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FROM THE President

“To the people who are engineering the future of our planet …”

I am writing this column as I unwind from our Annual International Meeting in Providence, R.I. More than 1,500 enthusiastic engineers and technologists representing more than 30 nations attended the meeting. Several things struck me about it. First, it appeared that nearly half the attendees were under the age of 40, with an impressive number of pre-professionals and young professionals. Second, many of those who attended the Bioenergy Day event were from businesses and agencies that previously did not attend our meetings. Third, the level of enthusiasm for what we do was truly infectious.

At last year’s 100th anniversary meeting, former President Bill Clinton observed that the problems facing society around the world constitute an engineer’s dream. This year’s keynote speaker, Patrick Hanlon, described our members as “the people who are engineering the future of our planet.” No wonder the excitement is high, and a new generation is engaged in our cause.

Technical and standards committees, Councils, and the new Board of Trustees are already hard at work to make progress on strategic activities and tasks agreed to in Providence. Many volunteer members were selected by their peers to lead committees and subcommittees. The ASABE electronic forums and committee conference call systems enable everyone to join and support committee activities.

I carried two mandates away from the membership at our annual meeting. First and “number one” is to advance our standing as the leading organization for the application of engineering across the bioenergy arena. The energy steering committee has already begun planning for BioEnergy Engineering 2009, a major multi-disciplinary international conference for researchers, supply industries, design/build firms, and plant operations engineers. The second mandate is to clarify the discipline names and terms we use with outside audiences so that we can effectively communicate with our many traditional and new stakeholders. Our keynote speaker set the stage for that effort.

Stay tuned for an exciting and intense ride this year as we build momentum for our second one hundred years.

Jim Dooley, Forest Concepts, LLC
jdooley@forestconcepts.com

ASABE CONFERENCES AND INTERNATIONAL MEETINGS
To receive more information about ASABE conferences and meetings, call ASABE at (800) 371-2734 or e-mail mtgs@asabe.org.

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<td>The ASABE Leadership Experience.</td>
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<td>ASABE Annual International Meeting.</td>
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ASABE ENDORSED EVENTS

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<td>Frutic Chile 2009: Eighth International Symposium of Information and Technology for the Sustainable Production of Fruit and Vegetables, Nuts, Wines, and Olives.</td>
<td>Jan. 5-9</td>
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<td><a href="http://www.fruitic09">www.fruitic09</a>. Contact Stanley Best, <a href="mailto:sbest@inia.cl">sbest@inia.cl</a></td>
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<td>XXXIII CIOSTA and CIGR V CONFERENCE. Technology and management to ensure sustainable agriculture, agro-systems, forestry, and safety.</td>
<td>June 17-19</td>
<td>Reggio Calabria, Italy.</td>
<td>Contact Gennaro Giametta, <a href="mailto:ciosta2009@unric.it">ciosta2009@unric.it</a>.</td>
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<td>Second Farming Systems Design Symposium.</td>
<td>Aug. 23-27</td>
<td>Monterey, California, USA.</td>
<td>Contact Jerry Hatfield, <a href="mailto:jerry.hatfield@ars.usda.gov">jerry.hatfield@ars.usda.gov</a>.</td>
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U.S. Specialty Crops at a Crossroad
Hi-tech or else?

Thomas F. Burks, Daniel L. Schmoldt, and Jeffrey J. Steiner

Numerous U.S. specialty crops are facing growing domestic and global market pressures that threaten their long-term viability. For instance, Brazilian citrus growers can produce, process, and ship juice to Floridian markets cheaper than Florida growers under the current tariff system. For many growers, labor expenses represent 40 to 60 percent of production costs. High labor costs, uncertain labor pools, limited access to international markets, and increased competition could eliminate numerous specialty crop industries within the next 10 years. This poses a serious threat to many rural communities and to national food security. Specialty crop production represents approximately 50 percent of the total value of U.S. crop production. For 2005, the retail value of U.S. specialty crops is estimated to have been around $60 billion.

Money matters
Most of these industries rely extensively on low-wage, seasonal, unskilled labor, which provides limited rural economic support. Socio-economic studies have firmly established that automation in any industrial sector creates more jobs for the overall economy than it eliminates. Automation reduces the number of repetitive-task, low-skill, and unsafe production jobs, while creating a whole new set of higher skill jobs in related manufacturing, support, service, and financial industries — and entirely new industries, in many cases, leading to greater economic prosperity.

Until late 1970s, land-grant universities and the United States Department of Agriculture (USDA) invested significant amounts of money in mechanization, robotics, and automation research and development (R&D). Since that time, federal support to improve production efficiency and farm safety through enhanced machine systems has greatly declined. Consequently, the R&D infrastructure for agricultural automation has significantly deteriorated over the past quarter century. It will take a serious commitment of resources to infuse U.S. research institutions with the personnel, facilities, and equipment to solve these labor problems.

Research needs
Because each individual segment of the specialty crop industry (e.g., wine/grape, potato, floriculture, etc.) represents only a relatively small portion of the overall specialty crop industry, many of their needs do not receive attention in national research programs. Consequently, they have organized during the past several years to collectively identify their common critical research needs. One area that has been identified by these industries is the need for tools and technologies that can improve production efficiency, product quality, and post-harvest operations, as well as reduce their environmental footprint from production and processing.

In April 2007, the USDA, the National Science Foundation (NSF), and the National Aeronautics and Space Administration (NASA) jointly sponsored a workshop on engineering-based solutions to bring together specialty crop leaders, technology providers, university faculty, federal research scientists, and numerous program leaders from various federal agencies. During the two-day event, grower groups identified crucial technology needs while the engineering community discussed science and technology readiness. Both fundamental and applied research needs were identified in addition to companion extension and education efforts (www.csrees.usda.gov/nea/ag_systems/pdfs/specialty_crops_engineering.pdf):
1) New technologies for delivering and controlling the applications of chemicals and nutrients to improve efficacy, reduce cost, improve worker safety, and reduce environmental impacts.

2) Mechanization and robotic solutions, as appropriate, to improve worker productivity and thus minimize labor cost. (Such items as fruit thinning, pruning, spraying, and harvesting were identified by a number of commodities.)

3) Autonomous navigation systems that can be applied to harvesting, mowing, spraying, and utility vehicles.

4) Precision agriculture technologies for yield mapping, yield prediction, nutrient application, pesticide application, water management, etc.

5) Disease and pest monitoring and scouting by various approaches including space-based remote sensing, low-altitude, and ground-based systems.

