS infrastructure already in place that could be used to develop an LTAR network.

Organizing the LTAR network

In late 2011, the ARS issued an agency-wide request for information (RFI) from research units interested in becoming part of the LTAR network, focusing on those with infrastructure to support long-term research, such as experimental watersheds, ranges, and farms. Seven criteria were used to evaluate candidate sites:

- Productivity (a track record of productive research).
- Infrastructure (a long-term research site large enough to capture landscape-scale processes).
- Data richness (the quality of the existing data).
- Data availability (a publicly accessible database).
- Geographic coverage (complementary with other potential sites).
- The strength of existing partnerships.
- An institutional commitment to continue site operations for 30 to 50 years into the future.

Other factors that were also considered important were existing water balance, energy balance, and/or carbon flux and sequestration research, and a formal association with one or more existing long-term research networks.

In December 2011, a seven-member panel of non-ARS experts reviewed 21 RFI responses and identified ten sites that best met the criteria. Following ARS concurrence, these ten sites were announced as the initial LTAR network. Collectively, these sites hold data records that are 12 to 100 years long and have site footprints ranging from 0.57 to 6,200 km^2. Five are cropland sites, and five are rangeland sites. Two of the rangeland sites are located in the central U.S. transition zone from cropland to rangeland. In addition to occupying eight of the 18 HUC-2 watersheds in the lower 48 states, these ten sites represent eight of the 17 National Ecological Observatory Network (NEON) eco-climatic domains and seven of the nine USDA Economic Research Service farm resource regions.

Although the ten sites are all led by ARS research units, each is engaged in research with multiple non-ARS partners. The full list of collaborators includes 60 academic institutions, 15 U.S. government agencies, 29 international collaborations in 12 countries, 11 research networks, 25 non-governmental organizations (NGOs), 19 private industries or associated organizations, and 12 state government agencies. The complete list is available at: www.ars.usda.gov/ltar.

Implementing the LTAR network

The LTAR Research Committee, which is comprised of a representative from each LTAR site and chaired by an ARS National Program Leader, has drafted a shared research strategy as a roadmap to guide network development. This development plan includes:

- Describing key LTAR site characteristics.
- Documenting scientific expertise across sites.
- Developing network-wide research questions and objectives.
- Identifying common data sets to be collected by all sites.
- Developing complementary shared research protocols.
- Identifying new partners.
- Developing a data storage and management plan.

In September 2012, the LTAR network held its first annual meeting in Estes Park, Colo., as part of the Long-Term Ecological Research (LTER) network's annual All Scientists Meeting, followed by a two-day workshop with NEON staff in Boulder, Colo., to explore potential LTAR/NEON

The South Fork of the Iowa River Watershed, part of the Upper Mississippi River Basin (UMRB) LTAR managed by ARS's National Laboratory for Agriculture and the Environment at Ames, Iowa. The UMRB LTAR focuses on tile-drained landscapes in the north central United States dominated by corn and soybean production.

The Jornada Experimental Range (JER) LTAR, located in the northern Chihuahuan Desert, the largest desert in North America.

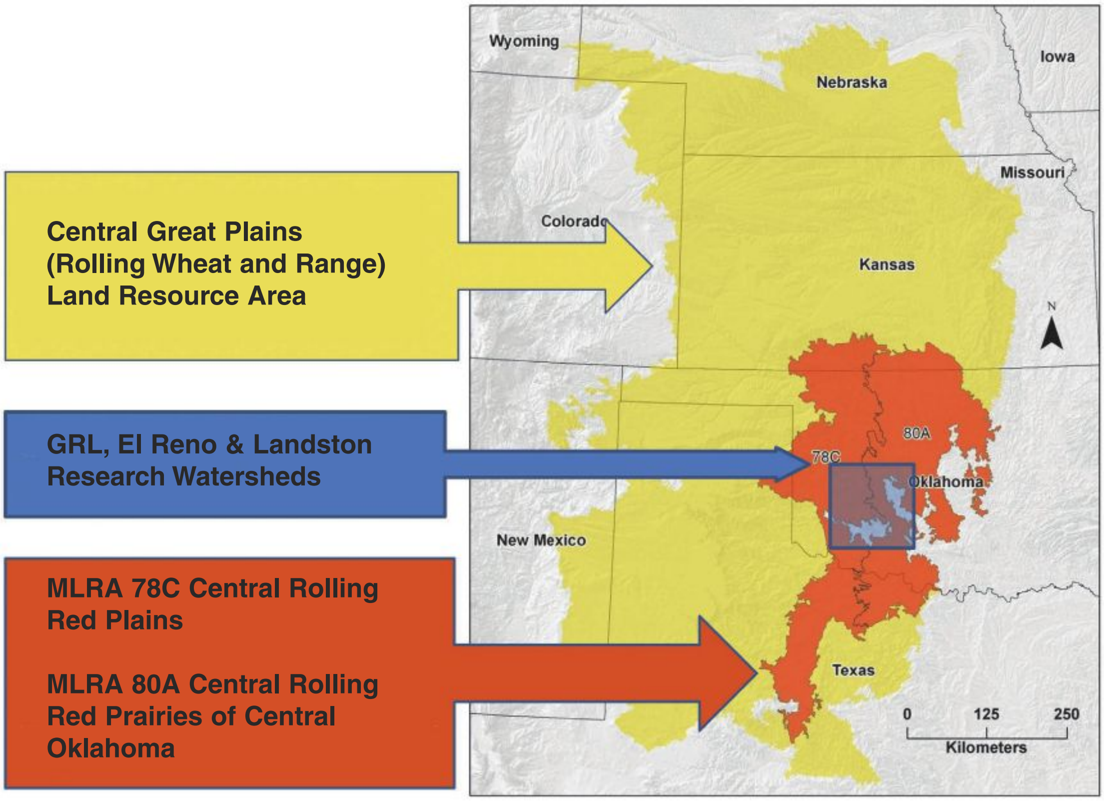
interactions. In November 2012, as part of the 50th anniversary of the Orgeval watershed (France's oldest hydrologic observatory), an LTAR network representative met with representatives of the international network of critical zone observatories to discuss potential future collaborations.

While the ten initial LTAR sites cover significant portions of the hydrologic, eco-climatologic, and agronomic diversity of the United States, there are still gaps to fill, such as the Lower Mississippi River basin, the Lower Chesapeake Bay, and key agricultural states like California, Florida, and Idaho. To address these gaps, the ARS issued a second RFI for additional LTAR sites in December 2012. This RFI is open to both ARS and non-ARS research groups. As with the previous RFI, responses will be evaluated by an expert panel using the seven stated criteria, with priority given to high-capacity sites that fill existing gaps in cases of equal merit.

You're invited

Since its conception, the organization of existing experimental watersheds and ranges into an LTAR network has been met with significant interest by a broad group of collaborators and stakeholders. The LTAR network is now part of the USDA Research, Education, and Economics Action Plan. In the current fiscal climate, the annual investment in LTAR research and infrastructure would be nearly impossible to duplicate. Although the ARS organized the network using existing resources, collaborative partnerships are fundamental to its long-term success. Thus, we extend an invitation to

The JER LTAR exemplifies desertified high-elevation (1200 m) rangelands of the southwestern United States that have low average annual precipitation (24 cm year^{-1}), mild winters (January average temperature -5°C), and hot summers (July average temperature 35°C).



The Southern Plains LTAR, managed by ARS's Grazinglands Research Laboratory (GRL) El Reno, Okla. The Southern Plains LTAR integrates watershed research in the Upper Washita River Basin and the Langston Research Watersheds, representing crop and rangelands of the Central Rolling Red Plains and Prairies in central Oklahoma.

use the LTAR network for research and to leverage extramural funding, to develop the LTAR network into a resource for all, including those in other countries with similar goals and infrastructure, to realize the potential for a global network of agro-ecosystem research sites.

Mark R. Walbridge, National Program Leader for Water Availability and Watershed Management, mark.walbridge@ars.usda.gov, and Steven R. Shafer, Director of the Beltsville Agricultural Research Center, USDA Agricultural Research Service, Beltsville, Md., USA, steven.shafer@ars.usda.gov.

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Some Problems with the ASTM Testing Protocol for Explosible Dust

Calvin B. Parnell Jr., P.E., Russell O. McGee, and Balaji Ganesan

There are some problems with the ASTM protocol for dust explosibility testing. These problems became apparent when tests of cotton gin dust (CGD) using the Center for Agricultural Air Quality Engineering and Science (CAAQES) protocol found that CGD was not an explosible dust. Samples of the CGD were then sent to Safety Consulting Engineers Inc. (SCE) for testing. We anticipated that SCE would confirm the CAAQES results. However, SCE found that CGD was a Class A explosible dust! If CGD is classified as explosible when it is not explosible, then cotton gins will be required to implement housekeeping and mitigation measures that will be expensive and unjustified.

We hypothesized that either the ASTM protocol or the CAAQES protocol was flawed. A special research effort was initiated by CAAQES. The objectives of this research were to (1) perform a detailed analysis of these two protocols, (2) document the flaws of either protocol, and (3) publish our findings. This article is a brief report of our findings.

What is a dust explosion?

