The word “change” has seen plenty of use over the past few years, especially in the political scene, and it’s an appropriate word to use in regard to ASABE. Our new executive director, Darrin Drollinger, will be in place by the time you read this. Yes, “executive director” is the correct term. The Board of Trustees decided at its April meeting to change the position title from executive vice-president to executive director. This change is consistent with the ASABE Constitution. The new title is also consistent with other non-profit organizations, and it suggests an appropriate focus on issues that are both internal and external to our Society.

Darrin, a 21-year ASABE member, was most recently the Association of Equipment Manufacturers’ vice-president of statistics, technical, and safety services. He has over twenty years of association management experience and a lifetime of passion for agricultural and biological engineering, which began in his family’s greenhouse business while growing up in Ohio. I’m looking forward to working with Darrin to move ASABE to new heights.

As well, I want to express how honored I am to be representing you for the next year as president of our Society, and I hope I can live up to your expectations. But I’m not kidding myself—I know that the members do the real work of ASABE. To all those involved in the Society, thank you. If you are not involved in Society activities, then I encourage you to get involved. If the Society is not meeting your needs, then be proactive and suggest changes. You’re just one, but you can help make ASABE what you need it to be. My goal, as president, is to see our membership grow, and I encourage each member to recruit just one more ASABE member. That’s not a difficult task: just one—reaching just one. In fact, each of us growing our membership by “just one” is my platform for the coming year.

Our Society is only as good as its members. The members create it, and the members can be proud of it. Talk up ASABE to your coworkers, encourage a non-member to join, and invite a member who did not attend this year’s Annual International Meeting (AIM) to attend the next AIM in 2011. We’ll have a great meeting in Louisville if everyone who attends the 2010 AIM also encourages another member—just one—to attend the 2011 AIM.

This year, we’ll be working together to make the necessary changes and move our Society on to greater accomplishments. With new leadership in place, we can look forward with anticipation, excitement, and commitment. I’ll be doing my part, and I’m just one—just like you. I invite you to email me with your suggestions and concerns.

Ronald L. McAllister
ron.mcallister@cnh.com

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.

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Grocery shoppers will typically pay more for produce that is guaranteed to be fresh. In fact, customers at farmer’s markets often pay twice as much as retail grocery shoppers for the same types of produce. When good management practices are used, family-operated greenhouse enterprises can profitably supply local markets with fresh produce year round, and hydroponic growing systems provide an ideal technology for producing vegetables that are to be marketed locally. In addition, although nutrient delivery methods and plant support media vary widely, most of these systems lead to reasonably good results. However, there is a big difference between a working system and one that is commercially successful.

To investigate the requirements for successful hydroponic agriculture, a hydroponic lettuce research laboratory was recently constructed in a greenhouse at the Ohio Agricultural and Research Development Center (OARDC) in Wooster, Ohio (fig. 1). To accommodate a wide variety of

Figure 1. The Hydroponic Lettuce Research Laboratory at the Ohio Agricultural and Research Development Center, Wooster, Ohio.

Figure 2. Eighteen 3.66 m (12 ft) channels growing leaf and bib lettuce 20.3 cm (8 in.) apart.
experimental designs, the water and nutrient delivery system is capable of randomly and simultaneously delivering sixteen different treatments to lettuce crops through sixteen growing channels supplied by eight recirculation tanks. Growing media, cultivars, light sources, solution flow rates, pH, electrical conductivity (EC), shading, and solution temperatures are all controllable factors that can be varied and evaluated. Each growing channel is 3.66 m (12 ft) long and is designed to grow eighteen plants 20.3 cm (8 in.) apart. Two additional growing channels provide a buffer row along the outside edges of the experiment, for a total of eighteen channels that can grow a total of 324 plants (fig. 2).

**Preliminary experiments**

To gain experience with this new laboratory, as a part of the very first experiment, two growing media were compared: rock wool and a new plastic fiber material. Rock wool growing cubes are the most widely used medium in hydroponic growing systems. Rock wool is an inert substrate that’s used for both free-drainage and recirculating systems. It’s produced by aerosolization of molten mineral compounds, resulting in a fibrous medium accessible to capillary action that is not degraded by microbiological activity. The plastic fiber medium is a new thermoplastic polymer resin of the polyester family that’s used in synthetic fibers. The dimensions for both types of growing cubes were 2.5 × 2.5 × 3.8 cm (1 × 1 × 1.5 in.). The cubes are designed to fit in 2.5 × 2.5 cm (1 × 1 in.) square openings located every 20.3 cm (8 in.) along the length of the growing channels. In addition to the growing cubes, two cultivars (bib lettuce or leaf lettuce), two nutrient solution flow rates (1 or 2 Lpm), two nutrient solution pH levels (5.4 or 6.0), and two nutrient solution EC levels (1.4 or 1.8 mmho cm⁻¹) were compared (table 1). The capability to test two specific nutrient solution temperatures was not available during the beginning experiments, so solution temperatures were not tested.

<table>
<thead>
<tr>
<th>Controlled Factor</th>
<th>Level 1</th>
<th>Level 2</th>
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<tbody>
<tr>
<td>Growing medium (cubes)</td>
<td>Rock wool</td>
<td>Plastic fiber</td>
</tr>
<tr>
<td>Lettuce cultivar</td>
<td>Rex Bib</td>
<td>Leaf</td>
</tr>
<tr>
<td>Nutrient solution: Flow rate</td>
<td>1 Lpm</td>
<td>2 Lpm</td>
</tr>
<tr>
<td>pH</td>
<td>5.4</td>
<td>6.0</td>
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<tr>
<td>Electrical conductivity</td>
<td>1.4 mmho cm⁻¹</td>
<td>1.8 mmho cm⁻¹</td>
</tr>
<tr>
<td>Temperature</td>
<td>20°C</td>
<td>30°C</td>
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</table>

Table 1. Factors and levels proposed for testing during the first experiment in fall 2008. Tests were repeated in spring 2009.

**Seed germination and seedling transplanting**

Seeds were germinated and grown for approximately two weeks in 25.4 × 50.8 cm (10 × 20 in.) growing cube trays (i.e., 200 plants per tray). Thereafter, the seedlings were transplanted to growing channels. Seedlings were transplanted on 10 September 2008 for our first experiment and on 16 April 2009 for our second experiment. Notice the rapid growth rate in the five-photo sequence in figure 3 on the following page.

The growing channels are designed with a 1.5% slope and a nutrient solution flow rate of 1 to 2 Lpm (0.264 to 0.528 gal min⁻¹). This design is required for the so-called nutrient film technique (NFT) for hydroponic growing systems. The depth of the recirculating stream is very shallow, supplying nutrients with only a film of water. However, this shallow depth permits the roots to be exposed to more than adequate supplies of oxygen. Since all of the water and nutrients are recycled, nothing is wasted. Figure 4 shows the amazing quantities of roots used by the plants for growth. This picture was taken the same day that the lettuce was harvested on 8 October 2008.

**Samples of laboratory results**

Preliminary results from the first two experiments (autumn 2008 and spring 2009) showed that lettuce yields were 29% to 35% less on average when grown in newly marketed plastic fiber cubes compared to traditionally used rock wool cubes. On the contrary, three follow-up experiments (summer, autumn, and winter 2009) indicated that coconut coir, an organic potting mix, and an experimental plastic foam yielded 23%, 16%, and 13% greater than rock wool, respectively.

![Figure 4. Roots thrive in a hydroponic NFT environment.](image-url)
Rex Bib and Green Leaf Two Star seeds germinate and grow in plastic fiber cubes on the left and rock wool cubes on the right.

Healthy roots from seedlings grown in rock wool cubes are ready for transplanting after two weeks.

Seedlings, after being immediately transplanted into growing channels.

Rex Bib and Green Leaf Two Star lettuce two weeks after being transplanted into growing channels.

Rex Bib and Green Leaf Two Star lettuce four weeks after being transplanted into growing channels ... ready to harvest.
During summer months, greenhouse crops are typically covered with a shade cloth. In our study, results indicated that the plants that were not shaded yielded 28% more lettuce on average (with no decrease in quality) than plants that were covered with 50% shade cloth.

Finally, based on an interaction between two controllable factors, nutrient solution flow rate and choice of cultivar, figure 5 shows that increasing the flow rate from 1 to 2 Lpm increased the fresh weight yield of Green Bib by 15.4% while reducing Red Bib fresh weight yield by over 5.4%.