6) Nanotechnology-based sensors, biological sensors, and chemical-based sensors for monitoring plant health, nutrient/moisture availability and uptake along with various forms of sensor networks.

7) Post-harvest operations, packaging, and food traceability and safety.

8) Value added by products, energy availability, conservation, and usage issues.

9) Data management, decision support systems, and diagnostic tools.

**Multidisciplinary simpatico**

Advances in automation, robotics, and instrumentation for the specialty crops industries will require multidisciplinary efforts across a wide range of scientific disciplines. Engineers, horticulturists, agronomists, pathologists, and economists will need to work in concert to produce specific solutions for vulnerable commodities while looking for broader applications across the entire agricultural sector. In addition to R&D efforts to create new machines and devices, there is also an urgent need to train a new cohort of agricultural and biological engineers in automation, sensing, and robotic technologies. Without an infusion of properly trained professionals and ongoing R&D, ultimately commercialization of newly developed technologies will falter.

The U.S. Secretary of Agriculture has responded to the specialty crop industries’ arguments and affirmed that the nation must establish viable R&D programs in order to sustain these crucial commodities. The Secretary’s 2008 Farm Bill proposals included a request for $1 billion over the next 10 years to develop science-based tools for the specialty crop industries. This past May, Congress passed the Food, Conservation, and Energy Act of 2008, which provides $230 million in mandatory funding for the Specialty Crop Research Initiative over five years. This Initiative establishes a specialty crop research and extension initiative to address the critical needs of the specialty crop industry by developing and disseminating science-based tools that target specific crops’ needs and their regions. Resulting new federal grant programs could create significant opportunities for industry and ASABE. The specialty crop industries earnestly desire that scientists and technology vendors join with their industries and together find ways to bring new technology to commercial application. With the advent of the 2008 Farm Bill process, the USDA has taken a leadership role in helping to maintain a viable U.S. specialty crop industry. This effort promises to offer new opportunities for Society members to participate in research and extension efforts, including commercial applications.

The Specialty Crop Technology Development Steering Committee (an informal, national group of industry, university, and federal participants) has sponsored the development of an information Web site and technology database. General information regarding this initiative is available at www.specialtycrop.info. In addition, the Specialty Crop Advanced Technology Database has been created to provide an opportunity for scientists and technology vendors from around the world to post their technology capabilities to a searchable database. The intention is to create a technology community where specialty crop producers, processors, scientists, and technology providers can come to find appropriate technologies to solve their urgent needs. It is hoped that Resource readers will take time to visit the site and, if possible, post their respective technology capabilities.

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As ASABE members, most of us are very familiar with engineering standards because we frequently use them to guide us through the design process. According to the American Society of Testing and Materials (ASTM), “A standard is a common language that promotes the flow of goods between buyer and seller and protects the general welfare.”

Standards are important for many reasons. For example, engineering standards:

- Provide interchangeability between similarly functional products and systems manufactured by two or more organizations, thus improving compatibility, safety, and performance for users.
- Reduce the variety of components required to serve an industry, thus improving availability and economy.
- Improve personal safety during operation of equipment and use of products and materials.
- Establish performance criteria for products, materials, or systems.
- Provide a common basis for testing, analyzing, describing, or informing regarding the performance and characteristics of products, methods, materials, or systems.
- Develop a sound basis for codes, education, and legislation and to promote uniformity of practice.
- Provide a technical basis for international standardization.
- Increase the efficiency of engineering effort in design, development, and production.

Historically speaking

The idea of standardization is not new. Cylindrical stones were used as weight measures in Egypt at around 7000 B.C. English nobility used the length of their body parts to establish standards; for example, in 1120, King Henry defined the “ell” as the length of his forearm. The city of Boston made brick size standard in 1689, stating that it was a crime to manufacture bricks in any other size than 23 x 10 x 10 cm (9 x 4 x 4 in.).

Eli Whitney (1765-1825), an inventor and mechanical engineer well known for creating the cotton gin, is referred to as “the father of standardization” because he brought mass production to the United States. The federal government awarded Whitney a $134,000 contract in 1798 to manufacture...
10,000 identical muskets. Though his idea of a “uniformity system” was initially met with resistance, Whitney proved that standardized parts with the same specifications could be used interchangeably in any musket.

**Milestones in “sameness”**

Widespread development and implementation of engineering standards have come about in the past century. The devastating Baltimore fire of 1904 showcased the need for standardization. Although fire trucks came from as far as New York City to assist with the blaze, any truck outside of the city of Baltimore was useless to fight the fire because the “foreign” hoses would not fit the fire hydrants in the city. The Baltimore fire destroyed more than 1,500 buildings over approximately 70 city blocks and ruined all power and communications systems in the city. City leaders had addressed this issue when a large fire in Fall River, Mass., in 1928 was controlled because the standardization of hydrants and hoses enabled fire trucks from 20 neighboring towns to help control the fire.

The American National Standards Institute (ANSI) was formed in 1916 when the American Institute of Electrical Engineers (now IEEE, the Institute of Electrical and Electronics Engineers, Inc.), the American Society of Mechanical Engineers (ASME), the American Society of Civil Engineers (ASCE), the American Institute of Mining and Metallurgical Engineers (AIMME), and ASTM got together to establish a national organization to coordinate the development of industrial and engineering standards, and to provide a clearinghouse for the standards developed by each member society.

The International Organization for Standardization (ISO) was founded in 1947 to provide individual countries membership in an international forum for the development of standards. The mission of ISO is to encourage the development of standardization and related activities in the world in order to facilitate international exchanges of goods and services and to provide governments with a technical base for safety, health, and environmental legislation (www.iso.org). ISO is best known for its 9000 and 14000 standards; these refer to groups of standards involving quality management and environmental management, respectively.

**Categorically speaking**


To locate standards that will be of use to the artifact in design, one can consult any of the four major sources of standards: government, professional society, trade association, and company.

Government standards include those from:

- CPSC: Consumer Product Safety Commission
• OSHA: Occupational Safety and Health Administration
• USDA: United States Department of Agriculture.
Professional society standards include:
• ASABE: American Society of Agricultural and Biological Engineers
• ASTM: American Society for Testing and Materials
• ASME: American Society of Mechanical Engineers
• SAE: The Engineering Society for Advancing Mobility in Land Sea Air and Space.
Trade associations include the Air Conditioning and Refrigeration Institute (ARI) and the National Electrical Manufacturers Association (NEMA). Companies that have their own engineering standards include General Motors, Ford Motor Company, and Boeing.