Four requirements are needed for a dust explosion: fuel, oxygen, ignition, and containment. The fuel is a dust cloud at a concentration at or above the minimum explosive concentration (MEC). If the dust cloud concentration is less than the MEC, then no explosion can occur, even if the other three requirements are met. One approach to preventing dust explosions at grain transfer points is to use ventilation systems that lower the dust concentrations to less than the MEC.

Dust explosions are usually a series of explosions, starting with a primary explosion followed by one or more secondary explosions. The primary explosion is usually small, with a maximum pressure of less than 0.14 bar (2 psig). This pressure is sufficient to rupture the containment chamber, releasing a pressure wave and fire front. The pressure wave moves away from the primary explosion at 330 m s^{-1}, followed by the flame front at 10 m s^{-1}. The movement of the pressure wave into other chambers entrains dust into secondary MECs, which are then ignited by the flame front. These secondary dust explosions can produce pressures in excess of 6.9 bar (100 psig). The CAAQES testing method is specifically designed to mimic a primary dust explosion ignited by a hot bearing in the elevator leg of a grain handling facility.

The ASTM testing protocol

The ASTM test for dust explosibility consists of dispersing dust into an enclosed, spherical 20 L chamber (fig. 1) fitted with a pressure sensing system. The dust cloud is then ignited by a flame from a 10 kJ energy source. The ASTM protocol for determining whether the dust is explosible is based on pressure measurements in the 20 L chamber. If the pressure exceeds 1 bar (14.5 psig), then the dust is considered explosible. This protocol does not specifically mimic a primary dust explosion in a grain handling facility.

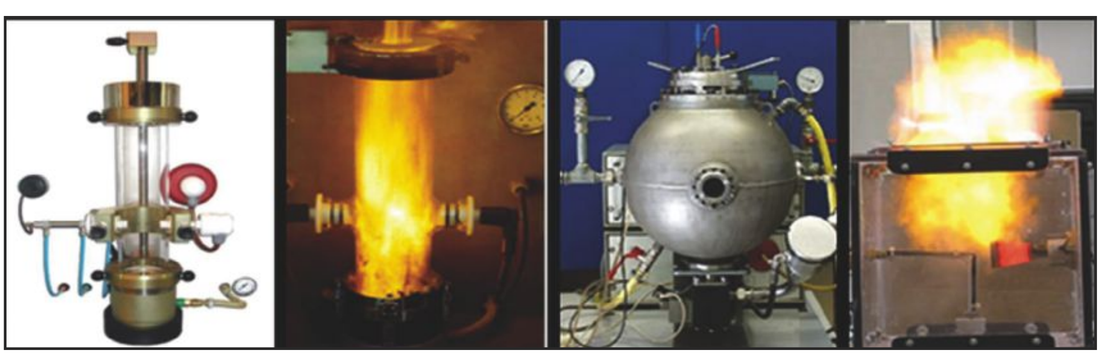


Figure 1. (left to right) The Hartman tube used by SCE, the Hartman tube in operation, the 20 L spherical chamber specified by ASTM, and the 28.3 L (1 ft^3) CAAQES chamber.

Initially, SCE performed screening tests consisting of ten replications of eleven different CGD concentrations using an enclosed 1.2 L Hartman tube with ignition from a 10 J energy source and found no deflagrations for any test. However, both ASTM and the National Fire Prevention Association require that dust be tested in a 20 L spherical chamber with a 10 kJ pyrotechnic energy source before classifying the dust as non-explosible. When SCE subsequently tested 1000 g m^{-3} of CGD in a 20 L chamber, ignited by a flame from a 10 kJ source, a pressure of 5.6 bar (81 psig) was measured. Therefore, SCE concluded that cotton gin dust was explosible.

In both the 1.2 L Hartman tube and the 20 L ASTM chamber, the concentration to be tested was determined as the mass of dust entrained divided by the volume of the chamber. Therefore, to test a concentration of 1000 g m^{-3} in the 20 L ASTM chamber, 20 g of dust must be dispersed into the chamber. As we will see, this is a major difference between the ASTM and CAAQES testing protocols.

Another difference between the two protocols is that the ASTM igniter is a flame that passes through the dust cloud. For a deflagration to occur, the flame must self-propagate through the cloud. However, the ASTM ignition flame is not a stationary source, so there is no way to confirm that the resulting pressure is a consequence of a self-propagating flame.

The CAAQES testing protocol

The CAAQES testing protocol consists of testing dust in a 28.3 L (1 ft^3) chamber using a stationary hot coil as the ignition source. This hot coil mimics the ignition of a primary dust explosion by a hot bearing. The CAAQES testing system is similar to the Hartman tube with a diaphragm (fig. 1) in that one of the criteria for a positive test (deflagration) is that the diaphragm bursts.

The CAAQES testing system was used by the U.S. Bureau of Mines to determine MECs: if a deflagration occurred for any tested dust concentration, then an MEC exists for that dust and the dust was classified as explosible. The reasoning behind this approach was that an MEC must exist before a primary explosion can occur. To put that another way, if a dust does not have an MEC, then it is not explosible. For an explosion to occur, the MEC must be ignited, and a self-propagating flame must produce sufficient pressure to burst the containment diaphragm.

Unlike the ASTM testing protocol, the CAAQES method is not limited to pressure measurements for determining whether or not a dust is explosible. Instead, three criteria are used to indicate that a deflagration has occurred: (1) rupture of the diaphragm, (2) flame leaving the chamber, and (3) a characteristic pressure vs. time curve. Ignition of the dust cloud is a consequence of the cloud merely touching the stationary ignition source. The resulting flame then self-propagates through the dust cloud, increasing the pressure in the chamber. The diaphragm bursts at less than 0.14 bar (2 psig), and the pressure then drops. If there is sufficient pressure to burst the diaphragm, then the flame must have self-propagated through the dust cloud.

In the CAAQES test chamber, only a fraction of the chamber contains the dust cloud at the time of ignition, as shown in the leftmost frame in figure 2. Unlike the ASTM protocol, the dust concentration is not defined by the limits of the chamber. Instead, the concentration is calculated by dividing the mass of dust in the chamber crucible by 0.01. For example, to test a concentration of 1000 g m^{-3}, 10 g of dust is placed in the crucible.

Comparing the two protocols

To compare the results of the ASTM and CAAQES testing protocols, the team at CAAQES conducted explosibility tests for three dusts: corn starch, CGD, and a third material identified as "dust X." An additional goal of the CAAQES tests was to approximate the MEC for cotton gin dust using the CAAQES chamber. Prior to the testing, analyses of ash and particle size distribution (PSD) were performed on the test dusts. The results are shown in tables 1 and 2. Three replications of ash and PSD determination were performed for each dust. The CGD ash content was 87 percent, which suggests that 87 percent of the gin dust was inert.

Figure 2 contains four video frames of a corn starch test conducted at a dust concentration of 100 g m^{-3} in the CAAQES chamber. The first two frames show the dust cloud

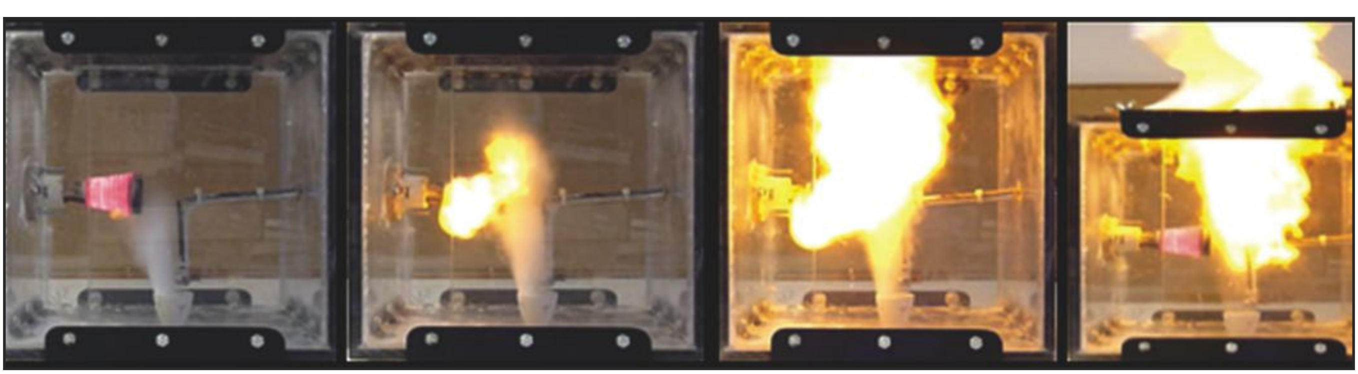


Figure 2. Corn starch being tested in the CAAQES chamber at 100 g m^{-3}.

Table 1. Ash analysis of the three dusts tested with the CAAQES method. The average ash content of the cotton gin dust (CGD) was 87%, and only 13% of the CGD was volatile.

Dust	Ash (±95% CI)
Corn starch	0.98% (±0.02)
"Dust X"	61.6% (±0.01)
CGD	87.2% (±1.13)

Table 2. Particle size distributions of the three test dusts, including mass median diameter (MMD) and geometric standard deviation (GSD).