**Impacts for growers**

This preliminary study has already yielded useful information for growers:

- Selection of the appropriate growing cube medium can potentially increase lettuce yields by up to 20%.
- Doubling the nutrient solution flow rate from 1 to 2 Lpm can increase lettuce yields by as much as 15% for certain varieties, although reducing yields for others.
- Cultivar choice may depend on growing cube selection, or vice versa.
- Finally, to shade or not to shade—it may be a tough decision.

In addition, these research results are not just about increasing yields. They are also about reducing the growing time per crop, and thereby increasing the number of crops per season, which could have huge economic benefits. Future research at the OARDC Hydroponic Lettuce Research Laboratory will yield even more beneficial results.

ASABE Member Engineer Robert Hansen is a research scientist in the Food, Agricultural, and Biological Engineering Department, Ohio Agricultural Research and Development Center (OARDC), Ohio State University, Wooster, USA, hansen.2@osu.edu; Jeff Balduff is responsible for technical sales and support, CropKing, Inc., Lodi, Ohio, USA, jbalduff@cropking.com; and ASABE Member Engineer Harold Keener is professor and associate chair of the Food, Agricultural and Biological Engineering Department, OARDC, Ohio State University, Wooster, USA, keener.3@osu.edu.
Researchers at the University of Kentucky (UK) are very close to having a viable solution to the problems incurred by the manual methods currently used for securing milk during transport. Our milk transport security system will provide improved accuracy, traceability, efficiency, and security—significantly adding to the security infrastructure for bulk food transport.

In the modern food supply chain, bulk food handling and transportation security protocols are of great importance because of the potential for threats to public health. The U.S. Department of Homeland Security has identified potential contamination of bulk milk as a focus area for security improvements. Within the dairy industry, existing protocols for security ensure consumer safety and product reliability; however, the manual methods currently used for securing milk during transport are manual, paper-intensive, and prone to errors.

A grant from the National Institute for Hometown Security in Somerset, Ky., funded a four-year project to develop a security system for bulk milk transport. Since January 2006, Chris Thompson, a senior agricultural regulatory specialist in the UK College of Agriculture, and I have led a team of researchers, including UK graduate and undergraduate students and researchers from the University of Louisville and Western Kentucky University, along with milk producers, processors, and transportation companies, to develop and optimize the milk transport security system to a pre-commercial state. The benefits of our development include improved data accuracy, superior traceability of the milk from the plant to the dairy farm, improved operational efficiency, increased productivity, and an increase in the information available to the dairy industry.

What it's all about

The UK system consists of a handheld device, a data server, and a processor-based system (called the Transport Monitoring System, or TMS) installed on the milk transport tank. The handheld device and server operate similarly to the system that UPS uses for identifying...
package pickups using barcodes. In our system, the driver identifies each dairy farm using a barcode and enters data at each farm where milk is picked up. The TMS monitors the electronic locks on the tank, the vehicle’s GPS location, and the temperatures, and it automatically sends this information to the server via cell phone communications.

The first step in a bulk milk pickup is data collection at the farm. The milk truck driver inputs the required information about the collected milk into the handheld device (temperature, volume, results of antibiotic tests, etc.), and the data are uploaded to the server. The information is then organized into security sessions, and the information for each truckload of milk is identified with a unique security session number. The security of the transport tank is maintained from the beginning of the tanker wash cycle to unloading at the processing plant. The hardware system of the TMS consists of electronic locks, temperature sensors, a user interface, and an auxiliary power supply.

CAN (controller area network) communication is used on the TMS, with one controller circuit board communicating with several node circuit boards to gather data from the locks and temperature sensors. Security data (such as lock position, temperature, GPS location, and power usage) are collected at one-minute intervals and transmitted automatically to the server. Communication protocols have been developed for the transmission and synchronization of the milk and security data between the handheld device, the TMS, and the data server. A patent application on the concept of securing milk in a transport tanker has been submitted by the University of Kentucky Research Foundation.

After the milk has been unloaded at the processing plant, the data stored on the server can be viewed via an internet interface. Users can easily view, print, and download a variety of forms and reports. A multitude of trace searches can also be conducted. For example, it’s easy to assemble a list of all the dairy farms that contributed to a given silo of milk at the dairy processor.

Commercial testing by milk marketing agencies and transportation companies was performed on the system in New York State and Kentucky from September to December 2009. The program developed for the handheld device performed extremely well and received excellent comments on ease of use from the 14 milk haulers who used it. A fully instrumented milk truck was tested in the Kentucky test and proved that the synchronization of the computational devices performed as designed. Data for the test were stored on the server, and the server-based software demonstrated that milk could be traced back to the farm using the data collection system.

Overall, the milk transport security system developed at the University of Kentucky provides security, accountability, surveillance, and response features for bulk milk transport, and it contributes significantly to the U.S. national security infrastructure. A startup company, TranSecurity Systems, Inc., has been formed with the goal of commercially implementing the technology. TranSecurity Systems is currently in discussions with milk marketing agencies, transportation companies, and other interested parties in the milk industry as well as the bulk liquid food transport industry to determine appropriate system configurations to meet their functional requirements.

**ASABE fellow Fred Payne** is a professor in the Department of Biological and Agricultural Engineering, University of Kentucky, Lexington, USA, fpayne@bae.uky.edu.
A disturbing trend

U.S. Grain Entrapments on the Increase

Matt Roberts and Bill Field

Purdue University’s Agricultural Safety and Health Program has been documenting grain entrapment cases since 1978. These cases include fatal engulfments as well as partial entrapments that required assistance in order for the victim to be extricated. In addition, nearly 800 fatal and non-fatal grain entrapment cases have been documented and entered into a national grain entrapment database, with the earliest case dating back to 1964. This article summarizes the reported grain entrapment cases documented during 2009, with some observations concerning the increasing frequency of these events.

By the numbers

Based on the cases documented to date, no fewer than 38 grain entrapments occurred in 2009. This is the highest recorded number since 1993, when 42 were documented. The 2009 total also exceeds the 33 and 34 cases documented during 2007 and 2008, respectively (fig. 1).

Disturbingly, the trend for this type of incident, unlike many other types of farm-related injuries and fatalities, is not improving. Between 1994 and 2002, the five-year average decreased from a record of 29.2 recorded entrapments per year to 18.8 (the lowest since 1987). However, since 2002, the five-year average has increased steadily to 28.4 incidents per year in 2008 and 31.2 in 2009—an increase of nearly 66 percent.

As in past years, it should be noted that this summary does not reflect all grain-related entrapments, fatal or non-fatal, that have occurred, due to the lack of a comprehensive reporting system and a continued reluctance on the part of some victims and employers to report partial entrapments where extrication was required but no public report was made. Based on the ratio of non-fatal to fatal incidents docu-

Figure 1. Number of annual grain entrapments recorded in the National Grain Entrapment Database and 5-year average between 2000 and 2009.
mented in Indiana over the past 30 years, which has had an aggressive surveillance program to identify these events, the total number of actual cases could be 20 to 30 percent greater nationwide.

In 2009, the states with the most documented grain entrapments, fatal and non-fatal, were Minnesota (9), Iowa (5), Illinois (5), and Indiana (5). This geographic distribution parallels the long-term trend for these events to occur primarily in the Corn Belt. Overall, entrapments were documented in 13 states in 2009.

By the location and gender
Historically, 70 percent of all documented entrapments have occurred on farms, with the balance taking place at commercial grain facilities. Beginning in 2007 and 2008, this distribution of cases changed substantially, with 49 percent occurring on farms and 51 percent taking place at commercial sites. For 2009, though, the cases reflect more historic trends. For cases where the location is known, 11 (37 percent) entrapments occurred at commercial facilities and 19 (63 percent) entrapments were on farms. For the remaining eight cases documented in 2009, the location is unknown. All documented victims were male, and there is a trend toward more managerial-level employees, operators, or owners being involved in entrapments.

Fatality percentages
In 2008 and 2009, the ratio of fatalities to non-fatal incidents decreased when compared to earlier years. From 1964 to 2005, 74 percent of entrapments resulted in death. During 2008, 45 percent resulted in death, and in 2009, 42 percent. More entrapment victims may be surviving these incidents due to increased emphasis on safer procedures, such as using an observer during confined space entry, and an increased emphasis on first responder training for grain entrapment extrication. At least three of the incidents documented in 2009 involved extrication using commercially available grain rescue tubes, which were not widely available until 2007 or 2008.

By the grain
During 2009, the primary medium of entrapment remained yellow corn. Over the past 30 years, corn has been involved in approximately 45 percent of the grain-related entrapments where the medium was known. Other bulk materials that have been documented in entrapments included soybeans, wheat, milo, processed feed, and soybean meal.