From a legal standpoint
Standards are usually recommendations and guidelines that are not legally enforceable unless the standards are incorporated into codes. Although this is true, if you fail to follow current engineering standards, you can be found liable if you are sued. Thus, using engineering standards in the design process is very important. Following the most up-to-date standards will not insulate you from lawsuits but will ensure that you hold paramount the safety of the public. This approach represents the best that you can accomplish from a technical and ethical standpoint as an engineer.

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Teaching Standards

Marybeth Lima

Mark Twain once said, “To a man with a hammer, everything looks like a nail.” In teaching students about engineering standards and their relationship to engineering design, my concern is that we are providing students with the equivalent of Mark Twain’s hammer. Standards are important because they provide students with instructions with which to design a device, process, or system. Standards provide a student with the knowledge for understanding the parameters necessary to successfully complete a design and are especially useful for students just learning to design a specific artifact. However, teaching engineering standards should go beyond teaching students where to find standards and how to use them. We also must teach students frameworks for understanding so that students can take engineering standards and appropriately place them in the context of the design process. There is much more to the design process than effectively executing engineering standards.

For example, playground design is a standards-driven process due to critical safety concerns with children at play. We conduct community design of public school playgrounds, in which the ideas, desires, and expertise of children, parents, teachers, and community members drive the design process. Engineering standards are not considered in the design process until all of us agree on the parameters of the design problem (how the problem is framed). Only after items like budget, theme, central play activities, skill sets to be brought to the process, skill sets that kids will develop on the playground once it is in use, etc., have been decided do we begin to look at engineering standards. It is my belief that engineers tend to jump immediately to standards because they are quantifiable and straightforward. Many times, however, framing a problem is neither quantifiable nor straightforward. Students must be taught that framing the problem (painting the picture in broad strokes) is a critical activity that takes place before using engineering standards (painting the details).

Once we begin using standards, we realize that they are not 100 percent applicable in every situation. There are many gray areas in engineering, and although engineering standards are not typically gray, their application can be. Knowing how to negotiate these situations involves the art of engineering judgment. It is my hope that we can expose students to such situations so that they can practice their skills in judgment.

For example, the American Society for Testing and Materials (ASTM) and the Consumer Product Safety Commission (CPSC) have established playground safety standards. These standards, like most, are voluntary, and consist of recommendations and guidelines that should be followed for playground design. One state responded to these standards by passing a law that all playground safety standards be implemented in all public playgrounds. Because the cost of bringing playgrounds fully into compliance was prohibitive, many playgrounds were removed, which resulted in the unintended consequence of leaving children with no places to play. This may be “going too far” in applying design standards. Most states enforce playground safety through a “standard of care,” which requires removal of “priority one hazards” — those that are possible, probable, and can cause grave injury. The standard of care means that each playground should have a comprehensive safety program established; the standard of care does involve some level of judgment on the part of engineers and playground safety inspectors.

If students are taught engineering standards, the context into which they integrate and the metacognitive processes in which to consider their use, we teach students that there is more to engineering than Mark Twain’s hammer and nails.
Achieving greater energy security for the United States and the rest of the world means utilizing multiple approaches. In the United States Department of Agriculture (USDA), giving greater visibility and relevance to biobased products has been an area of focus for many years. This effort was a major research priority during World War II in the search for alternative natural sources for rubber. Today, some of the research initiated more than a half century ago is paying off with commercial production of natural latex from guayule. Recent advances in science, and in particular, molecular biology and plant genetics, can and will shorten the time to develop significant new agricultural and forestry “crops” that will produce the cost-effective products the world needs to ensure sustainable energy security. This third feature in the energy series describes some of the advances in research that are currently being used to develop improved bioproducts for years to come.

Biobased products derived from renewable biologically based feedstocks are garnering attention as a way to create new industries, employment, and income; provide new markets for farm commodities; increase national security by lessening dependence on foreign oil; and improve the environment through the use of non-toxic, usually biodegradable or recyclable, products that can minimize our country’s carbon footprint. Their unique attributes can help to enhance their market value and compete in both conventional and niche markets. For example, fabrics made with DuPont™ Sorona® corn-based polymer resist sun bleaching and are used in apparel such as swimwear to help colors retain clarity. Natureworks® polyactic acid (PLA) bottles use a revolutionary type of plastic made from corn that biodegrades in a commercial composting facility. One organic dairy, Naturally Iowa, Inc., packages its milk in PLA containers and uses the slogan “We Milk the Cows and Grow the Bottles” to increase its competitive advantage among increasingly environmentally conscious consumers. Biodegradable films made from Mirel™ bioplastic (Metabolix, Inc.) have properties unique to this class of fat-based polymers.

The USDA has a long history of applying agricultural research and development to expand value-added food and nonfood products from commodities and undervalued products of agriculture into domestic and international markets. The USDA has contributed to the research and development and/or purchase of numerous bioproducts, such as soy lubricants and corn-based absorbents, through its Energy Alternatives National Program (NP 307), Quality and Utilization of Agricultural Products National Program (NP 306), and BioPreferred Program, elaborated on below.

Adding value to biofuels’ production

Research under the auspices of the USDA’s Agricultural Research Service (ARS), NP 307 is expanding the bioproducts that can be derived from biofuels production. Whereas petroleum refineries produce dozens of fuels and chemical intermediates, most biorefineries are dedicated to a single primary product and by-product such as ethanol and distillers dried grains with solubles (DDGS) and biodiesel and crude glycerol. Petroleum refineries have a higher profit margin on the specialty co-products that are made along with commodity fuels. Furthermore, they can shift production to make one product versus another, if the price is right. This model can be replicated with biobased fuels and products. USDA researchers are examining how bioproducts from corn-based ethanol, biodiesel, as well as “next generation” biofuels such as cellulosic ethanol and bio-oil, can aid in the successful commercialization of the biofuels industry by enabling high-value products that can significantly and positively impact the economics of bioenergy production.
Corn-based ethanol

The ethanol industry is growing rapidly, and better utilization of the co-products of the manufacture can help to make ethanol production more economically feasible with less reliance on government subsidy. Co-products from processing corn grain into ethanol include enriched protein and fat products for livestock feed, high-value corn oil, phytosterols (plant sterols structurally similar to cholesterol that act in the intestine to lower cholesterol absorption), sweeteners, adhesives, and environmentally sensitive materials.