Dust	MMD (±95% CI)	GSD (±95% CI)
Corn starch	15.5 μm (±0.29)	1.6 (±0.08)
"Dust X"	13.7 μm (±0.06)	2.1 (±0.03)
CGD	23.7 μm (±0.88)	1.9 (±0.01)

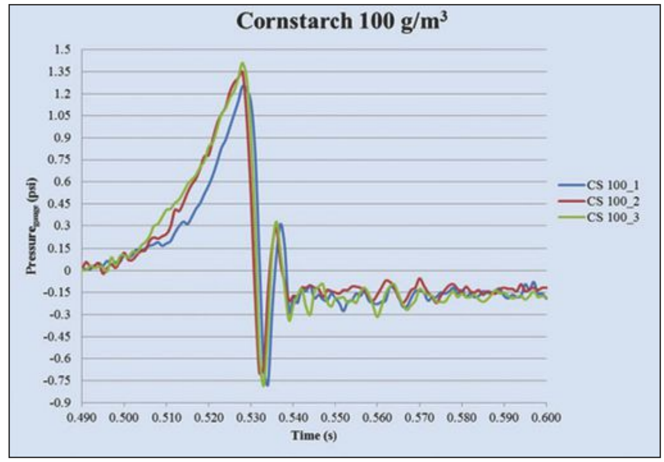


Figure 3. Characteristic pressure vs. time curves for corn starch at 100 g m^{-3}.

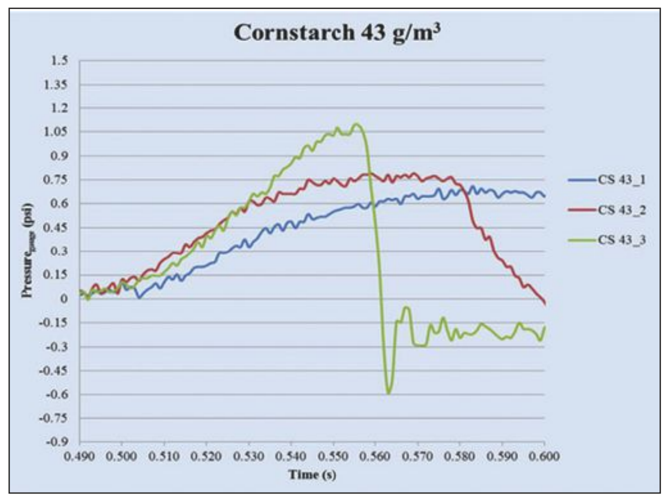


Figure 4. Characteristic pressure vs. time curves for corn starch at its MEC (43 g m^{-3}).

forming and then contacting the stationary ignition source. Note that only a small fraction of the chamber volume is occupied by the dust cloud. The third frame shows the self-propagating flame consuming the corn starch particles. The fourth frame shows the ruptured diaphragm and the flame leaving the chamber.

Figure 3 shows pressure vs. time curves for corn starch for three tests at a dust concentration of 100 g m^{-3}. In each test, the self-propagating flame increased the pressure inside the CAAQES chamber. When the diaphragm burst, the pressure rapidly decreased, creating a vacuum. This is consistent with reports following an explosion at a grain handling facility that piping leading from the primary explosion site collapsed as a consequence of vacuum. Figure 4 shows typical pressure vs. time curves for tests of corn starch at a concentration near its MEC (43 g m^{-3}). Note that two of the tests did not result in bursting of the diaphragm.

Figure 5 contains three video frames of a CGD test at a concentration of 1000 g m^{-3} in the CAAQES chamber. The first frame shows the gin dust being dispersed in the air. The second frame shows the dust cloud contacting the hot coil and igniting. The third frame shows that there was insufficient pressure to burst the diaphragm, as the flame did not self-propagate through the cloud. Figure 6 shows characteristic pressure vs. time curves for CGD at a concentration of 1000 g m^{-3}. No deflagrations were observed for any of the tests. The flat lines in the graph show that there was a small rise in pressure, but it was insufficient to burst the diaphragm. It was concluded that gin dust did not have an MEC, and therefore it is not an explosible dust.

For comparison with corn starch and CGD, figure 7 contains three video frames of "dust X" test at a concentration of

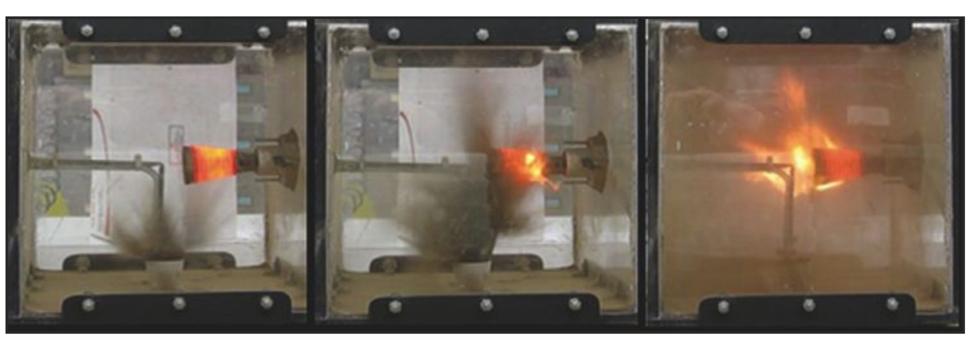


Figure 5. Cotton gin dust (CGD) being tested in the CAAQES chamber at 1000 g m^{-3}.

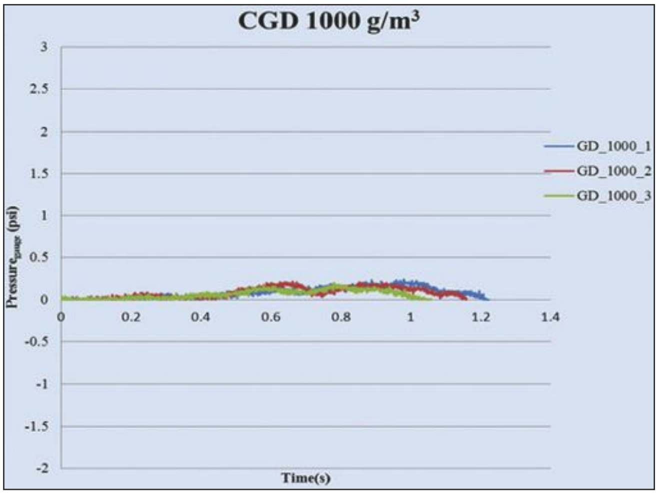


Figure 6. Characteristic pressure vs. time curves for CGD at 1000 g m^{-3}.

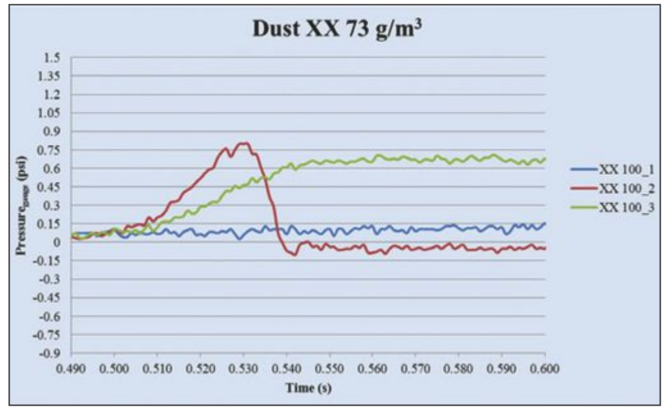


Figure 8. Characteristic pressure vs. time curves for "dust X" at 73 g m^{-3}.

80 g m^{-3} in the CAAQES chamber, and figure 8 shows the characteristic pressure vs. time curves for "dust X" at its MEC of 73 g m^{-3}.

The results are in

The ASTM criterion for determining whether or not a dust is explosible involves testing concentrations of the dust in an enclosed 20 L chamber and measuring the resulting pressure. If a deflagration occurs and the resulting pressure is 1 bar (14.5 psig) or more, then the dust is considered explosible. SCE previously conducted CGD tests at a concentration of 1000 g m^{-3} with a flame from a 10 kJ source and measured a pressure of 5.6 bar (81 psig). The team at SCE therefore concluded that CGD is explosible.

However, the ASTM protocol for explosible dust testing can result in incorrect indication of a deflagration because it uses pressure as the only indicator of a deflagration, with a flame as the igniter. For a true deflagration, the resulting pressure must be the result of a self-propagating flame. The ASTM protocol also does not mimic the conditions in a grain elevator, with a primary explosion ignited by a stationary source followed by one or more secondary dust explosions. The ASTM method does not require that a dust have an MEC to be explosible, nor does it acknowledge that an MEC must be present before an explosion can occur.

In contrast, the CAAQES protocol involves conducting tests with a wide range of dust concentrations. If any concentration results in a deflagration in the CAAQES chamber, then the dust is explosible. The CAAQES method can also be used to determine the MEC of a dust. In fact, a dust must have an MEC to be classified as explosible.

The CAAQES method of mimicking a grain dust explosion in a grain handling facility—using three criteria for deflagration as well as determining the MEC of the dust—is more accurate than the ASTM method. Using only a fraction of the chamber volume for the dust concentration, rather than the entire chamber volume, is also superior to the ASTM method. Finally, using a stationary coil rather than a flame as the igniter ensures that the pressure increase is the consequence of a flame self-propagating through the dust cloud. Based on the findings of the CAAQES method, and given the superiority of this method, we concluded that CGD is not an explosible dust.