The primary causes leading to entrapment of most victims were identified as entering a bin to loosen crusted, spoiled, or frozen grain while unloading equipment was running, or falling into grain transport vehicles while they were being either loaded or unloaded. There continues to be a direct relationship between out-of-condition grain and a greater probability of entrapment.

The 2009 corn crop was of record size. According to the USDA, corn harvested in 2009 amounted to 13.15 billion bushels, and soybeans harvested were 3.36 billion bushels. In several regions, the crop was harvested under less-than-ideal conditions, resulting in more reports of out-of-condition or spoiled grain in storage and increased incidents of plugged flow. In addition, the domestic corn demand for ethanol has resulted in the largest buildup of storage capacity across the Midwest in history. These factors will result in more corn being stored for longer periods of time than in past years, and an increased potential for grain entrapments, unless there is a change in current work practices. An industry-wide consensus should be reached on the development of an engineering safety standard for grain storage structures. The commercial grain industry and grain bin manufacturers are urged to increase their employee and farmer/customer education efforts to prevent grain entrapments from occurring.

An ounce of prevention worth a bushel of cure
In addition, there is a need to strengthen employee and first responder training to ensure that appropriate response strategies are in place in case of grain entrapments. Excellent training resources, such as the videos “Don’t Go with the Flow” and “Your Safety Matters,” are available from the National Grain and Feed Association (www.ngfa.org). These materials were developed in response to the observed upswing in grain entrapment incidents at commercial fatalities during the early 1990s. More farmer/producer-oriented safety resources are now available from many county-level Extension offices and from programs such as Purdue’s Post-Harvest Grain Quality and Stored Product Protection Program (www.grainquality.org).

Every flowing grain entrapment is a preventable incident. The 2009 record crop should be a reason to celebrate, not a cause for tragedy and sorrow. The grain entrapment problem can be addressed through the use of appropriately designed storage facilities, proper use of personal protective equipment, implementation of safe work practices, and having in place effective emergency response capabilities. Let’s reverse the trend in grain entrapments, starting now.

Let’s reverse the trend in grain entrapments, starting now.

Matt Roberts is a grain quality specialist and ASABE member Bill Field is a professor in the Department of Agricultural and Biological Engineering, Purdue University, West Lafayette, Ind., USA, field@purdue.edu.
To the average person, high-energy lasers may seem like science fiction, but lasers are a well-established technology, and they are used for a wide variety of applications. At the University of South Carolina, we are using them to improve our understanding of agriculture and its impact on the atmosphere. Specifically, lidar (short for “light detection and ranging”) is a remote sensing technique that uses a high-energy laser to “see” aerosol particles in the sky.

How it works
The lidar system emits a pulse of infrared light, at a wavelength near the same size as agricultural aerosols. Some of the light is scattered by the particles and returns to the lidar, where a telescope detects it. This optical signal is then digitized and recorded by a computer. The laser and telescope are both computer-controlled, and they can scan precisely in both horizontal and vertical directions. The result is a two-dimensional picture of the microscopic aerosols. The entire process happens very quickly: the laser pulses at 50 times a second, and the system can scan over several acres of a field in less than a minute. Currently, the lidar system is a research tool, providing information about where aerosols are going and how they are getting there. In the future, we hope that the tool can be developed into an operational package, providing real-time feedback to producers about their management practices.

It's all about aerosols
Agricultural aerosols come from a variety of sources, and each type is of a different concern. Sprays are applied to protect crops or enhance their growth. Off-site drift of spray is an issue for both the grower, as a loss of costly material, and for the public, as a potential environmental concern. In other areas, such as concentrated animal feeding operations (CAFOs) and field tillage, aerosol generation is a by-product...
of the operation and is a concern for the health of the workers and the local population, as well as a potential factor in climate change. Lidar can provide valuable information for the understanding and management of these issues.

Thus far, agricultural spraying has been the area with the most potential for converting the lidar system from a research tool to an operational instrument. Spraying is a vital component to the success of any agricultural application. Liquid sprays, including pesticides for protection and fertilization for growth, are applied to crops from both aerial and ground-based platforms. However, sprays are only effective if they go where intended, and they can have adverse effects if they drift off-target.

What happens to the spray once it is released is a complex process that depends on controllable factors, such as the droplet size and spray mixture, and uncontrollable factors, such as the weather. As a research tool, lidar helps us understand these complex interactions and how they control spray movement. Used in conjunction with meteorological instruments, visualizations of the spray clouds (like the one shown below) are used to assess the effects of wind speed and atmospheric stability on spray movement and deposition. With a known release quantity, it is possible to determine the concentration of material still in the air, and more recent work is establishing a quantifiable relationship between atmospheric stability and spray movement.

What the future holds

Long term, we envision that this information will be transferred to an operational environment in several ways. The connections between easily obtainable meteorological variables and spray movement dispersion patterns can be used to create best management practices and recommendations for spraying. In addition, this information can be used to update and improve the models used for spray path planning. Finally, in the future, we hope that a lidar system can be developed to work in real-time, to notify sprayers of drift as it occurs, so they can adapt their spray application immediately. We are still years away from a system that sophisticated—but it’s not science fiction.

ASABE member April Hiscox is an assistant professor in the Department of Environmental Science, Louisiana State University, Baton Rouge, USA, ahiscox@lsu.edu. In August 2010, she will be joining the Department of Geography at the University of South Carolina, Columbia, USA.

For Further Reading

To say that I was a farm kid who took the traditional path to agricultural engineering would be a stretch. I was born on Staten Island, N.Y., and lived there until I was eight years old. My dad was a New York City firefighter. He left the fire department in the late 1970s and moved us west—way, way west—to a place in the country called Pittstown, N.J., where, at the time, there were many dairy farms.

On Staten Island, foul balls during recess went into the street. In Pittstown, foul territory was an active cow pasture. Anyway, the place was rural then, and surprisingly, it’s still rural now. So, although I didn’t grow up on a farm, I did grow up around farms.

When I was a junior in high school, my drafting instructor asked me what I intended to do after graduation. I told him I wanted to be a draftsman. He thought that was fine, but I should consider being an engineer. He got me an after-school job with a civil engineering firm where I did drawing revisions (in ink!)—pretty low-level stuff that, nevertheless, convinced me to pursue engineering. Actually, I wanted to be a land surveyor, since I was then, as now, pretty keen on spending my time slogging through woods, fields, and streams, no matter what the weather or time of day. Little did I know that I’d be slogging through dairy cow manure instead—and loving it!

An ag engineer by chance

As I said, I wanted to be a land surveyor, so I applied to the University of Delaware’s civil engineering program. While I was double-checking my application form, making sure the major was coded correctly, I saw something called agricultural engineering. I read the description, and I was hooked. I promptly changed my application from civil engineering to ag engineering. Yes, I was just that impulsive. Later, during my senior year, I met Dr. Bill Bickert (now retired) of Michigan State University’s agricultural engineering department. Bill let me know there were opportunities at MSU for graduate assistantships in the dairy manure management area. While I was working toward my MS, a group of grad assistants, including a few undergraduates, took the Fundamentals of Engineering (FE, then called the EIT) exam.

Why did I take the exam?

First, my undergraduate professors stressed the importance of professional registration, and second, it just seemed like the natural thing, the next logical step in becoming an engineer—kind of like breathing.

After all, would you accept legal advice from a lawyer who hadn’t passed the bar? Would you submit yourself, your spouse, or your children to an operation performed by a physician who was not board-certified? I
suspect the answer is “no” in all cases. So why seek engineering consultation from a non-certified engineer? This is not to say that non-certified engineers are incompetent, but PE testing ensures minimum competence. In a nutshell, that’s why I went for PE certification—it simply demonstrates professionalism.

At the time I took the exam, there was no clear need for me to be certified. I reasoned, however, that if some day, for some reason, somebody needed to compare my credentials to someone else’s, then my PE certification would give me a leg up, whether for a job, a promotion, a contract, whatever. Besides, what would it hurt—why not be certified?

Fast forward ...

... from back when I took the exam until now. I can see that a very clear need has arisen for PEs in the area of manure management. Manure systems at animal facilities need PE certification for all aspects of new construction, system modification, and permitting. In fact, in Pennsylvania, you can’t legally call yourself an engineer or represent yourself as one without a PE license. What’s the law in your state?