Researchers at ARS’s Eastern Regional Research Center (ERRC), Wyndmoor, Penn., have been working on ethanol co-products for more than 15 years. Researchers have turned ethanol byproducts into a valuable food emulsifier that can be used in hundreds of food products and can replace imported and expensive gum arabic. Other researchers have developed a method to produce a healthy corn oil from the ethanol process that contains the natural pigments zeaxanthin and lutein, which are necessary for eye health and preventing age-related macular degeneration. In addition, several processes have been developed to make cholesterol-lowering oils from corn byproducts. These cholesterol-lowering products are now used in foods and dietary supplements around the world.

One of the most important co-products from the conventional corn-to-ethanol process is DDGS, which can have a big effect on the overall profitability of the dry grind ethanol process. More than 80 percent of the ethanol is produced this way. Research is underway at ARS’s North Central Agricultural Research Laboratory (NCARL), Brookings, S.D., and ERRC to improve the value of DDGS. For example, there are significant constraints to the long-distance transport of DDGS because of the material caking in railroad cars, and the large railroads will no longer ship DDGS unless ethanol producers purchase or lease their own cars. Research is taking place at NCARL on improving the storability and flowability of DDGS, including pelletizing the material. In addition to the current use of DDGS as an animal feed, primarily for cattle, NCARL is also developing processes to convert DDGS into higher-value aquaculture feeds and pet foods. Processing methods are being evaluated at ARS’s National Center for Agricultural Utilization Research (NCAUR) in Peoria, Ill., for removing economically important materials from the DDGS, such as zein (a protein in corn) and oil. (DDGS are about 10 percent corn oil by weight.) Researchers have shown that when zein is modified in the appropriate fashion, it takes on attributes of traditional plastics. These new materials are being investigated as alternatives to petroleum-based materials in making textile fibers for clothing and nonwoven fabrics (like dryer sheets), but more research is needed to enable their commercial use. Oil produced from DDGS could be made into biodiesel. DDGS are also being evaluated for use in crop fields as a weed suppressant to cut down on the use of herbicides.

Biodiesel

Current biodiesel supplies are often made from animal fats (e.g., tallow and yellow grease) and vegetable oils (e.g., soybean oil), but processing biodiesel from triglycerides also yields crude glycerin, also known as glycerol. Although raw glycerin is currently used in large-scale cosmetic and food manufacturing, there is plenty to meet the current demand, and many biodiesel plants are selling their glycerin to refineries so it can be purified. As transportation costs often exceed the value of crude glycerin, the industry loses money. ARS researchers at ERRC are developing technologies wherein glycerin can be converted via biological and chemical processes into an array of petrochemical equivalents.

These researchers are developing innovative uses of glycerol in two
classes of bioproducts: biosurfactants and biopolymers. Biosurfactants, known as sophorolipids, are currently used in “cosmeceutical” (cosmetic products that have drug-like benefits) and automatic dishwashing detergent formulations. Bacterial polymers, known as polyhydroxyalkanoates (PHAs), have widespread properties, ranging from hard and tough to elastic, and can be used to produce a wide range of items such as golf tees, disposable razor handles, credit cards, and bottles. Both classes of bioproducts are considered “eco-friendly” as they are produced from a renewable resource and can be quickly biodegraded upon disposal. The National Biodiesel Board and the Soap and Detergent Association recently honored this research with an award. ERRC researchers also develop chemical processes to convert glycerol into novel polymeric molecules useful as coatings and lubricants.

**Cellulosic ethanol**

Bioproducts produced from lignocellulosic biomass, such as agricultural and forestry residues, may help to increase the economic viability of “next generation” biofuels such as cellulosic ethanol. Researchers at the ARS Dairy Forage Center have fermented alfalfa fiber to produce ethanol plus a residue that may serve as an all-natural adhesive. A patent application has been submitted to make an adhesive composition useful for producing wood products. This product may find particular application as a replacement for the phenol-formaldehyde resin commonly used in the manufacturing of plywood and other wood products. ARS research at NCAUR is focusing on the development of biobased processes from lignocellulosic biomass for producing sweeteners such as xylitol and mannitol, low-calorie sweeteners widely used in foods, pharmaceuticals, medical, and chemical industries.

**Bio-oil**

Biomass-to-liquid fuels such as bio-oil, which can be upgraded to diesel-like fuels, are produced by pyrolytic reactions. A biochar is produced as a co-product of pyrolyzing cellulosic materials such as switchgrass. While researchers at the ARS ERRC are looking for ways to optimize the production and quality of bio-oil, those at the ARS National Soil Tilth Laboratory in Ames, Iowa, are examining the potential use of biochar as a valuable soil additive to enhance soil fertility as well as sequester carbon – “The Charcoal Vision.” This char material may be analogous to the discovery of rich terra preta, a black soil in the Amazon River basin, which is thought to have been made by the region’s original human inhabitants to enrich the soil using charred trash. The U.S. Department of Energy (DOE) recently released a solicitation that offers up to $7 million over the next two years to support research in improved methods of biomass pyrolysis for stable pyrolysis liquids. ARS research on the beneficial attributes of the char co-product may help to accelerate the economic production of this biofuel.
Developing value-added biobased products from agriculture

Additional bioproduct research is taking place as a result of ARS’s Quality and Utilization of Agricultural Products National Program (NP 306). NP 306’s focus is on developing, modifying, and utilizing new and advanced technologies to convert animal and plant components – protein, oil/fat, starch, fiber – and processing byproducts into new products to meet niche market opportunities. NP 306 is also developing natural products for biobased lubricants, hydraulic fluids, metalworking fluids, composites, and biodegradable plastics, and is developing technologies and processes to convert agricultural products into important value-added products.

ARS researchers in this program have developed soy-based lubricant formulations now being used as hydraulic oils and metalworking fluids. This is important given the fact that the United States consumes more than 9.5 billion L (2.5 billion gal) of lubricants and industrial fluids annually, of which more than 95 percent are petroleum-based. A soy-based hydraulic fluid has been used successfully in the Statue of Liberty’s elevator for nearly five years.

The starch that is available in corn was made into “Super Slurper” materials, a superabsorbent polymer invented by ARS scientists in the 1970s. This product absorbs up to 2,000 times its weight in liquid and has inspired several commercial products including disposable diapers, fuel filters, absorbent wound dressings, and seed coats. In recent years, it has been used as a fast, new way of drying books exposed to water damage.