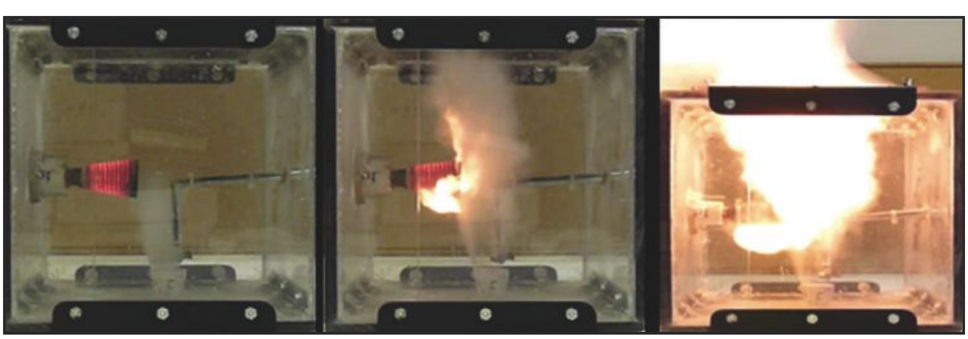


Figure 7. "Dust X" being tested in the CAAQES chamber at 80 g m^{-3}.

ASABE member Calvin B. Parnell Jr., P.E., Professor, c-parnell@tamu.edu, ASABE member Russell O. McGee, Assistant Research Scientist, romcgee@tamu.edu, and ASABE member Balaji Ganesan, Graduate Student, balagane@tamu.edu, Department of Biological and Agricultural Engineering, Texas A&M University, College Station, USA.

Closed-Loop, Energy-Efficient Biofuel Production

Pratap Pullammanappallil

Fast-diminishing fossil fuel reserves, along with the high prices of crude oil imported into the United States and concerns about climate change, have led researchers and large-scale industries to investigate sustainable, low-cost biomass feedstocks for production of renewable biofuels like ethanol, butanol, and biodiesel. Currently, in the United States and Brazil, ethanol is primarily produced from food crops like corn and sugarcane, respectively. The use of food crops for biofuel production raises ethical concerns about diverting food to fuel production. A reasonable alternative is bioethanol production from lignocellulosic biomass originating from non-food sources.

The Agricultural and Biological Engineering Department (ABE) at the University of Florida (UF) is developing an integrated process that recovers energy, nutrients, and water from a celluosic ethanol distillation process. The cellulosic ethanol process developed by Lonnie Ingram, a distinguished professor of Microbiology and Cell Science at UF, uses a genetically engineered *E. coli* bacteria to produce fuel ethanol from inedible plant biomass, such as sugarcane residue (called bagasse), municipal green waste, and agricultural and forest residues. The cellulosic ethanol process is currently being demonstrated at the Stan Mayfield Biorefinery Pilot Plant in Perry, Fla.

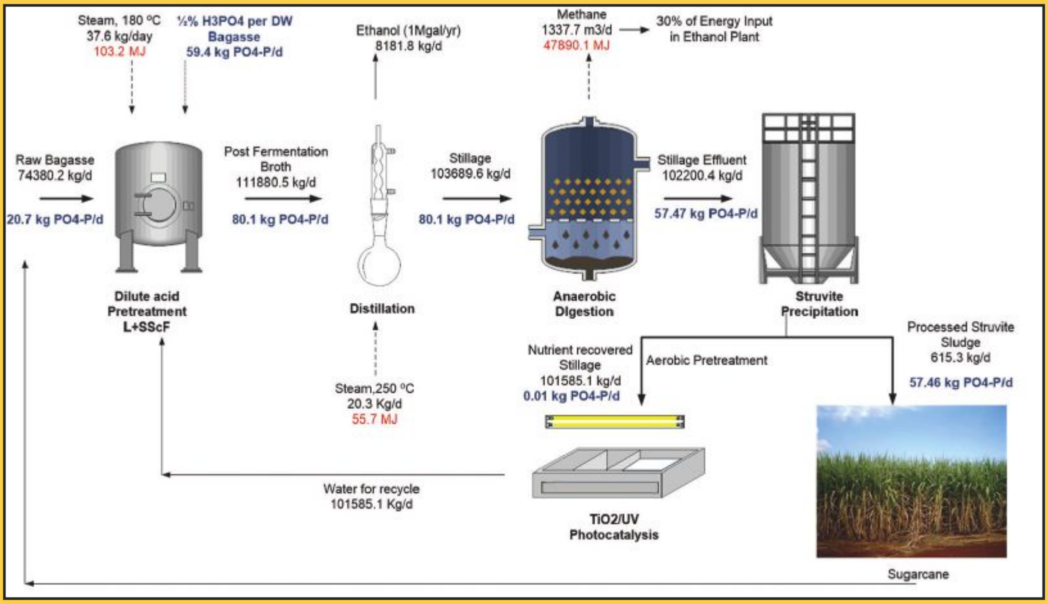
The recalcitrant nature of lignin, a natural polymer that constitutes a large portion of plant biomass, makes it difficult for microorganisms to access the sugars that make up the complex carbohydrates of plants. Therefore, a number of pretreatment options are being explored to make these sugars more readily available for subsequent fermentation.

Meanwhile, at the downstream end of the bioethanol production process, following the distillation of ethanol from the fermented liquor, a wastewater stream is produced. This distillery wastewater is a high-strength, dark-colored, nutrient-rich, acidic liquid that presents significant disposal problems. Discharge of such nutrient-rich wastewater into water bodies can cause eutrophication, which has deleterious effects on aquatic life. With the EPA tightening the standards for industrial effluent discharge, accompanied by the decreasing availability of land for waste disposal, more intense treatment approaches must be applied to the wastewater.

The Stan Mayfield biorefinery enables UF researchers to conduct multifaceted studies and develop economical ways to produce bioethanol and its derivatives from non-edible parts of plants and other biomass.

Closing the loop effectively

To address these issues, we are developing an integrated downstream process that recovers resources from the distillation waste stream which would otherwise be wasted. The residual fermentation broth after distillation is referred to as stillage. Our integrated system includes a process for anaerobic digestion of the stillage to produce biogas (which is a biofuel), struvite precipitation for phosphorous recovery, and finally cleaning the wastewater using an advanced oxidation process. Each component of the integrated system has been the subject of research by Gayathri Ram Mohan, a graduate student in the ABE department.



Schematic of the biofuels pilot plant in Gainesville, Fla.

• Continuous anaerobic digestion of the stillage was successfully carried out in a fluidized bed reactor. Long-term, bench-scale digestion of the stillage was useful in determining the feasibility of the process, the biochemical methane potential of the stillage, and the various parameters required to design a large-scale digester. Methane yield from anaerobic digestion of stillage was more than 12 v/v (volume of methane at 0°C and 1 atm pressure to volume of stillage).

• Following energy recovery in the form of biogas, the stillage effluent, which contains nitrogen and phosphorous, is subjected to struvite precipitation. Struvite is a slow-release phosphate fertilizer, and its precipitation paves the way to recover and reuse plant nutrients from stillage. The phosphorous concentrations can be reduced to less than 2 ppm using this process.

• Next, the remaining effluent is passed through a TiO_2/UV photoreactor for final cleaning. This photocatalytic treatment allows recovery of water from the process, which can be recycled in the plant.

Mass and energy balances for a biofuel plant producing 3.8 million L (1 million gal) of ethanol per year showed that the raw bagasse requirement would be about ten times the mass of ethanol produced, and a significant amount of water would be required to make a pumpable slurry. Therefore, the mass of stillage produced would be about 37% more than that of the raw bagasse feed. By anaerobic digestion, the organic content of stillage is converted to biogas (60% CH_4, 40% CO_2) with a heating value of 46 MMBtu d^{-1}. Struvite precipitation from the digested effluent yields 615 kg d^{-1} of struvite-containing processed sludge. The remaining dark-colored, nutrient-deprived stream, after exposure to advanced oxidation via TiO_2-mediated photocatalysis, would decolorize due to degradation of the color-causing compounds and recalcitrant organics. This treatment would help with reuse of the recovered water in the plant.

If the amount of energy required for distillation is calculated assuming that 15 lbs (approximately 16,000 Btu) of steam is required to distill 1 gal of ethanol from a mixture containing 10% ethanol, then this energy requirement can be mostly (>90%) supplied by the biogas produced from the anaerobic digestion of stillage. Studies conducted by the USDA on the energy balance of a corn ethanol process showed that about 13,679 Btu L^{-1} (51,779 Btu gal^{-1}) of energy is used in the ethanol conversion process. If this figure is used as a basis for the cellulosic ethanol process, then the biogas produced by anaerobically digesting the stillage can be used to compensate about 30% of the energy input in the conversion process.

A mass balance was also carried out on the overall orthophosphate-phosphorous released in the process. About 70% of the phosphate content of the stillage comes from the acid pretreatment step, with the remaining 30% released from the feedstock itself. Other than the phosphate that is used for biomass growth in the digester, there is no loss of phosphate throughout the process. Therefore, about 99% of the phosphate is recovered as struvite-containing sludge that can be used as a fertilizer.