Becoming registered is one thing; the specific discipline in which to pursue certification is another. For me, the choice was clear—I would take the PE exam in agricultural engineering. However, for some people, the choice isn’t so clear. Today we have degree programs in agricultural engineering, biosystems engineering, bioengineering, biological engineering, and my favorite: food, agricultural, and biological engineering. If you graduated from one of these programs, then which exam do you take? The one your colleague took—the exam with a War and Peace-size review manual? I’ve heard many times from my soil and water colleagues that the ag PE exam has too much machinery. Well, here’s a news flash: if you are designing water control structures, irrigation systems, manure systems, or anything about pumps, then you’d better know something about belts and sheaves. The same goes for tractor frames. The principles of shear, bending, flexure, buckling, etc., are the same whether you are designing a tractor frame or roofing a barn.

What do the years ahead hold?

Looking at the future of the ag PE exam, there is good news and bad news. First, the bad news: a significant number of ASABE members and other perspective candidates for the ag PE exam are opting for the civil engineering exam instead, which is putting the ag PE exam at risk for lack of demand. The good news? There is a significant number of potential candidates for the ag PE exam. Of course, when selecting which exam to take, you need to consider which exam best reflects your practice area. The most recent PAKS survey identified “natural resource engineering” as the area in which most respondents are working, followed by “machinery systems.” Consequently, this is reflected in the content of the new ag PE exam. As for those of you who took the civil PE exam but now work for the NRCS, how familiar are you with traffic planning? I’ll bet your job has more to do with applications of power and machinery than with designing off-ramps and cloverleafs.

Theatre popcorn and probation

Did you ever see the movie “Animal House”? It’s a great comedy about a misfit college fraternity that has some serious trouble with the school’s dean. In a famous scene, the dean declares that he is putting the whole frat on probation. When someone reminds him that the house is already on probation, the dean thunders: “They are? Well, as of this moment, they’re on DOUBLE SECRET PROBATION!” As an exam item writer, PAKS committee member, and PE task force member, I can tell you the ag PE exam is now on double probation (although not secret). What I mean is, the number of exam takers is less than sustainable. In my view, this is a result of fewer and fewer exam takers thinking of themselves as agricultural engineers.

If your professional background is more biological, don’t let the word “machinery” scare you. The test is pretty basic, and whether you are specifying irrigation components or hydraulic pumps, most of the principles and concepts are the same. Similarly, whether analyzing forces on a tractor frame or a roof structure, it’s all statics. In addition, in recent years, considerable effort has been made to keep the pass rate for the ag PE exam more in line with the pass rates of other PE exams. Let’s face it. In the past, the ag PE exam was tough, more difficult than most. That’s not the case anymore, with a pass rate of 80 percent as of the 2009 offering. If you are looking to take a PE exam, then consider the agricultural engineering exam for all of the reasons that I’ve just cited.

And here’s another good reason

There has never been a better time to be an engineer working in agriculture, whether you call yourself an agricultural, biological, biosystems, bio, food, or whatever engineer. Our profession is at the forefront of some of the most challenging issues facing the world: sustainable energy, environmental contamination, and food safety, to name a few. These issues are in the news every day, and our profession has the tools, the skills, and the minds needed to provide the answers. So support your profession, support engineering, and support agriculture by becoming a certified ag PE.

ASABE member Andrew Wedel earned his PE in 1999 and is registered in Delaware, Michigan, New York, Pennsylvania, Virginia, and Wisconsin; e-mail him at AWedel@mclanahan.com.
An historic experimental watershed in the Texas Blackland Prairie near the town of Riesel, Texas, has provided valuable information to the water resource community for more than 70 years, making it one of the longest continuously monitored hydrologic research sites in the country. The Riesel Watershed, as it is commonly called, is one of many experimental watersheds operated by the Agricultural Research Service (ARS). In fact, of the three original watersheds established by the USDA in the late 1930s, the Riesel Watershed and the North Appalachian Experimental Watershed near Coshocton, Ohio, are still operating. 

Currently at the Riesel Watershed, 17 water monitoring stations and 15 rain gauges measure rainfall, runoff, and water quality on native prairie, improved pasture, and cultivated cropland sites. The remnant native prairie site is especially valuable because it provides baseline natural background information on runoff and water quality. In addition to the active field-scale runoff sites, which range in size from 0.10 to 53.4 ha (0.25 to 132 acres), data have been collected from multiple larger watersheds and rain gauges on private land in the nearby Brushy Creek watershed. The ongoing data collection and research effort at Riesel continues to enrich a massive legacy database, which contains 70+ years of runoff, precipitation, sediment, and land management data.

When the original ARS watersheds were established in the late 1930s, little information was available on the impacts of agricultural land use and management on runoff, soil loss, and water quality. Therefore, the Riesel Watershed was designed to provide desperately needed real-world information. Much of the early research at Riesel focused on the ability of conservation management systems—including terraces, grassed waterways, and contour farming—to reduce peak flow rates and soil erosion. This research contributed significantly to the scientific foundation of the U.S. conservation farming revolution. Subsequent research at Riesel has established fundamental understanding of the agronomic and environmental effects of tillage, fertilizer, and chemical management alternatives (see sidebar). The wealth of hydrologic and water quality data accompanied by management practice information also contributed to the development of hydrologic and water quality models such as EPIC/APEX, GLEAMS, and SWAT. These models are now applied worldwide to manage water availability and water quality.

Visitors from across the United States and around the world come to Riesel to collaborate with ARS scientists and
learn about state-of-the-art hydrologic and water quality instrumentation. In fact, since 2000, scientists, engineers, and students from Australia, Brazil, Canada, China, Germany, India, Nigeria, Pakistan, the United Kingdom, Zimbabwe, and many U.S. universities have visited the watershed. Baylor University Geology Department professor Peter Allen says his department uses the Riesel Watershed for senior and graduate hydrology classes “because it is an excellent example of a world-class hydrologic field lab with examples of instrumentation from weather stations to weirs.” The contemporary relevance of Riesel and the entire ARS watershed network is clearly exemplified by requests for site access, legacy data, and scientific collaboration from countless universities, federal agencies, and the international scientific community.

Long-term poultry litter research program

A concrete example of the practical value of long-term experimental watersheds is an ongoing poultry litter study at the Riesel Watershed. Since 2000, ARS scientists and engineers, in cooperation with Texas A&M AgriLIFE Extension and the Texas State Soil and Water Conservation Board, have quantified the effects of land-applying poultry litter as a soil amendment and nutrient source for crop and forage production. To date, research topics in this project have included soil microbiology, runoff water quality, on-farm economics, nutrient cycling, and natural resource modeling and assessment. Recently initiated research, which will carry the project into its 13th year, is evaluating the reduction of bacteria runoff and odor emission by in-house windrow composting of litter prior to field application. Such broad-scale, long-term research would be very difficult to maintain without base research fund allocation and an established research infrastructure.

The base funding and infrastructure and the research they support at ARS watersheds are extremely beneficial to resource management agencies, communities, and universities. The Riesel Watershed, for example, allows ARS to expeditiously and cost-effectively meet research needs of agencies like the Texas State Soil and Water Conservation Board. Similarly, water-related research and teaching programs at universities such as Texas A&M, Baylor, and Duke benefit greatly from Riesel’s ongoing research, established infrastructure, legacy data, and collaborative opportunities.
Long-term hydrologic data

Long-term hydrologic data sets are rare but extremely valuable for the management of water supply, water quality, and flood impacts and for the optimal design of culverts, bridges, detention basins, and reservoirs, especially when coupled with land management information. Universities, state and private agencies, and industry all need water resource information; however, they typically do not have the resources or the stated responsibility to conduct long-term integrated watershed research and monitoring. Thus, the national USDA-ARS experimental watershed network, along with long-term research and monitoring sites operated or supported by the U.S. Geological Survey, USDA Forest Service, Department of the Interior, and National Science Foundation, are essential for deriving this information. The ARS and its federal partners have a vital responsibility to sustain the long-term watershed networks to provide on-going research and data to support conservation, protection, and allocation of our nation’s precious water resources. This task is especially urgent today, as most scientists and engineers expect water shortages, floods, and water quality degradation to increasingly affect future generations. Cost-effective solutions to these complex problems can only be developed with dedicated science, innovative engineering, real-world data, wise policy, and effective education—all of which rely on long-term watershed-based research and monitoring.

Despite budgetary and political pressures, the demonstrated accomplishments and future value of established, long-term experimental watersheds cannot be overlooked when setting priorities and allocating expenditures for water resources research. The National Research Council has emphasized the need for long-term research and monitoring integrated across time and spatial scales, as well as the value of maintaining sites with exceptionally long-term records. The ARS experimental watershed network fits both of these profiles. The ARS watersheds are uniquely positioned with legacy data, an established and functional infrastructure, watershed land control, and scientific expertise. In the future, this national watershed network can be relied on to contribute the science, technology, and data necessary to resolve the competing demands for water resources. Federal support of the ARS watershed network and other experimental watersheds has yielded critical understanding of our water resources. This commitment must remain a national priority to ensure our nation’s economic security and environmental sustainability.