Additional value-added uses of starch are being developed by a Cooperative State Research Education and Extension Service (CSREES) project at the University of Montana for the cost-effective production of starch-based chemical intermediates that can be easily modified for specific applications, e.g., biodegradable plastics. The ultimate goal is to establish a technical platform for specialized carbohydrate refining, which converts renewable carbohydrates to carbohydrate diacids (aldaric acids) through an oxidation process, for applications such as acid monomers to produce biodegradable polymers labeled polyhydroxy-polymamides (PHPAs) and as chemical building blocks for other carbohydrate-based chemical synthesis. Successful implementation of this technology on an industrial scale will represent a meaningful demonstration of the feasibility and importance of using renewable and abundant carbohydrate resources for large-scale chemical processing.

New crops are also being examined as a way to provide diverse materials for new bioproducts and to offer new economic opportunities for growers. CSREES and ARS have had an ongoing collaborative research program for two decades to develop the small desert shrub, guayule, available in the United States as a source of natural hypoallergenic latex. Initial markets for this product will be healthcare professionals who must wear gloves for protection but who are allergic to conventional rubber products. ARS provided assistance to an industrial partner that will break ground this year on a manufacturing facility to produce 4,000 tons/yr of hypoallergenic latex. Because only 10 percent of the guayule material is converted to latex, the residual material after latex extraction, guayule bagasse, can be a potential source of lignocellulosic biomass for renewable energy.

Researchers at the ARS ERRC and Western Regional Resource Center, Albany, Calif., are also studying the pyrolysis of this bagasse for the production of biooil and char.

Promoting consumer demand and new markets for biobased products

Consumer interest in green, natural, and environmently sustainable products is on the rise. The U.S. government is helping to promote demand and develop new consumer markets for biobased products through its BioPreferred Products program, which was authorized by the Farm Security and Rural Investment Act of 2002. The goal of that legislation was to increase the government’s purchase and use of biobased products by requiring all federal agencies and their contractors to give a purchasing preference to biobased products identified by the USDA as long as they meet price, performance, and availability criteria. As of May 2008, there were a total of 2,741 products from 659 companies that

“Super Slurper” technology has a number of uses in commercial products as an absorber of fluids.
qualified for the BioPreferred Program. The recently passed Food, Conservation, and Energy Act of 2008, also known as the Farm Bill, continues and expands the federal preference for procurement of biobased products and the biobased products labeling program by providing $9 million in mandatory funding. About a dozen USDA agencies with programs related to biobased products and/or bioenergy participate in the Biobased Products and Bioenergy Coordination Council, which was established by the U.S. Secretary of Agriculture. The DOE, which co-chairs the Biomass Research Development Initiative with the USDA as part of a multi-agency effort to coordinate and accelerate all federal biobased products and bioenergy research and development, is also promoting the use of bioproducts at its facilities.

Numerous states and land grant universities have research centers focusing on biobased products. For example, the Center for Crops Utilization Research at Iowa State University is a research, development, and technology transfer program that is focused on adding value to midwestern crops. In June of this year, USDA hosted its second annual “BioEnergy Awareness Day,” also known as BEAD II, which brought in researchers from USDA laboratories and land grant universities and other colleges from around the United States to display the latest research in bioenergy and bioproducts.

As mentioned at the onset, companies are increasingly developing and using biobased products in new markets. Companies like John Deere have been developing and using soybean-based composites in farm machinery as a way to promote internal green company policy and help drive demand for farm products among their customer base. Ford Motor Company has actively researched the use of soy-based resins for use in seat foam and fenders. Some traditional chemical companies are forming alliances with food processors and other firms devoted to the development and production of bio-derived chemical products. For example, Ashland and Cargill have recently formed a joint venture to produce a high-grade propylene glycol (PG) made from glycerin, a co-product of biodiesel production. Approximately one-half of the PG market goes into products such as food, cosmetics, pharmaceuticals, functional fluids, and detergents that have direct consumer impact. For many of these consumer products, high-grade propylene glycol made from vegetable oil rather than petroleum is expected to be a popular option. In the housing and sustainable building industry, the U.S. Green Building Council is offering points to those builders who use biobased products in its Leadership in Energy and Environmental Design Green Building Rating System.

In summary

Extensive research is taking place in the area of biobased products at USDA laboratories, land grant universities, in the states, and in the private sector that offers the promise of a reduced carbon footprint as well as decreased dependency on foreign oil. The biobased economy offers the potential of building entirely new industries based on green renewable agricultural and other biobased materials. Increasingly, biobased products are entering commercial markets and will help biofuel producers have a better chance of conferring sustainable economic viability in their operations.
Agricultural feedstocks for biofuel production are typically characterized by a wide spatial distribution of available biomass, time- and weather-sensitive crop maturity, variable moisture content, low bulk density, and a short harvest window. To further complicate the situation, bioenergy feedstocks must often compete for resources (such as machinery, buildings, and people) with other concurrent harvest operations. Considering all of these adversities, a collection, storage, and transport network for biomass must ensure timely supply with minimum cost. Advances in computational tools have made it possible to build mathematical models for analysis and optimization of complex biomass supply systems. The development of such models requires a concerted effort in theoretical development, experimentation, and validation.

**IBSAL, a modeling environment for modeling biomass supply**

The Integrated Biomass Supply and Logistics (IBSAL) modeling environment provides time-dependent simulation of biomass feedstock supply operations. The modeling platform consists of a network of operational modules and connectors that thread the modules into a complete supply system. Each module is a mathematical simulation of a process or event. The process modules are drying, wetting, and dry-matter loss. The events are operations such as combining, baling, stacking, grinding, pelletizing, and storing. Costs and energy calculations common to all operations are gathered into individual modules. A module is independently constructed with a set of inputs and outputs. A complete, assembled model simulates the flow of biomass from farm or forest to biorefinery (Figure 1).

IBSAL is developed using Extend (www.imaginethatinc.com), a commercially available dynamic modeling language. Extend can be used in two modes: ready-to-use graphical blocks, and a C-based computer language with many built-in functions. The graphical blocks carry out specific tasks such as queues, decisions, input, and output functions. The accessible C++-like programming code, called ModL, is available for programming and interfacing with the graphical blocks. A model is created by dragging blocks from a library to a worksheet, connecting the blocks, and then entering the appropriate data in the dialog boxes available for each block. The program is capable of modeling continuous and discrete processes. IBSAL operates in mixed discrete and continuous modes.
The model output includes dry-matter losses due to storage and due to equipment operation. In addition to custom rates, the calculated costs include fixed and operating costs, from which the cost of ownership for equipment can be calculated. The quantity of equipment needed to supply feedstocks given location-specific biomass quantities and harvest and delivery schedules can also be determined. The model calculates energy input to the system and mass of carbon emitted by the power equipment. As a demonstration of the model's ability to design and analyze biomass feedstock supply chains, a simulation of corn stover collection in Iowa is presented here.