Every ton of sugarcane produces 0.3 tons of bagasse. The amount of sugarcane required to meet the feedstock requirements of a 3.8 million L (1 million gal) per year ethanol plant would be 270 tons d^{-1}. The recommended phosphate dosage for P-limited soils is about 36 kg of P per hectare. Based on this information, the phosphate precipitated as struvite-containing sludge can supply approximately 50% of the phosphate needed to cultivate the sugarcane required to produce an adequate supply of bagasse feedstock for bioethanol production.

This integrated treatment system allows successful recovery of resources while reducing the carbon and water footprints of the biofuel production process. Similar research is now being conducted on stillages obtained from the fermentation of other types of feedstock, including eucalyptus and wheat straw.

ASABE member Pratap Pullammanappallil, Associate Professor, Department of of Agricultural and Biological Engineering, University of Florida, Gainesville, USA, pcpratap@ufl.edu.

IMAGES of AGRICULTURAL and BIOLOGICAL ENGINEERING

VISUAL CHALLENGE 3

To celebrate the visual aspects of agricultural and biological engineering, *Resource* is pleased to present selected entries from the third annual ASABE Visual Challenge. Over 100 images were entered, illustrating the varied facets of the work engineers do and locations they work in around the world.

As in previous years, our call for "statements without words" proved once again that ag and bio engineers are often as proficient in photography and the graphic arts as they are in science and technology. The contributors' entries show the dark beauty of the stormy sky to the desolateness of Nepal's remote countryside–all with a sharp eye for color and composition. And some unexpected moments are captured, too. Several of this year's entrants just happened to have a camera ready at the right time: as mist gathered over Honduran coffee trees and as a Beijing bee found her work site. For the first time, cartooning was introduced.

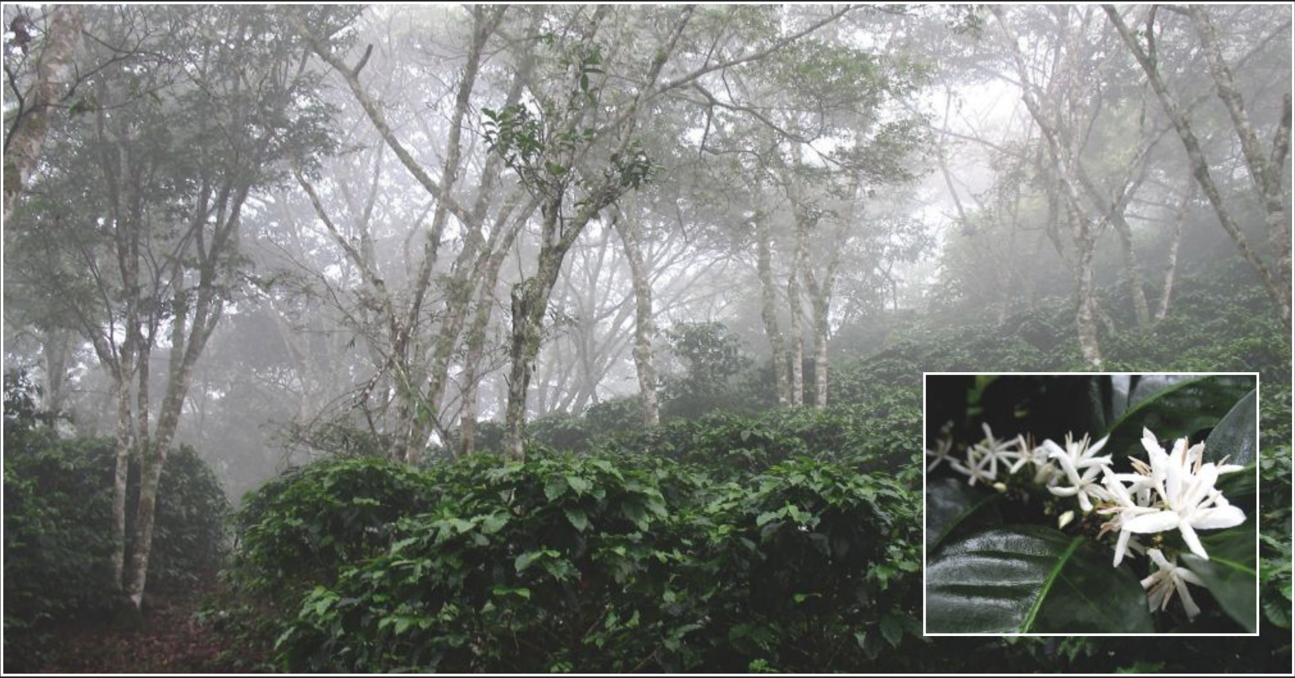
Most important, some of the beauty and meaning of the ABE profession and its many accomplishments come to life in these images, showing those outside the field: "This is what we do–on the job and off." Of course, the selected entries are only a glimpse of the wide variety of activities–and occasional surprises–that can be found in agricultural and biological engineering.

Thank you for your entries, and for the work–*both meaningful and beautiful*–that you do.

IRRIGATION with PIPE (inset)

Benjamin Covington, *Graduate Research Assistant, Iowa State University Agricultural and Biosystems Engineering Department, Ames, USA*

"I have hundreds of ag and bio engineering pictures, but here are just a few favorites ..."



SHADE GROWN COFFEE with COFFEE BLOSSOMS (inset)

Matthew De Kam, *AMEC Power & Process, Minneapolis, Minn., USA*

"As an engineer with AMEC—a focused supplier of consultancy, engineering, and project management services to the world's oil and gas, mining, clean energy, environment, and infrastructure markets—I took these photos (above) high in the mountains near Comayagua, Honduras, while working with a group of coffee farmers to evaluate their coffee farms for sustainability certification. While working with farmers in the department of Olancho, Honduras, Central America, a variety of papaya from Columbia obtained from the National Agricultural University of Honduras was introduced (below right).

ONE OF NATURE'S PROFITABLE RELATIONSHIPS

Freddie Lamm, *Research Agricultural Engineer, Kansas State University Northwest Research Extension Center, Colby, Kan., USA*

"A bee pollinating a flower in Beijing, China—nature's perfect work."

RAUL ALEMAN'S PAPAYAS

Matthew De Kam

South Dakota Thunder Head

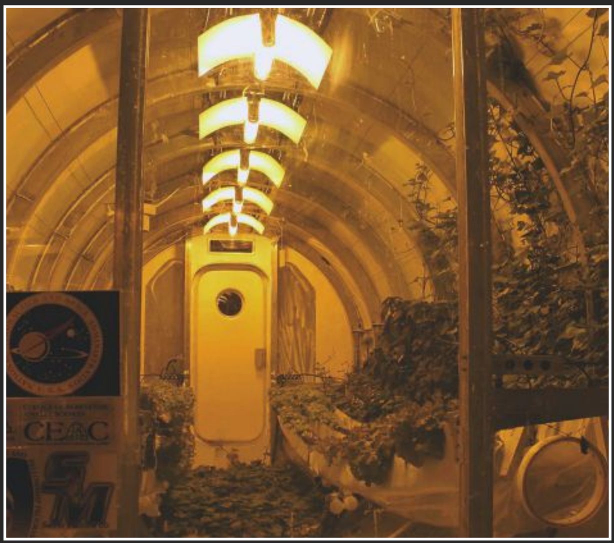
Benjamin Covington *Graduate Research Assistant, Iowa State University Agricultural and Biosystems Engineering Department, Ames, USA*

Storm brews on the horizon on the banks of the Missouri River.

MANUAL WOOL PROCESSING, NEPAL

Yakindra Timilsena, *PhD student, School of Health Sciences, Mt. Helen Campus, University of Ballarat, VIC, Australia*

"I am from Nepal, a new member of ASABE, and received a master's degree in Food Engineering from the Asian Institute of Technology in Thailand. Now I am in Australia working for a PhD. I share this photo related to traditional agricultural engineering technology, which was taken while I was working in a very remote district of Nepal. It shows how manual wool processing is done in rural areas."



EYES TO THE FUTURE: University of Arizona Controlled Environment Agriculture

Gene Giacomelli, *Professor, Agricultural and Biosystems Engineering, and Director, Controlled Environment Agriculture Program, University of Arizona, Tucson, USA*

The NASA Steckler Space Grant Lunar Greenhouse at the University of Arizona CEAC houses water-cooled, sodium vapor lamps—showcasing the green of sweet potatoes, strawberries, and other crops in advanced hydroponic growing systems—now used more for urban habitats, severe environment extremes, or innovative industry plant needs on Earth. And, of course, the systems are also for space colonists."

TROUBLE SHOOTING RAMPANT ROBOT

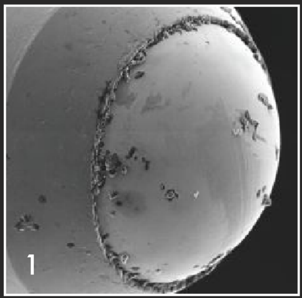
Graeme Quick, *author, technical writer, engineering consultant, farmer and fruit tree grower, Peachester, Queensland, Australia*

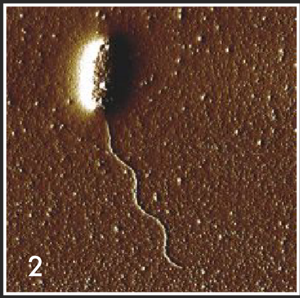
"I do my cartooning for serious fun and to accompany the odd document where relevant if related to agricultural robotics."