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For Further Reading

The application of pesticides in fruit crops, particularly methods of reducing drift and improving deposition, has been a concern for many years. Spray drift is an important and costly problem facing growers. Drift results in damage to susceptible off-target crops, environmental contamination to watercourses, and an unintentionally reduced rate of application to the target crop, thus reducing the effectiveness of the pesticide. Pesticide drift also affects neighboring properties, often leading to public outcry. The problem continues apace as more people choose to live in the picturesque setting of an orchard or vineyard.

Many dollars, little value

Over the years, millions of dollars have been spent on research into spray drift, but most of the results languish in academic journals. Virtually nothing had filtered down to the fruit growers and sprayer manufacturers. While some researchers continue to report that drift occurs, little or no effort has been applied to designing spraying machines that actually reduce drift. Only a few manufacturers have designed sprayers to match the reduced canopy volume, due to the adoption of shorter trees and denser plantings, of today’s modern orchards and vineyards.

Additionally, many growers choose not to replace their mechanically reliable, yet technologically outdated, sprayers. As a result, a large number of orchard and vineyard sprayers are more than ten years old. In fact, the majority of growers still use traditional airblast sprayers, originally designed back in the 1960s and fitted with more drift-prone hollow-cone nozzles. Traditional airblast sprayers direct the air from a single axial-flow fan, mounted directly behind the sprayer, in an upward and outward direction. Axial fans are designed to move large volumes of air at low pressures. Consequently, as the spray is emitted from the nozzles into the air stream, a large plume of spray is sent into the canopy and much of it drifts upward and away, well above the target row.

Two major aspects of sprayer design affect spray drift—airflow and liquid flow. To reduce drift, the direction, speed, and volume of air from the sprayer must be adjusted to match the growing canopy, especially in early to mid-season. As for the liquid entrained in the air, the droplet size needs to be considered and controlled. Here’s an overview of how we have approached these issues in our research at Cornell University, including some of the practical solutions that we have developed.

Airflow

In 2001, our research team was fortunate to obtain the use of an extremely large building (85 m long, 16.5 m wide, and 18.3 m high; 280 × 54 × 60 ft) to conduct indoor airflow trials with an airblast sprayer. This allowed us to eliminate experimental errors, such as would have been caused by wind, and the large volume of enclosed space eliminated interference from the walls and roof. We monitored air speed and direction using simple frames fitted with monofilament line and cotton ribbons, and with helium-filled soap bubbles with neutral buoyancy. We spent two days just watching the airflow before designing a series of adaptations to control the air.
In order to direct the air to the crop canopy, we devised a set of deflectors that reduced airflow above the tree or vine height. In subsequent field trials, we found an improvement in deposition of 30 percent, with much better deposition throughout all regions of the vine canopy. However, the indoor trials also showed us that a large volume of air was blowing a great distance past the target canopy. We decided that we needed to limit the airflow, either at the air inlet or outlet or by changing the fan speed. To do so, we developed the Cornell “doughnut”—a circular air restrictor that mounts on the air intake of the sprayer. A series of three doughnuts were designed, with the circular hole in the middle varying in size, allowing the operator to match the airflow with the growth-stage of the canopy. The result was reduced drift and increased deposition.

Adjusting air volume as it leaves the sprayer was accomplished by using a louver, which allows on-the-go airflow adjustment, from zero to maximum, while driving along the row. Our original design was fitted to a tower sprayer, and we reduced drift by 71 percent while increasing deposition by 82 percent in early season trials in Vignoles grapes. We developed a similar device for a traditional axial-fan airlift sprayer, with excellent results. In 2009, we filed a patent application for these airflow controllers.

Air speed and volume can also be altered by changing the sprayer fan speed. We undertook trials using a hydraulic motor and oil flow controller to adjust the input speed to the fan gearbox from 0 to 540 rpm. An infinitely variable fan speed allows the grower to adjust the air speed near sensitive areas and match the airflow to the canopy. Many grape growers have mechanical harvesters that are awash with hydraulic motors and stand idle all summer. These existing machines can be adapted for this purpose.

One of the simplest ways of reducing drift is to reduce the fan speed by lowering the tractor engine speed and subsequently lowering the power take-off (PTO) speed. In field trials, we found that lowering the PTO speed by 25 percent could reduce drift by over 75 percent. This dramatic reduction in drift was accompanied by reduced fuel use and less noise.

Liquid flow
Traditionally, hollow-cone nozzles have been used for fruit spraying. The fine droplets provide excellent coverage; unfortunately, they can also increase the drift problem. Air-induction nozzles, which produce less drift-prone droplets, have proven to be well suited to herbicide spraying in many crops. We conducted field trials during 2005-2008 to determine if air-induction nozzles could be effective in a canopy sprayer. The results showed excellent control of drift, with no significant differences in controlling vine canopy diseases. In conjunction with two nozzle manufacturers (Lechler and Wilger), we tested nozzle selection systems that allow the operator to switch between air-induction and hollow-cone nozzles at the end rows of a vineyard or orchard, or when near a sensitive boundary.

A vertical patternator can be used to demonstrate the direction of the spray cloud as it leaves the sprayer. A patternator typically consists of a series of stainless steel plates attached to a mast that passes through the spray plume. Spray liquid collects on the plates and then runs down into collecting vessels. We purchased a vertical patternator to use as a repeatable standard in our research trials when we modify
canopy sprayers. We have also used it to test over 80 sprayers during extension meetings.

When used in the field, a patternator demonstrates two major issues with axial-fan sprayers: the non-symmetry between the left and right sides of the sprayer, and the amount of spray that overshoots the target canopy. Based on these results, we can alter the nozzle orientation and achieve near-perfect adjustment, so that the spray cloud only hits the target canopy and directs the same spray pattern from each side of the sprayer. Best of all, this improvement comes at no cost to the grower.

Unfortunately, a stainless steel patternator is an expensive research tool, so we designed an inexpensive ($400) patternator for growers based on window screen. When it rains, you’ve probably noticed that water runs down the screen outside of a window, while the glass remains dry. Similarly, our patternator uses window screens with small collecting gutters attached. The spray liquid runs from the gutters to collecting jars and enables the grower to adjust the sprayer nozzles accordingly. Plans for the patternator are available on my website (www.nysaes.cornell.edu/ent/faculty/landers/pestapp/PATTERNATOR.htm).

Gaps in the target canopy and between the trees allow spray droplets to pass through and become spray drift. Ultrasonic sensors to detect gaps have been available for 20 years, but they remain prohibitively expensive for most growers. With the advent of EQUIP grants from the USDA, we were able to encourage ten apple growers to purchase ten sensor-equipped sprayers for their apple orchards in western New York and take part in field trials. We found that the savings ranged up to 19 percent. With typical savings of $8000 in 2007, fruit growers could realize a three-year payback on their investment. The amount of pesticide reduction depends on the trellis design, crop variety, and the number and cost of sprays. The growers commented on the positive effect of better timing, as fewer sprayer refills were required per day. We have encouraged manufacturers to include sensors on their vineyard sprayers, but so far to no avail.

In 2009, we designed an infrared system and fitted it to a vineyard sprayer. The sensors recognize the absence/presence and height of the grapevines and send signals to the solenoid valves that operate the nozzles. After one season of trials, we have achieved a 40 percent reduction in spray use in early season applications in Vignoles grapes and 18 percent savings in mid-season applications.

A decade of research into one of the greatest causes of spray drift, the axial-fan airblast sprayer, has resulted in a number of relatively inexpensive solutions for growers to adopt and for sprayer manufacturers to develop. We are fortunate that many fruit growers are receptive to new ideas, and a growing number are adopting the changes that we are suggesting. It’s especially rewarding to see growers benefit from the novel techniques that we have developed. Unfortunately, too much past research into spray drift has often been research for its own sake, and it has not proven particularly useful. If we are to achieve real improvements in drift reduction, then applied research and extension is the answer.

**Andrew Landers** holds a faculty position at Cornell University’s New York State Agricultural Experiment Station, Geneva, New York, where his research, extension, and teaching work is based on the application of technology to the fruit industry. He is author of the forthcoming books *Effective Vineyard Spraying* and *Effective Orchard Spraying* (www.EffectiveSpraying.com).
ARS and Mississippi researchers have developed a ventilation system for broiler chicken houses that could cut producers' need for heating fuel by more than 20 percent. (Photo by Stephen Ausmus, courtesy of USDA-ARS)

**Chicken house attics can be tapped to warm broilers**

**In Brief:** Reducing the cost of keeping broiler chickens warm could result from research by the USDA Agricultural Research Service (ARS) scientists and university cooperators.