**Simulating corn stover collection in Iowa**

Table 1 lists an example of a model built on IBSAL's platform to simulate corn stover harvest in Iowa. To set up the simulation and run the model, weather and harvest progress data for Des Moines, Iowa, were used. The safe moisture content for baling stover was assumed to be less than 20 percent (wet basis). The total cost of collecting and stacking is calculated as $30.57 per dry tonne (dt), of which $1.93/dt is the cost of the combine (assuming that 10 percent of the total cost of the combine is allocated to biomass harvest). The cost of shredding (chopping) biomass after grain harvest is $4.81/dt. Collecting and baling stover into large square $1.2 \times 1.2 \times 2.4$ m (4 × 4 × 8 ft) bales amounts to $17.46/dt. Other listed cost items are $3.54/dt for automatic collecting and stacking, and $2.84/dt for storing bales on a dirt pad. The cost of storage includes the cost of land and its preparation for use as a stacking area. Table 1 also lists energy input and the corresponding carbon emissions from the power equipment (tractors and stacking equipment). The energy input at 342.2 MJ/dt is roughly 2 percent of the energy content of biomass at 17 GJ/dt.

The last column in Table 1 lists the net dry mass calculated after each operation. The theoretical biomass yield based on a 1:1 ratio of biomass to grain is 9.8 dt/ha (3.9 dt/acre). Table 1 shows that IBSAL calculated a net yield of 7.7 dt/ha (3.1 dt/acre) after grain harvest, i.e., roughly 15 percent of the biomass was lost during grain harvest. The dry mass losses in subsequent operations result in net yields of 6.8, 6.5, and 5.8 dt/ha (2.8, 2.6, and 2.3 dt/acre). The difference of 3.3 dt/ha (1.3 dt/acre) between the theoretical 9.8 dt/ha (3.9 dt/acre) and the value of 6.5 dt/ha (2.6 dt/acre) after baling is more than the 1.6 dt/ha (0.6 dt/acre) recommended biomass residue to be left on the soil for minimizing soil erosion. IBSAL checks the net yield against this conservation requirement and places a cap on the amount of removable biomass.

<table>
<thead>
<tr>
<th>Operations</th>
<th>Cost ($/dt)</th>
<th>Energy (MJ/dt)</th>
<th>Carbon emissions (kg/dt)</th>
<th>Net dry mass (dt/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combining*</td>
<td>1.93</td>
<td>21.1</td>
<td>0.45</td>
<td>8.4</td>
</tr>
<tr>
<td>Shredding</td>
<td>4.81</td>
<td>82.7</td>
<td>1.75</td>
<td>7.7</td>
</tr>
<tr>
<td>Baling (large squares)</td>
<td>17.46</td>
<td>188.8</td>
<td>3.99</td>
<td>6.8</td>
</tr>
<tr>
<td>Transporting and stacking</td>
<td>3.54</td>
<td>48.6</td>
<td>1.03</td>
<td>6.5</td>
</tr>
<tr>
<td>Storage costs on dirt pad</td>
<td>2.84</td>
<td>0.0</td>
<td>0.00</td>
<td>5.8</td>
</tr>
<tr>
<td>Total</td>
<td>30.57</td>
<td>341.2</td>
<td>7.22</td>
<td>—</td>
</tr>
</tbody>
</table>

* 10% of the costs and time of the combine is allocated to stover.
IBSAL also estimates the minimum quantity of equipment needed to supply the required 850,000 dt of biomass per year. The numbers are 150 combines, 65 shredders, 110 balers, 26 automatic bale collectors, 40 bale loaders, 40 bale wrappers, and 175 tractors (to pull balers and shredders). The total investment, including preparation of ground for storage, is $100,110,885. For transport of bales from field sites to biorefineries, 30 loaders and 240 trucks are needed. The total purchase cost for the equipment is $37,816,530. The harvest of biomass is scheduled for 71 days (beginning in August). The transportation of bales from on-farm storage sites to biorefineries is gradual over 350 days of the year.

IBSAL makes yield-based adjustments in calculating field speed and field efficiency. For a specific piece of equipment, the baseline machine productivity is based on estimates given in ASABE Standards EP496.3 and D497.5 for a machine-specific yield. Machine productivity drops when actual yields are larger or smaller than the specified yield. IBSAL reflects this sensitivity of productivity to yield by using a parabolic equation that relates field efficiency to a deviation in yield. Similarly, IBSAL maintains a constant throughput for a machine by a linear relationship between forward speed and yield. The model uses a larger or smaller machine once the calculated speed or efficiency falls outside of the specified ranges for that machine.

**Optimization and sensitivity analysis**

IBSAL can be used to conduct optimization and sensitivity analyses. Figure 2 shows the results of using IBSAL to determine the optimum size of particles needed to minimize the cost of transport. Smaller particles increase the bulk density, resulting in reduced transport cost. However, producing small particles requires increased power for size reduction, and thus increases the cost. The result of the decreasing cost of transport and the increasing cost of grinding provides a cost curve that identifies the optimum particle size. As Figure 2 shows, the optimum particle size for 60 km transport is between 1.78 and 2.54 mm (0.07 and 0.1 in.).

The averaged USDA data on harvest progress over a five-year period (2002-2005) show that for a fall harvest, 99 percent of the harvest was completed in Des Moines, Iowa; 100 percent of the harvest was completed in Lubbock, Texas; and 71 percent of the harvest was completed in Lansing, Mich. Incomplete harvest was due to adverse conditions, especially early frost and snow. Using these data, IBSAL calculated the cost of collection for Des Moines at $30.57/dt, compared to $38.21/dt for Lansing and $29.04/dt for Lubbock. The sensitivity of costs to grain yields of 11.7, 8.0, and 6.1 dt/ha (220, 150, and 115 bu/acre; 56 bu/acre at 15.5 percent moisture content) was calculated assuming no change in the size of

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**Figure 2.** For a given scenario, IBSAL can be used to determine the best material particle size for reducing the delivered cost of material, which includes the costs of handling, transportation, and grinding.
equipment. The collection costs increased by about $2/dt on either side of 8 dt/ha (150 bu/acre). The harvested tonnage did not change, as expected (field speed was adjusted to yield).