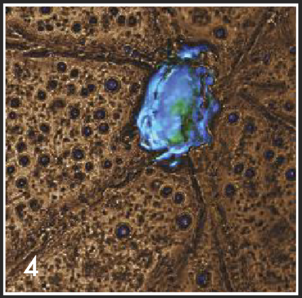
HAITI HOOP HOUSE

Brian Boman, *Professor of Agricultural and Biological Engineering, University of Florida, Indian River Research and Education Center, Fort Pierce, USA*

"One of my favorite photos shows one of the hoop houses that I introduced to Haiti, located in a remote area northeast of the town of Furcy at an elevation of about 5,500 feet. I still don't know how they got the materials there and built it. It is a hike of many miles from the road that I took the photo from. The men who built it said "No problem!" Not only did they need to carry the materials, they had to level the area by hand so they could put up the hoop house. They liked the location because they were able to pipe water to it from a spring higher up the mountain (off to the right on the photo). The steep slopes are typical of the farming in this area of Haiti. As part of the cost share for the hoop houses, the farmer must stop farming the mountain slope and plant 50 trees for reforestation."







MAGNIFICENT MICROSCOPICS

Eric Birkenhauer, *graduate student in biological engineering;* **Evan Wright,** *undergrad biological engineering student;* **Adam Vogt,** *research assistant; and* **Suresh Neethirajan,** *Assistant Professor, School of Engineering, BioNano Lab, University of Guelph, Canada*

BALL-IN-SOCKET, image 1

"The tip of a ballpoint pen at 200 micron resolution."

BIONANO ROBOT, image 2

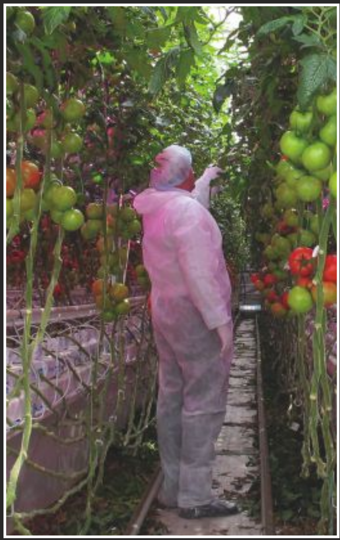
"Atomic force microscopic image of a unipolar flagella bacterium."

CROWN OF THORNS, image 3

"SEM image of the surface of a plant leaf revealing length-scale roughness at higher magnification."

ICE IN MARTIAN CRATER, image 4

"Inverted optical microscopic image of two-day old culture of E. coli. *DAPI, GFP, phase contrast, and bright field images are overlaid with some artistic license."*



GREENHOUSE HYDROPONIC TOMATOES GROWN VIA INTRA-CANOPY LEDs, left

A.J. Both, *Associate Extension Specialist, Bioresource Engineering, Department of Environmental Sciences, Rutgers, The State University of New Jersey, New Brunswick, N.J., USA*

"New developments in LED lighting technology provide exciting opportunities for horticultural applications. This photo was taken at a research project site by Greenhouse Horticulture, part of Wageningen University and Research Centre, and GreenQ at their greenhouse complex in Bleiswijk, The Netherlands. The researcher pictured is Tom Dueck from Wageningen UR."

PLUG TRAYS AND HANGING BASKETS, right

"Space optimization is key to the economical production of plants in greenhouses, as photographed in Young's Plant Farm, Auburn, Ala."

BIONENERGY: ON THE MOVE

Robert "Bobby" Grisso

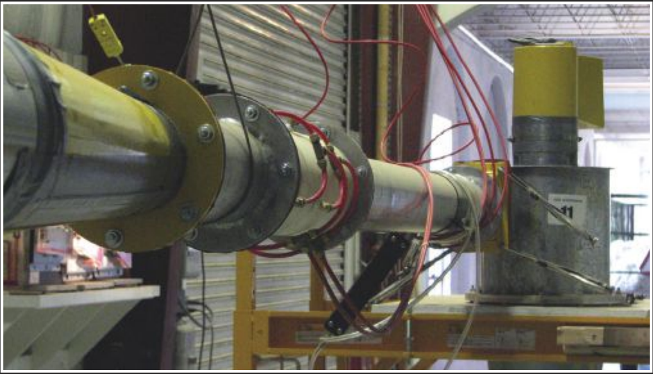
Professor, Biological Systems Engineering, Virginia Tech College of Agriculture and Life Sciences, and Associate Director Virginia Cooperative Extension, Blacksburg, USA

"Field operations for switchgrass harvest for bioenergy near Vore, Tenn."

AGAINST THE RISING SUN

Peter Ako Larbi, *Postdoctoral Research Associate, Washington State University Center for Precision and Automated Agricultural Systems, Prosser, Wash., USA*

"Paul Clayton captured me setting up a spray dispersion experiment to validate a developed spray model at the University of Florida's Citrus Research and Education, Lake Alfred. The model was published in Transactions of the ASABE *55(1): 29-39."*



CYCLONE EFFICIENCY

Paul Funk, *USDA-ARS Southwestern Cotton Ginning Research Laboratory, Las Cruces, N. Mex., USA*

"Ginning is one step in the total cotton system, and it interacts with earlier steps such as harvesting and later steps such as mill processing. A series of targeted Laboratory research projects address critical cotton production, ginning, textile processing, and regulatory compliance issues, especially those pertaining to Western irrigated cottons."

HARVESTING TWO-YEAR-OLD PACIFIC ALBUS TREES: FIBER FOR BIOCHEMICALS, BIOFUELS, AND BIOENERGY PRODUCTION

Nabil Mohamed, *Water and Energy Resource Engineer, GreenWood Resources, Boardman Tree Farm, Hermiston, Ore., USA*

"GWR BTF is a working, real-world model of a short-rotation tree farm, where 21st century technology enables agroforestry to efficiently and economically produce fiber from one of the earth's most renewable resource—trees—in a sustainable and eco-friendly manner. I am responsible for all water and energy resource engineering at the world's largest irrigated fiber farm and one of the largest contiguous drip-irrigated farms in the world. Potential yield per hectare is five times the ethanol yield of corn and at a production cost estimate of less than one dollar per gallon of ethanol. Development and testing of harvest equipment was done at BTF to specifically harvest the larger sized two-year-old trees."

DAY'S END AT THE OFFICE

The peaceful office hallway at the close of a work day stands in quiet contrast to an agricultural engineer's complex work testing dust cyclones. The cotton ginning research lab's mission is to develop technologies that solve problems directly affecting the cotton ginning industry to maximize the economic viability and competitiveness and minimize the environmental impact of U.S. cotton production and processing.

TREE HARVEST SOLID WOOD MILL SITE

"One of the largest U.S, hardwood mills is strategically located within the center of 10,440 hectares of sustainable tree farm, surrounded on all sides with 8,000,000 Pacific Albus trees. Pacific Albus, a hybrid Poplar grown in the Pacific Northwest, is from the Latin word albus, meaning white. It has similar characteristics to Aspen and Cottonwood."

Resource ***cover photo also by*** **Nabil Mohamed.**

Lin Fang, graduate student in agricultural and biological engineering at Penn State, observes an active growing culture sample at the biofuels laboratory on the University Park campus. ***All photos by Patrick Mansell, courtesy of Penn State University.***

Changing cellulose formation increases biofuel potential

In Brief: Changing the way a plant forms cellulose may lead to more efficient, less expensive biofuel production, according to Penn State University engineers.

"What every biofuel manufacturer wants to do is to get to the sugars, " says **ASABE member Jeffrey Catchmark**, associate professor of agricultural and biological engineering. "But the structure of cellulose itself can be an obstacle."

Catchmark says that most of a plant's sugar-based energy is locked up in the crystalline structure of cellulose. To make cellulose, plants create long chains of sugar—glucose—that are then crystallized and densely packed into tight, ordered bundles that are resistant to water and other solvents. This bundling may help build strong plant cell walls, but biofuel makers must use extra effort to break down and separate the bundles and the crystalline cellulose to extract the sugars used to ferment fuels.

Using bacteria that produce cellulose as a model to test the process, the researchers discovered an approach for modifying cellulose synthesis in living plants for improved biofuel production efficiency. During the synthesis process, the researchers added glucomannan, a complex carbohydrate found in plants that sticks to cellulose. They found that glucomannan altered the structure and assembly of the cellulose, allowing the cellulose to be broken down more efficiently.

Lin Fang displays a purified microbial cellulose sample in her lab.

Another method for adding glucomannan during cellulose formation requires genetically engineering the plant to express or over-express the enzymes that form glucomannan, according to the researchers, who applied for a provisional patent on the process.

"In our work, what we are interested in is whether we can improve digestibility by altering the crystal structure or by altering the bundle formation," says Catchmark, who worked with Lin Fang, a graduate student in agricultural and biological engineering.