Insulating, ventilating, and heating broiler chicken houses can be expensive, especially when fuel prices are high, according to ASABE member and study leader Joseph Purswell, an agricultural engineer at the ARS Poultry Research Unit in Mississippi State, Miss. He worked with Barry Lott, a retired professor at Mississippi State University, to investigate ways to reduce the energy costs of heating chicken houses, thus increasing profits for producers.

They found that the air that gathers in broiler house attics can be as much as 7°C (20°F) warmer than the air outside. The attic air is at least 15°C (5°F) warmer about 70 percent of the time.

Purswell and Lott developed a ventilation system that uses ceiling inlets to redistribute solar-heated attic air, as opposed to bringing in cooler, outside air. They began gathering data in 2006 from a Mississippi chicken producer who installed several broiler houses based on their design.

The scientists concluded that circulating the warmer attic air within the chicken houses reduced the demand for heating fuel by about 20 to 25 percent. In one study in mild weather conditions, the technology reduced fuel use by 35 percent.

Similar technology has been applied to swine and layer facilities, but this is the first research to examine whether the technology works with broiler houses, which have a significantly different construction.

Commercial interest in the technology has increased with rising fuel prices over the past several years, according to Purswell. That has prompted producers throughout the broiler belt to request information on how to take advantage of the technology.

The ventilation system also reduces moisture and ammonia inside the houses, improving air quality.

For more information, contact Chris Guy, USDA-ARS Public Affairs Specialist, Chris.Guy@ars.usda.gov.
Keeping herbicide drift where it belongs

In Brief: Researchers are transforming weed control with new precision tools and application techniques that can keep herbicides precisely where they belong. As a result, farmers are able to optimize the performance of herbicides and minimize the small amounts that drift off target as they are being applied.

One of the latest breakthroughs involves low-drift nozzles that can significantly reduce the proportion of very fine (small) spray droplets that are susceptible to drift.

“These low-drift nozzles are really having a revolutionary impact,” says Tom Wolf, ASABE member and research scientist with Agriculture and Agri-Food Canada. “Research shows we can reduce the spray that drifts away from its target to less than 0.5 percent of the applied amount. That’s a decrease of more than 80 percent compared to conventional sprays.”

The secret is a clever design that reduces the internal operating pressure of the sprayer nozzle and mixes air into the herbicide spray as it is applied.

“We’ve seen nearly 100 percent adoption among custom applicators in Canada, and up to 50 percent of the more innovative growers on large farms are using them as well,” Wolf says. “They have clearly found that the devices work well in their operations.”

Still, there are obstacles to even broader adoption. Not all weeds and all herbicides respond the same way when changes are made to reduce the number of very fine spray droplets.

“It can be tough to provide practical recommendations to applicators on diversified farms,” Wolf says. “But scientists are meeting that challenge by communicating their research findings to herbicide manufacturers and applicators alike. We’re finding that low-drift sprays can be used successfully in the majority of situations that an applicator is likely to encounter.”

Robert Klein, a crop specialist at Nebraska’s West Central Research and Extension Center, recommends combining multiple drift control strategies in order to achieve optimal results. Here are eight proven techniques he recommends:

Increase spray coarseness. Switching to low-drift nozzles has a large impact on drift. For traditional nozzles, lowering pressure can also increase droplet size and reduce drift. There is a fine line, however, between droplets that are too small (causing excessive drift) and too large (providing insufficient coverage). Look to your nozzle manufacturer for guidance on the recommended pressure. Low-drift nozzles typically require a higher pressure to operate properly.

Gauge the weather. Environmental factors can be critical to the control of spray drift. Klein cites wind speed as one important example. “When wind speed increases, so does the potential for drift downwind of the sprayer,” he says. Today’s ultrasonic weather sensors can help. A far cry from yesterday’s rudimentary weather vanes, sensors measure air temperature, humidity, dew point, barometric pressure, wind chill, wind direction, and wind speed. The units are extremely compact and can be mounted inside a sprayer cab. That means the applicator has continuous, up-to-date weather data and can apply herbicides when they are least likely to drift.

Control the flow. Modulated flow controls reduce drift by rapidly pulsing each spray nozzle on and off. This allows pressure and droplet size to remain constant as the sprayer moves across the field at various speeds.

Rev up the air speed. Air-assisted sprayers emit a high-velocity, downward air stream that pushes the spray droplets directly onto the targeted weeds or treatment area. As a result, they can reduce drift if used properly.

Create a buffer. Untreated zones around fields can serve as buffers that keep drift away from off-target sites.

Add drift retardants. If you use a traditional sprayer, special additives can be used to reduce the number of fine droplets. Make certain, though, that you select an additive especially designed for the type of nozzle and herbicide that you use. Certain additives can be a minus when used with the wrong nozzle tip.

Hoof your sprayer. By mounting hoods around the nozzles on a sprayer boom, you can create a physical barrier that reduces spray drift. It’s a simple but effective technique.

Monitor the boom height. Extension specialists recommend keeping booms close to your weed target in order to decrease the possibility of downwind drift. But be careful to follow the manufacturer’s instructions so you maintain the uniform spray pattern and coverage needed to control weeds effectively.

“Each of these approaches has its strong points,” Klein says. “In order to make sure we’re using the optimal combination of techniques for each scenario, it is important for scientists, applicators, farmers, and manufacturers to communicate closely and share best practices.”

For more information, contact Lee Van Wychen, Lee.VanWychen@wssa.net.
First parasitic nematodes reported in biofuel crops

In Brief: Researchers at the Energy Biosciences Institute at the University of Illinois (U of I) have discovered widespread occurrence of plant-parasitic nematodes in the first reported nematode survey of Miscanthus and switchgrass plants used for biofuels.

Lead researcher Tesfamariam Mekete, a U of I post-doctoral research associate, said the team’s first step was to identify potential pathogenic nematodes of these top two energy-yielding cellulose-ethanol feedstock plants.

“Nematodes are a part of our soil systems,” Mekete said. “However, when it comes to potential crops for biofuel production, we simply don’t know which nematodes are present in these crops and at what levels.”

The 2008-2009 nematode survey included samples from 37 Miscanthus and 48 switchgrass plots in Illinois, Georgia, Iowa, Kentucky, South Dakota, and Tennessee.

All sample sites had at least two nematode species that have been reported to reduce biomass in most monocotyledon hosts. The damaging population thresholds for these nematodes to Miscanthus and switchgrass are still unknown. However, the population densities encountered may present a potential risk to biofuels production when compared with threshold densities reported on other monocotyledon hosts, Mekete said.

Researchers discovered lesion (Pratylenchus), dagger (Xiphinema), needle (Longidorus), lance (Hoplolaimus), stunt (Tylenchorhynchus), spiral (Helicotylenchus), and ring (Criconemata) nematodes in Miscanthus and switchgrass.

These nematodes have previously been reported to cause damage to several plant species such as corn, bent grass, switchgrass, and turf grasses.

“The high levels of nematodes found in our survey and the damage symptoms observed in infected roots suggest that parasitism may contribute to the decline of biomass production,” Mekete said.

Needle nematodes, discovered at high levels in the sandy soils of Illinois and Georgia, caused visible stunting of lateral roots and destruction of the fibrous root system. Mekete’s team hopes to do further research in Havana, Ill., to study the interaction between this nematode and biomass yield.

Researchers are now studying damage thresholds of lesion, root-knot, and needle nematodes to Miscanthus and switchgrass under greenhouse conditions. Future studies will include host suitability and population dynamics of the most prevalent nematodes associated with these perennial grasses.

In addition to discovering information on the distribution, presence, abundance, and identification of these nematodes, researchers also developed species-specific DNA tests to help identify nematodes so future research can focus on developing control tactics.

“Diseases and pests have the potential to cause significant constraints on biomass production, putting the crops at risk for reductions in biomass yield and quality,” Mekete said. “Of the many pests and diseases, plant-parasitic nematodes are of great economic importance because they can directly influence plant biomass and predispose plants to attack by other soil-borne pathogens.”

For more information, contact Jennifer Shike, jshike@illinois.edu.

Nanoparticle protects oil in foods from oxidation and spoilage

In Brief: Using a nanoparticle from corn, a Purdue University scientist has found a way to lengthen the shelf life of many food products and sustain their health benefits.