**In summary**

The IBSAL model is a powerful tool for evaluating the biomass supply chain from field to biorefinery. IBSAL consists of a series of equations that calculate the collectible fraction of biomass, while tracking biomass moisture during harvest and storage, machinery performance, compositional changes, and dry matter losses. The model analyzes the effects of variations (annual weather patterns, variations in yield and moisture, variable biomass composition) associated with the feedstock supply.

The model can be used as a decision tool for designing bioenergy feedstock supply chains. For example, should wet or dry technologies be used to harvest, store, and deliver biomass in a particular location? And what is the most economical format (bales or granules) for biomass delivery? The accuracy of the equations used in the model is critical to IBSAL's power and utility. Research is under way to validate the performance of these equations with field data.

ASABE members Shahab Sokhansanj (sokhansanj@ornl.gov), Anthony Turhollow (turhollowaf@ornl.gov), and Erin Wilkerson (wilkersoneg@ornl.gov) are agricultural engineers with the Bioenergy Resources and Engineering Systems Group, Division of Environmental Sciences, Oak Ridge National Laboratory, Oak Ridge, Tenn., USA.

For further reference


Convening just ahead of the U.S. Independence Day celebration, in a historic city known for its embrace of religious and cultural diversity, ASABE’s 2008 Annual International Meeting, in Providence, R.I., drew more than 1,500 attendees from around the globe.

On Monday morning, AE50 award winners were recognized for achievement in product engineering. The AE50 presentations were followed by this year’s keynote address by marketing executive Patrick Hanlon. What makes one product or brand “sticky” and another forgettable? In his remarks, Hanlon, author of *Primal Branding: Create Zealots for Your Brand, Your Company and Your Future*, offered much to contemplate in terms

A fife and drum trio lends a measure of pomp to the opening of Wednesday’s Awards luncheon.
of the profession’s own identity. Hanlon asserted that at the core of a brand is a belief system, and the elements of that belief system — a creation story, creed, icons, rituals, nonbelievers, language, and a leader — can be effectively applied to the profession.

This year’s technical program included a special Centennial Session on Advances in Soil and Water Engineering, which comprised five invited presentations that showcased past accomplishments and exciting new initiatives by agricultural and biological engineers.

“Bioenergy Day,” organized by the T-11 Energy Committee, featured a full day of oral and poster presentations — all very well attended — that provided provocative, informative content on current research, technology, and challenges associated with bioenergy development.

This year’s Distinguished Lecture welcomed Jack Wiley and Reed Turner, who addressed “Power Hop Instability in Tractors,” a phenomenon that can be influenced by tire inflation pressure. Lower inflation pressure not only controls power hop, it also increases tractor productivity and fuel economy, and reduces soil compaction and tire wear. (See Resource, July 2008, for more information.)

In the 2008 Fountain Wars Competition, six schools were represented: Kansas State, Purdue University, Texas A&M, University of Florida, University of Illinois, and University of Tennessee. Texas A&M took top honors, followed by Kansas State and the University of Illinois.

The ASABE Robotics Competition challenged teams to develop small-scale robotic timber harvesters capable of collecting trees of varying diameter, in a manner similar to a feller buncher. Teams from Kansas State University, Texas A&M, and University of Illinois participated in the contest, which was won by KSU.

Another student competition, the ASABE100 Multi-Media Competition for High School Students, brought three national finalists to Providence, where they gave oral presentations in which they identified the top engineering challenge of the next 50 years. Louis Teng of Silver Spring, Md., won the contest and a top prize of $4,000.

Adding luster to the week’s activities was Hall of Fame broadcaster Orion Samuelson, speaker at the Foundation Gala Dinner. In his remarks, he applauded the profession for its contributions to advancements in agriculture, noting that agricultural and biological engineering is fully capable of meeting new challenges as they emerge, including finding solutions to energy needs. “Never question that you can do it,” Samuelson urged. “You can do it.”

On Saturday evening, just prior to the opening of the Annual Meeting, many members enjoyed a unique, canal-side...
summer event in Providence called “Waterfire,” where music and small bonfires are combined for an unusual sunset attraction. Food vendors of all kinds could be found along the route, although many ASABE members opted for catered fare at a specially organized VIP tent.

Two changes in the meeting program were well received by meeting attendees. The traditional Sunday welcome reception was moved up to late afternoon, an adjustment that freed attendees to make evening dinner plans. Also, the traditional Wednesday Awards Luncheon was trimmed, with a portion of it being incorporated into a Tuesday luncheon combining some of the awards presentations with the annual ASABE Business Meeting. The change significantly shortened the Wednesday event.

Throughout the first two days of the meeting, the Young Professionals Community kept the mood lively. Their “Pedal Power” contest first pitted a half dozen members against each other in a friendly fundraising competition. Meeting attendees were asked to stuff the ballot boxes — with cash. The top vote getters then competed in a pedal-tractor race. Qualifying for the pedal race were Mary Leigh Wolfe and Chuck Roth and staff members Mark Crossley and Travis Tsunemori. Roth out-pedaled Tsunemori across the finish line to claim top honors.

ASABE Past President Charles Sukup (right) welcomes guest speaker Orion Samuelson to the ASABE Foundation Dinner. Sukup Manufacturing generously sponsored Samuelson’s appearance.

ASABE staff member Travis Tsunemori (left) gleefully attempts to outmaneuver Chuck Roth through a turn in the Young Professionals Community “Pedal Power” mini-tractor race. At the finish line, it was Roth wearing the victor’s smile.

Dolores C. Landeck, ASABE Director of Public Affairs, St. Joseph, Mich., USA; landeck@asabe.org.
Researchers at Oklahoma State University (OSU), Iowa State University (ISU), and the USDA-ARS National Soil Tilth Laboratory (NSTL) have formed a unique research team to solve an important water quality problem. This team is addressing the transport of pathogens (specifically, the indicator organism *Escherichia coli* or *E. coli*) through soils and, more specifically, the role of macropores in the transport of *E. coli* to subsurface drains. Pathogen contamination of water supplies is now considered one of the top water-quality issues in the United States and around the world.