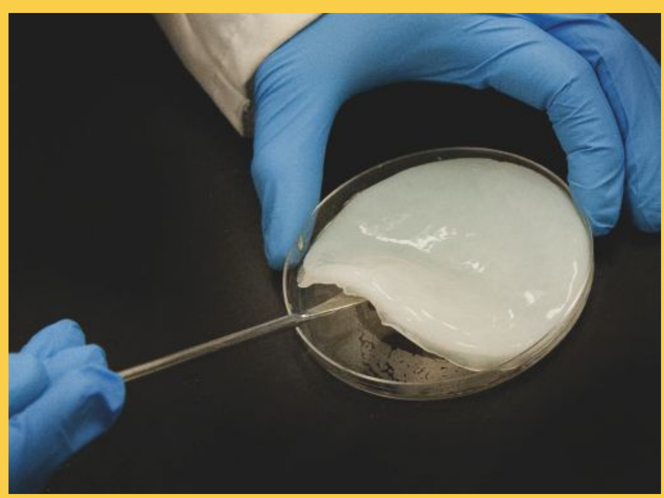
Jeff Catchmark, associate professor of agricultural and biological engineering at Penn State, studies purified microbial cellulose.

By growing plants with cellulose that is less crystallized and that has fewer structured bundles, biofuel manufacturers will not need to spend as much time and effort breaking down these pretreated plants, according to the researchers. Currently, biofuel manufacturers must use several industrial processes that are time- and energy-intensive and relatively expensive, including chemical, mechanical, and fermentation processes, to break down the cellulose and separate other materials.

Catchmark says that biofuel manufacturers may be able to further optimize their production processes to suit the modified plants for even greater efficiency. "This will give biofuel makers more options," Catchmark says. "Hopefully, you will need less effort and lower costs with the pretreatment, and achieve improved conversion efficiency."

Catchmark says that while the technique was used on bacteria, it could be adapted to various plant species because plants and certain bacteria share similarities in how they create cellulose. He says that researchers could use the process in both grass and wood plant species, giving biofuel makers additional options. The researchers now plan to test the methods on plants.

For more information, contact Matthew Swayne, Penn State Science and Research Information Officer, mls29@psu.edu.



A purified microbial cellulose sample is prepared for examination to determine the full potential of plant use in biofuels.

Biological science aide Anne Berry puts wheat in the hopper of a color-image sorter. The camera behind her captures a color image of each kernel as it falls off the end of the chute. The kernels are then sorted based on visual features and deposited into either of two separate buckets at the base of the sorter. This fast, accurate, and economical seed sorter is proving popular with a variety of users. *Photo by Thomas Pearson.*

Savvy seed sorter separates good from bad

In Brief: Fast, portable, and comparatively inexpensive, an improved seed-sorting machine developed by a USDA scientist and an industry colleague is helping plant breeders and others separate desirable seeds from undesirable seeds with an impressive degree of accuracy.

USDA-ARS agricultural engineer and **ASABE member Thomas C. Pearson** developed the seed sorter in collaboration with National Manufacturing in Lincoln, Neb. The company has marketed the device to plant breeders and other customers in the United States and abroad.

The compact, portable sorter is a simpler and faster version of other machine-vision equipment that Pearson developed earlier, with improved versatility. According to Pearson, the sorter is currently being used to separate unwanted grass seeds from the seeds of native plants needed to revegetate publicly owned lands in the western United States, among other uses.

A major breeder of peas and beans for vegetable farms uses the machine to remove damaged seeds. Some university plant breeders rely on the sorter to discern and discard spotty peas or to reject wheat kernels that show discoloration associated with *Fusarium* head blight, a costly disease of wheat and barley.

In tests in his laboratory at the USDA-ARS Center for Grain and Animal Health Research in Manhattan, Kan., Pearson showed that the sorter can help wheat breeders by differentiating kernels of hard red wheat from kernels of hard white winter wheat with 98.6 percent accuracy.

In other tests, the sorter was accurate 94 percent of the time in separating yellow from brown flax seed. Sorting is critical because the yellow and brown seeds are used for different purposes, Pearson explains.

Sorting begins when seeds, placed in a vibrating hopper, start sliding down any of three adjacent chutes. When a seed falls off the end of its chute, a color camera, equipped with a CMOS image sensor, captures an image of the seed and sends the image to a chip for processing.

The chip is preprogrammed to determine whether the seed's surface texture and red, green, and blue color values more closely match those of an "acceptable" seed than those of a "reject." Seeds that appear similar to "rejects" are quickly directed by a puff of air into the "reject" container, while the desirable seeds fall neatly into the "acceptable" bucket. To see a video of the seed sorter in action, visit: www.ars.usda.gov/is/pr/2013/130711.htm.

For more information, contact Marcia Wood, USDA-ARS Public Affairs Specialist, Marcia.Wood@ars.usda.gov.

TEXAS A&M UNIVERSITY
BIOLOGICAL & AGRICULTURAL ENGINEERING DEPARTMENT

ASSISTANT PROFESSOR/EXTENSION SPECIALIST (IRRIGATION ENGINEERING)

This 12-month, non-tenure track position (70% Texas A&M AgriLife Extension, 30% Texas A&M AgriLife Research) focuses on implementation of an innovative extension and applied research irrigation and water management program addressing the needs of agricultural producers and groundwater conservation districts with emphasis on the Northern High Plains of Texas. Work location is the Texas A&M AgriLife Research & Extension Center, Amarillo, Texas.

Position Responsibilities: Responsible for development and delivery of educational materials on irrigation technologies, water quantity and conservation, irrigation scheduling, and optimizing limited water resources to meet the goals of minimizing aquifer depletion while maintaining profitable agricultural enterprises. Conduct irrigation and water management demonstrations, develop knowledge of energy usage with irrigation pumping plants, evaluate irrigation crop production systems, evaluate grower usage of irrigation scheduling techniques. Expectations include publishing of research results in peer-reviewed journals and program support through extramural funding. Specialist expected to develop a working relationship with the irrigation industry and participate in industry and professional associations.

Qualifications: Required, by date of appointment, a Ph.D. in biological, agricultural, or an equivalent engineering degree. Effective verbal and written skills, interest and capability to work both independently and as a multidisciplinary team member. Experience with field research and knowledge of Texas Great Plains water resource issues is desirable. The candidate should hold a professional engineering license or be capable of pursuing one in the state of Texas.

Application Procedure: Application review begins November 1, 2013, and will continue until position is filled. Projected start date is January 1, 2014. Submit application at http://greatjobs.tamu.edu (Search for NOV # 07094). Send an email notice of application submission to: Dr. Dana Porter, d-porter@tamu.edu, Search Committee Chair. *E-mail only applications cannot be accepted.*

Texas A&M AgriLife is an equal opportunity employer.

TEXAS A&M UNIVERSITY
BIOLOGICAL & AGRICULTURAL ENGINEERING DEPARTMENT

ASSISTANT/ASSOCIATE PROFESSOR AND EXTENSION SPECIALIST (WATER/WASTEWATER ENGINEERING)

This 12-month, non-tenure track position (70% Texas A&M AgriLife Extension, 30% Texas A&M AgriLife Research) focuses on development of a statewide extension education and research program related to surface and groundwater quality protection emphasizing non-point sources, on-site sewage facilities (OSSF) and other environmental issues. The work location is the Texas A&M Agri-Life Blackland Research & Extension Center, Temple, Texas.

Position Responsibilities: The Specialist will organize and conduct training courses for OSSF installers and homeowner maintenance required courses. In addition, will address education and research needs in water treatment technologies (such as desalination), water capture and reuse, and conservation technologies that address identified needs in both agricultural and urban sectors. Expectations include publishing of research results in peer-reviewed journal and program support through extramural funding.

Qualifications: The candidate is required to have, by date of appointment, a Ph.D. in biological, agricultural, or an equivalent engineering degree. A demonstrated background or knowledge of water quality issues, pollution treatment systems, hydrology, nonpoint source pollution, environmental remediation, best management practices, and environmental systems is desired. Six years or more experience in extension, teaching, research, or related work is preferred. Experience and qualifications to become licensed to lead OSSF installer and maintenance technician courses is required. The candidate must have good communication skills, the ability to work with people, and computer literacy. Experience with field research and knowledge of Texas water resource issues is desirable. The candidate should hold a professional engineering license or be capable of pursuing one in the state of Texas.

Application Procedure: Application review begins November 1, 2013, and will continue until position is filled. Projected start date is January 1, 2014. Submit application at http://greatjobs.tamu.edu (Search for NOV # 07098). Send an email notice of application submission to: Dr. Clyde Munster, c-munster@tamu.edu, Search Committee Chair. *E-mail only applications cannot be accepted.*

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

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

Strong Attendance and Great Speakers Make the 2013 AIM Memorable

The numbers tell a terrific story: more than 1,600 attendees, including 500 students, from 29 countries descended on Kansas City in July for the 2013 ASABE Annual International Meeting. Nearly 120 attendees came from China, 90 from Canada, and 25 from Korea. They were captivated by three outstanding headline speakers, 155 technical sessions, and more than 1,100 presentations. Added to that were a superb selection of technical and social tours, some of which sold out quickly.