Yuan Yao, an assistant professor of food science, has successfully modified the phytoglycogen nanoparticle, a starchlike substance that makes up nearly 30 percent of the dry mass of some sweet corn. The modification allows the nanoparticle to attach to oils and emulsify them while also acting as a barrier to oxidation, which causes food to become rancid.

Oxidation destabilizes oil droplets in emulsified food, degrading and changing the chemical structure of the oil and causing it to go bad. This oxidation happens in a wide range of products, shortening their shelf lives.

“This can be widely used in the food industry, cosmetics and nutritional supplements, any system in which the oxidation of lipids is a concern,” Yao said. “The shelf life of a product can be low and the quality of the food can become bad because of the oxidation of the lipids.”

In fish oils, for example, lipid oxidation degrades omega-3 fatty acids, which are essential in infant development and are thought to help with chronic inflammatory and heart diseases in adults.

Yao was able to modify the surface of phytoglycogen nanoparticle to make it behave like an emulsifier, creating phytoglycogen octenyl succinate, or PG-OS. PG-OS is thicker and denser than commonly used emulsifiers, creating a better defense from oxygen, free radicals, and metal ions, which cause lipid oxidation.

Yao’s findings also showed that ε-polylysine, a food-grade polypeptide, can be added to the oil droplets to aid in the protection from oxidation. Polylysine is much smaller
than the PG-OS nanoparticles, allowing it to fill in the gaps between PG-OS nanoparticles.

According to Yao’s study, PG-OS nanoparticles with ε-polylsine significantly increased the amount of time required for oxidation to ruin the oil droplets, in some cases doubling the shelf life of the model product. Shelf life was tested by warming the emulsifiers and checking for chemical reactions that signal oxidation has occurred.

Yao has filed a provisional patent application for the technology.

For more information, contact Brian Wallheimer, bwallhei@purdue.edu; Yuan Yao, yao1@purdue.edu; or Steve Leer, sleer@purdue.edu.

Innovative device counts corn stalks in experimental fields

**In Brief:** To improve the process of counting corn stalks and gather other important information from agricultural fields, University of Illinois agricultural engineer and ASABE member Tony Grift developed an innovative device that eliminates the need for manually counting plants.

Agricultural businesses that develop and market corn seed varieties typically use high school students or other unskilled labor to walk their experimental fields counting corn stalks. The information is useful in determining important seed qualities and planter efficiency. This tedious task often leads to significant counting errors and inconsistencies. But Grift’s machine, mounted with laser transmitters and an on-board computer, allows for corn stalk counting to be accomplished with greater ease and enhanced accuracy.

“In experimental corn fields, an important performance indicator is the number of plants that emerge as a proxy for seed germination rate,” said Grift. “Another important factor is the spacing between plants and the presence of ‘doubles’. Doubles are caused by dual seeds that have dropped close together, resulting in two inferior plants rather than a single, full-grown plant. Consistent spacing and the absence or presence of doubles can serve as a quality measure of a planter.”

The corn stalk counter is built on a tricycle-style frame and employs a laser-based photo-interruption mechanism. Two sensor arrays, each capable of generating four laser beams, are mounted on the sides of the machine. The distance between the centers of the sensor arrays is 75 cm, which is typical spacing between rows for Midwestern crops. The left and right sensor arrays can be moved up and down to accommodate plant sizes. The machine is powered by a 12-volt battery, and a dual power converter provides power for an onboard computer and 15-inch flat panel monitor.

As the corn stalk counter is manually driven down rows of corn, the laser beams are intercepted by the plants and information is recorded on the number of corn stalks, corn stalk diameters, plant spacing, and driving speed.

“By knowing the spacing between plants, it is possible to detect plants that are growing undesirably close together. To thin the population, the system could be used to identify the first plant in existing doubles and mark it for removal,” Grift said.

The corn stalk counter has proven its abilities in the laboratory and is scheduled for testing in the field. Additional potential uses for the groundbreaking device are also being investigated.

“Since the machine measures plant diameter, it can potentially be used to determine how large the plants are and their potential biomass yield,” Grift said. “In future developments, the system could be adapted and installed on a harvester to monitor biomass yield for corn stover, Miscanthus, switchgrass, and other agricultural biomass grown for bioenergy uses.”

For more information, contact Tony Grift, grift@illinois.edu, or news writer LeAnn M. Ormsby, lormsby@illinois.edu.
Frogs, foam, and fuel: UC researchers convert solar energy to sugars

In Brief: Engineers from the University of Cincinnati have devised a foam that captures energy and removes excess carbon dioxide from the air—thanks to semi-tropical frogs.

For decades, farmers have been trying to find ways to get more energy out of the sun. In natural photosynthesis, plants take in solar energy and carbon dioxide and then convert it to oxygen and sugars. The oxygen is released to the air and the sugars are dispersed throughout the plant—like that sweet corn we look for in the summer. Unfortunately, the allocation of light energy into products we use is not as efficient as we would like. Now engineering researchers at the University of Cincinnati are doing something about that.

The researchers are finding ways to take energy from the sun and carbon from the air to create new forms of biofuels, thanks to a semi-tropical frog species. Their results have been published online as “Artificial Photosynthesis in Ranaspumin-2 Based Foam.”

Research assistant professor David Wendell, student Jacob Todd, and College of Engineering and Applied Science dean Carlo Montemagno co-authored the paper, based on research in Montemagno’s lab in the Department of Biomedical Engineering. Their work focused on making a new artificial photosynthetic material that uses plant, bacterial, frog, and fungal enzymes, trapped within a foam housing, to produce sugars from sunlight and carbon dioxide.

Foam was chosen because it can effectively concentrate the reactants but allow very good light and air penetration. The design was based on the foam nests of a semi-tropical frog called the Tungara frog, which creates very long-lived foams for its developing tadpoles.

“The advantage for our system compared to plants and algae is that all of the captured solar energy is converted to sugars, whereas these organisms must divert a great deal of energy to other functions to maintain life and reproduce,” says Wendell. “Our foam also uses no soil, so food production would not be interrupted, and it can be used in highly enriched carbon dioxide environments, like the exhaust from coal-burning power plants, unlike many natural photosynthetic systems.”

He adds, “In natural plant systems, too much carbon dioxide shuts down photosynthesis, but ours does not have this limitation due to the bacterial-based photo-capture strategy.”

There are many benefits to being able to create a plant-like foam. “You can convert the sugars into many different things, including ethanol and other biofuels,” Wendell explains. “And it removes carbon dioxide from the air, but maintains current arable land for food production.”

“This new technology establishes an economical way of harnessing the physiology of living systems by creating new materials that incorporate life processes into its structure,” says Montemagno. “This work presents a new pathway for harvesting solar energy to produce either oil or food with efficiencies that exceed other biosolar production methodologies. More broadly, it establishes a mechanism for incorporating the functionality found in living systems into systems that we engineer and build.”

The next step for the team will be to try to make the technology feasible for large-scale applications like carbon capture at coal-burning power plants.

“This involves developing a strategy to extract both the lipid shell of the algae (used for biodiesel) and the cytoplasmic contents (the guts), and reusing these proteins in the foam,” says Wendell. “We are also looking into other short carbon molecules we can make by altering the enzyme cocktail in the foam.”

Montemagno adds, “It is a significant step in delivering the promise of nanotechnology.”

For more information, contact Wendy Beckman, beckmawh@ucmail.uc.edu.
New process yields transportation fuel

In Brief: A team of University of Wisconsin-Madison engineers has developed a highly efficient, environmentally friendly process that selectively converts gamma-valerolactone, a biomass derivative, into the chemical equivalent of jet fuel.

The simple process preserves about 95 percent of the energy from the original biomass, requires little hydrogen input, and captures carbon dioxide under high pressure for future beneficial use.

James Dumesic, Steenbock Professor of Chemical and Biological Engineering at UW-Madison, postdoctoral researchers Jesse Bond and David Martin Alonso, and graduate students Dong Wang and Ryan West recently published details of the advance.

Much of the Dumesic group’s previous research on using cellulosic biomass for biofuels has focused on processes that convert abundant plant-based sugars into transportation fuels. However, in previously studied conversion methods, sugar molecules frequently degrade to form levulinic acid and formic acid—two products the previous methods couldn’t readily transform into high-energy liquid fuels.

The team’s new method exploits sugar’s tendency to degrade. “Instead of trying to fight the degradation, we started with levulinic acid and formic acid and tried to see what we could do using that as a platform,” says Dumesic.

In the presence of metal catalysts, the two acids react to form gamma-valerolactone, or GVL, which is currently manufactured in small quantities as an herbal food and perfume additive. Using laboratory-scale equipment and stable, inexpensive catalysts, Dumesic’s group converts aqueous solutions of GVL into jet fuel. “It really is very simple,” says Bond, of the two-step catalytic process. “We can pull off these two catalytic stages, as well as the requisite separation steps, in series, with basic equipment. With very minimal processing, we can produce a pure stream of jet-fuel-range alkenes and a fairly pure stream of carbon dioxide.”

While biofuels, such as ethanol, are becoming more popular as blending agents in automobile fuels, they have limitations for use in jet fuel because of their low energy density. And, given present internal combustion engine designs, conventional biofuels cannot fully replace petroleum-derived hydrocarbons.

“The hydrocarbons produced from GVL in this new process are chemically equivalent to those used in the present infrastructure,” says Alonso. “The product we make is ready for the jet fuel application and can be added to existing hydrocarbon blends, as needed, to meet specs.”

The biggest barrier to implementing the renewable fuel is the cost of GVL. Until now, says Dumesic, there has not been an incentive to mass-produce the compound. “The bottleneck in having the fuel ready for prime time is the availability of cost-effective GVL,” he says.

Now that they have demonstrated the process for converting GVL to transportation fuel, Dumesic and his students are developing more efficient methods for making GVL from biomass sources such as wood, corn stover, switchgrass, and others. “Once the GVL is made effectively, I think this is an excellent way to convert it to jet fuel,” he says.

For more information, contact Renee Meiller, meiller@engr.wisc.edu.
As an engineer, you are proficient in science and technology, and you have to be a good communicator as well. In fact, engineers have a unique responsibility to communicate technical concepts to a larger audience. Traditionally, we have done that with words and numbers. Increasingly, we communicate in images.

Visual imagination combined with technical skill can produce astonishing—and deeply informative—images.

To call attention to and celebrate the visual aspects of agricultural and biological engineering, *Resource* is announcing the first-ever 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/all of three categories: photographs/captured images, illustrations/drawings, and informational/explanatory graphics.

Entries will be judged on their visual appeal, clarity, or explanatory power (according to the entry category) as well as their relevance to the Challenge theme. Use your entry to convey the beauty and meaning of your work, your research developments, and your Society division. All entries should be original work.

The Challenge is an opportunity to be creative and to show those outside the ABE field: “This is what we do.”

Submit your entry as an e-mail attachment in jpg format (300 dpi or higher) to Glenn Laing (laing@asabe.org). Enter “Visual Challenge” in the subject line, and include your full name, professional affiliation, contact information, and a title with 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 November/December 2010 issue of *Resource*. 
Agricultural and Biological Engineering Within ASABE - Definition

It is the intent of the ASABE Board of Trustees (BOT) to recognize a unified definition of Agricultural and Biological Engineering within the Society. It is also clear that the unique aspects of both Agricultural Engineering and Biological Engineering shall be acknowledged for their contributions, commonalities, and unity and that both disciplines have equal importance within the Society. Therefore...

Agricultural and Biological Engineering is the discipline of engineering that applies engineering principles and the fundamental concepts of biology to the design of agricultural and biological systems and tools, ranging in scale from molecular to ecosystem level, for the safe, efficient, and environmentally-sensitive production, processing, and management of agricultural, biological, food, and natural resources systems.

WHEREAS, the American Society of Agricultural Engineers (ASAE) was founded in 1907 to improve the development of farm machinery. From the beginning, members of the Society recognized the role of biology in agriculture. Incorporation of “biological” into the Society’s name was discussed as early as 1937. In 1990, the Society adopted the tag line, “The Society for Engineering in Agricultural, Food, and Biological Systems.” In 2005, ASAE formally became the American Society of Agricultural and Biological Engineers (ASABE).

WHEREAS, ASABE technical divisions include Aquacultural Engineering; Biological Engineering; Ergonomics, Safety, and Health; Food Engineering; Forest Engineering; Information and Electrical Technologies; Power and Machinery; Soil and Water; Structures and Environment; and other emerging areas which all intersect and overlap, exhibiting a wide breadth of technical expertise with exceptional depth and providing a unique forum for interaction to share information of interest to many engineering disciplines, particularly Agricultural and Biological Engineering.

WHEREAS, Agricultural Engineering is globally recognized as the discipline that applies the principles of engineering to agricultural and biological sciences, both plant and animal, to design or develop efficient and environmentally sensitive methods for managing and producing food, fiber, timber, and renewable energy for the people of the world.

WHEREAS, Biological Engineering, a discipline involved in every technical division of ASABE, is defined by the Institute of Biological Engineers as being globally recognized as the biology-based engineering discipline that integrates life sciences with engineering in the advancement and application of fundamental concepts of biological systems from molecular to ecosystem levels.

WHEREAS, Agricultural and Biological Engineers collectively ensure that the world has the necessities of life including safe and plentiful food, clean water, renewable fuel and energy, safe working conditions, and a healthy environment by employing knowledge and expertise of sciences, both pure and applied, and engineering principles to design devices, equipment, and materials for the production, processing, and management of agricultural, biological, food, and natural resources systems.
In a 1999 report, the Canadian Academy of Engineering (CAE) suggested the need for an evolution in engineering education in Canada. Basically, the CAE noted the broadening roles played by engineers and the parallel requirement for a curriculum that goes beyond a concentration on engineering science. Since then, organizations as diverse as the Carnegie Foundation, the National Academy of Engineering, and the Royal Academy of Engineering have made similar recommendations.

These reports are seen by many as a call for a renewed focus on design. If we understand “design” as a search for solutions to problems, as opposed to a process of finding answers to questions, then it follows that design education requires a broader understanding of non-technical constraints. In other words, the reports encourage academics to make design a more respectable part of our undergraduate and graduate engineering programs.

Since the early 1960s, engineering curricula have shifted from application to explanation. Most academic engineers now spend their careers on campus, first receiving and then delivering engineering as a science rather than a practice. As a result, most academic engineers think, write, and teach the ideas of engineering, but not the uses of engineering. This is not incorrect, but we also need people on campus who know what most engineering graduates will actually do with the education that they receive. In general, people with engineering degrees are employed in industry, not in academia.

A quick solution to this shortage is to invite guest speakers to campus to share their industry experience. However, engineers who are actively involved in off-campus careers can only pay visits to classrooms, and these visits are limited because they interfere with the individual’s day-to-day responsibilities. In addition, as welcome as such visits are, they are only a temporary solution to a permanent problem.

What we really need are people with industry experience who have determined that they can afford to retire from industry and devote some time to teaching. At the University of Manitoba, we have tapped into this pool of retired engineers. We have created a position that we call the engineer-in-residence (E-i-R): a paid, half-time appointment with academic rank and office facilities.

The half-time appointment provides our E-i-Rs the opportunity to enjoy some of the freedom of retirement with an additional income that supplements, but doesn’t replace, their pension. We ask these experienced engineers to work with faculty engineers who are involved in the theoretical side of the fields in which the E-i-Rs were once employed. Not surprisingly, the relationships grow because the E-i-Rs are a resource that had not previously been available. The E-i-Rs bring connections and perceptions that can’t be found within the academy, and that reinforce the fundamentals of the engineering curriculum.

To fund our first E-i-R, we used resources from an endowed chair in design engineering. Today, we have funds from memoranda of understanding with various industry groups that support most of our E-i-Rs. The industries that provide this support use the E-i-Rs as their points of contact on campus, so everyone benefits.

While the relationships between academics and E-i-Rs are important, the most valuable on-campus function that our E-i-Rs serve is talking to the students. To put it plainly, they help students understand how some of that “useless stuff” that Professor X is pushing at them will actually get used in the real world.

All five of our E-i-Rs—and two who have since “re-retired”—found different comfort zones. They teach, supervise tech society clubs, participate in research projects, advise capstone design teams, serve on committees, and provide an essential liaison with former colleagues and competitors. In fact, none of our E-i-Rs, current or past, have been just half-time. They work longer hours than expected because they enjoy working with the students so much. And because of their professional backgrounds, we now have experienced design engineers working on campus, which is a great educational resource.

When you think about it, this new idea is really very old: it recalls the aboriginal tradition of seeking advice from elders. Don’t let that wisdom be lost.
Leading engineers and scientists from around the world will give 110 presentations on issues and new technology related to developments in manure management and air quality for agricultural operations.

Combining two long-standing ASABE conferences into one meeting allows participants to pick the sessions that best match their interests. Three half-day CPD courses will also be offered. Mark your calendar and plan on attending this important conference!