Clear high points of the meeting's technical content were the headline speakers. General Session keynote speaker Helmi Ansari, of PepsiCo Foods Canada, provided an engaging overview of his company's response to the need for more sustainable practices in the food industry. Immediately following the General Session, Robert Easter, president of the University of Illinois, introduced the Global Challenges Forum with a presentation of his own, and then moderated a panel of international speakers and session attendees. For Bioenergy Day, Sonny Ramaswamy, Director of the USDA National Institute for Food and Agriculture, headlined a rich slate of presenters, packing much information into his fast-paced look at the food-water-energy nexus.

Other highlights:

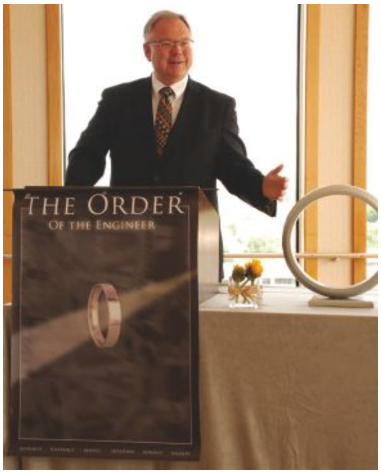
- The University of Illinois, Kansas State University, and the University of Arkansas were respective winners of the Robotics Competition, Fountain Wars, and the open portion of the Gunlogson Competition.
- The Kansas City Royals baseball outing and the ASABE Foundation Benefit at the Kansas City Jazz Museum were sell-out successes.
- Bruce Hartsough and Carmen Agouridis were the winners in this year's YPC Fun Run.
- Student video competition and a new video on ag and bioengineering captured hearty applause. If you weren't able to attend, check out:

  www.youtube.com/watch?v=WM16bY0W8o8&feature=youtu.be

  www.youtube.com/watch?v=SN9J7Hj7Ok4

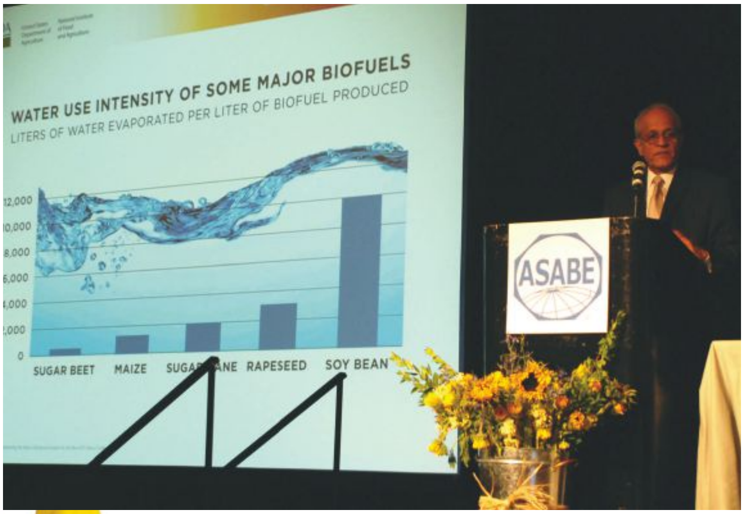
Many thanks to our key sponsor John Deere, and also to AGCO and CNH for their generous support of the 2013 AIM and Foundation activities.

Dolores Landeck, ASABE Director of Public Affairs, landeck@asabe.org.

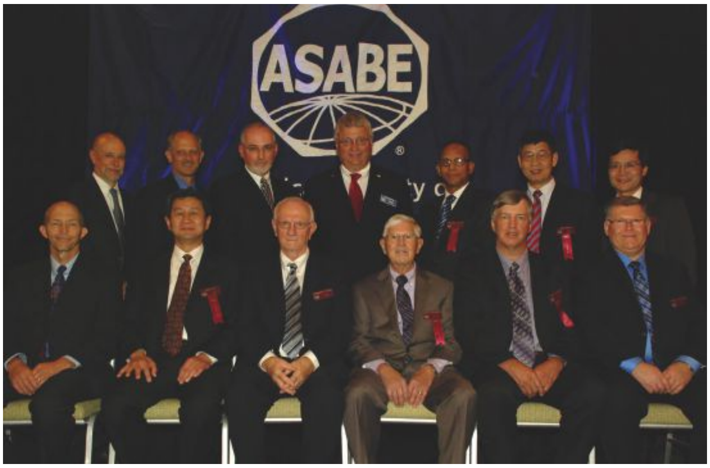


Speaking to the 2013 class of Order of the Engineer inductees, ASABE Past President Charles Sukup delivered brief and inspiring remarks on the contributions of engineering to humankind.

Runners and walkers headed out on a muggy Sunday morning in Kansas City in the 2013 Fun Run and Walk, sponsored by the Young Professionals Community.



Sonny Ramaswamy, USDA-NIFA, presented the keynote address Bioenergy Day, advocating increased research to accelerate advancements in agricultural productivity, technology, pest resistance, water use, and other areas critical to a sustainable food-energy-water nexus.



ASABE inducted thirteen outstanding individuals as Fellows of the Society. This year's class (first row, left to right): Greg Hanson, Yang Tao, Norman Fausey, Donn DeCoursey, Danny Rogers, and Kenneth Hellevang. Back row, left to right: Durham Ken Giles, Paul Heinemann, Steven Taylor, ASABE President (and 2006 Fellow inductee) Tony Kajewski, Prasanta Kalita, Qun Zhang, and Renfu Lu.

Brian Luck, Chris McGuire, and Brady Lewis "harvested and delivered" water balloons in the All-in-Good-Fun contest to benefit the YPC.

YPC officers, left to right: President Kate Klavon, Iowa State University; Second Vice President Lauren Wondra, University of Nebraska; First Vice President Austin Roepke, University of Illinois; Treasurer Jaimee Malone, Oklahoma State University; and Secretary Linda Geiger, Iowa State University.

The keynote speaker, Helmi Ansari, described his efforts to embrace sustainability as a core business initiative, enabling people across Pepsico Foods Canada to be owners and champions for environmental sustainability in their daily work.

Past President Ron McAllister enjoyed a coffee break with CNH colleague Maria Grazia Barghini, who coordinates CNH support of ASABE and the ASABE Foundation.

The Fountain Wars team from Kansas State University pirated the event win.

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RESOURCE

Open Access is Coming to Federally Funded Research

Donna Hull

The White House Office of Science and Technology Policy (OSTP) released a memorandum on February 22, 2013, related to increasing access to the results of federally funded scientific research. When fully implemented, it is likely that ASABE peer-reviewed articles that are based on federally funded research will need to be made available to the public, an arrangement called "open access."

Here's the specific wording: "OSTP hereby directs each federal agency with over $100 million in annual conduct of research and development expenditures to develop a plan to support increased public access to the results of research funded by the federal government. This includes any results published in peer-reviewed scholarly publications that are based on research that directly arises from federal funds."

For the complete text of the memorandum, go to: www.whitehouse.gov/sites/default/files/microsites/ostp/ostp_public_access_memo_2013.pdf. Each federal agency is to submit a draft plan within six months of the date of the memorandum. Full implementation is anticipated to take two to three years.

How will this affect ASABE?

The requirement to provide open access to articles based on federally funded research will not have a significant impact on ASABE's publications revenue. The requirement only applies to documents related to federally funded research that are published after the agency plans go into effect and therefore does not include any of the over 25,000 documents already in the ASABE Technical Library. In addition, many documents that are added to the Technical Library are not a result of federal funding. The agency plans are also likely to include an embargo period before requiring that affected documents be made publicly available. For these reasons, libraries would still find a license agreement to ASABE content attractive. There could be a slight decline in sales of individual documents to non-members and those not covered by license agreements, but as individual sales are a very small percentage of our publications revenue, this would have a minor impact.

However, depending on the plans developed by the various federal agencies, the compliance requirements for publishers could become a burden. In anticipation of this, publishers have proposed a framework for a possible public-private partnership, called The Clearinghouse for the Open Research of the United States (CHORUS). According to the CHORUS website (www.publishers.org/press/107/), "The proposed solution would build on publishers' existing infrastructure to enhance public access to research literature, avoiding duplication of effort, minimizing cost to the government, and ensuring the continued availability of the research literature."

CrossRef, a nonprofit organization responsible for enabling linking among the world's scholarly publishing platforms, is a major player in CHORUS. In ASABE's case, we are already beginning to supply CrossRef with metadata for all new publications. Adding an additional field to the metadata indicating that federal funding was involved would be the primary effort required of us to comply with the new mandate. CrossRef would then develop a process to flag the affected documents in our Technical Library for open access and provide a mechanism allowing readers to identify federally funded research.

Discussions are underway with federal agencies and CHORUS representatives to develop a plan that meets both publisher and agency needs. Ideally, such a plan would minimize costs to the government while reducing the burden of compliance for publishers by using current and developing tools such as CrossRef, FundRef, and ORCID.

CHORUS proponents include publishers, resource partners, associations including ASABE, and other organizations involved in scholarly publishing. According to the CHORUS website, this "broad-based group of signatory publishers, both commercial and not-for-profit, collectively produces the vast majority of the articles reporting on federally funded research."

ASABE members and others involved in federally funded research are encouraged to take an active role in the discussions within their funding agencies to develop plans for complying with the OSTP memorandum. The overall goal is increasing access to the results of federally funded scientific research. We'll keep you posted as this process moves forward.

Donna Hull is ASABE Director of Publications, hull@asabe.org.