**Macropores and subsurface drains**

Field studies on subsurface drain plots commonly exhibit spikes in contaminant concentrations when rainfall events occur shortly after manure, fertilizer, or pesticide applications. It is hypothesized that this occurrence is due to macropores that are directly connected to subsurface drains. A direct connection to subsurface drains means a direct connection to water in ditches and rivers/streams and, hence, contamination of those water bodies.

Some of these macropores are present due to extensive earthworm burrow networks. In fact, USDA-ARS researchers at Coshocton, Ohio, led by Martin Shipitalo, have documented the detailed interaction of earthworm macropores and subsurface drain lines. Earthworms come to the soil surface to feed, breed, and migrate and then return to the soil in the vicinity of the subsurface drain because of its favorable moisture regime. Studies have shown that macropores located within 50 cm (20 in.) on either side of the drain line can potentially be directly connected between the surface and subsurface drain.

**Intrigued by the data**

The authors, ASABE members Garey Fox (Biosystems and Agricultural Engineering, OSU) and Rob Malone (NSTL) began working together with George Sabbagh at Bayer CropScience in Stillwell, Kan., investigating immediate breakthrough of pesticides through these directly connected macropores. In Illinois field sites, rainfall events shortly after pesticide application caused large spikes in pesticide concentrations in drain flow. Numerical models were unable to simulate these concentration spikes unless they were modified to include the presence of directly connected macropores.

With more and more field studies indicating large concentrations of *E. coli* in drain flow shortly after animal manure application, the researchers teamed with ASABE member Ramesh Kanwar (Chair, Agricultural and Biosystems Engineering, ISU), ASABE member Carl Pederson (Research Assistant, Agricultural and Biosystems Engineering, ISU) and microbiologist Tom A macro pore directly connects to a sub-surface drain. A polymer resin was poured from the surface, and then the soil was excavated around the macropore. (Photo courtesy of Martin Shipitalo, USDA-ARS, Coshocton, Ohio, USA)

At right: Garey Fox (right) and Jorge Guzman inspect an earthworm macropore in soil from the ISU Nashua Research Experimental Station in northeast Iowa. (Photo by Todd Johnson, OSU)
Moorman (NSTL) to develop an integrated field, laboratory, and numerical modeling study recently funded by the USDA Cooperative State Research, Education, and Extension Service (CSREES) as part of their National Research Initiative (NRI) grant program (Award No. 2007-35102-18242).

**Research now and ongoing**

As part of the three-year (2007-2010) NRI project, innovative laboratory column studies are being performed at OSU to study *E. coli* transport with artificial macropores. It is believed that the primary transport of pathogenic microorganisms in most soils occurs through macropores that bypass the filtering and adsorptive effects of the soil matrix. The column studies include a subsurface drainage boundary condition with macropores of varying lengths that are either directly connected to the soil surface or buried underneath the soil surface. The buried macropores simulate tillage or other management practices that disrupt macropore networks at the surface. Water containing *E. coli* is applied at the soil surface, and then concentrations of *E. coli* exiting from the macropore and drain are monitored.

Innovative laboratory column studies investigating the transport of *E. coli* to subsurface drains with surface-connected and buried macropores. The picture on the left shows the soil column packed with soil and installed pencil-size tensiometers for measuring soil pore-water pressure. On the right is the soil column unpacked to demonstrate the macropore setup with the cutout showing the tube that samples the macropore flow exiting from the perforated pipe used to simulate a zero-pressure boundary condition (e.g., subsurface drain).

The macropores studied in this research are also connecting more than just contaminants and subsurface drains. They are also connecting cultures. Funding by the USDA NRI program provided monies for Ph.D. students at both OSU and ISU. Jorge Guzman (Ph.D. student, OSU) is from Columbia and Hoang Kim Chi (Ph.D. student, ISU) is from Vietnam. These two students frequently communicate on procedures and results from the laboratory and field studies. Their OSU and ISU dissertations will be connected by macropores and earthworms!

Directly connected macropore emits smoke during a trial smoke-test experiment at the ISU Nashua Research Experimental Station. (*Photo by Jorge Guzman, OSU*)

The research also includes field experiments at the ISU Nashua Research Experimental Station in northeast Iowa. The field experiments include smoke tests to identify directly connected macropores, whereby smoke is injected at the outlet of the tile drain. Concentrated smoke plumes on the soil surface then indicate a direct pathway between the subsurface drain and the soil surface. Initial smoke tests indicated approximately 3.2 macropores per m (one macropore per ft). Liquid swine manure, containing *E. coli*, is applied to the subsurface drained plot. *E. coli* transport studies are then conducted using a rainfall simulator with continual monitoring of drain flow for *E. coli*. Four field experiments will be performed over the next two years (spring and fall) on two plots at Nashua.

In the later part of the study, the research results from the field and laboratory experiments will be utilized in the modification of a lumped macroporosity, subsurface drainage model for predicting *E. coli* transport through directly connected macropores. Our initial results, however, are confirming the prominent role of directly connected macropores on transporting *E. coli* to subsurface drains.

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**ASABE members**

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A New Generation of Farm-Based Anaerobic Digesters

Engineers at Michigan State University’s Department of Biosystems and Agricultural Engineering are retooling an old technology to become a viable part of odor control, nutrient management, and a sustainable energy system in Michigan.

Steven Safferman and Marianne Tripoli

Anaerobic digesters (ADs) have been successfully used to generate energy since 1857. The first AD was built in a leper colony in India in that year. They first appeared in the United States in the 1970s in response to complaints about odor emanating from a swine farm in Iowa. The energy crisis of the 1970s spurred their growth as an alternative energy source for farms, but the early failure rate for the United States was high — 65 percent and 83 percent for Michigan, as stated in September 1997: “A Report of the Michigan Biomass Energy Program. Farm-Based Anaerobic Digestion in Michigan: History, Current Status and Future Outlook” by Jack L. Rozdilsky, former coordinator of the Michigan Biomass Energy Program.

Despite this initial setback, ADs have steadily increased since AgSTAR’s inception in 1994. As of April 2008, there were 114 operational farm-based digesters in the United States, with 10 located in Michigan in various stages of planning and operation (www.epa.gov/agstar/accomplish.html). The reason for their renaissance is their immense potential to provide an environmentally friendly solution to several farm-based problems with one technology. That is why engineers at the Michigan State University’s (MSU) Department of Biosystems and Agricultural Engineering (BAE) have made it a priority to ensure that ADs become the cornerstone of a sustainable energy portfolio, an integrated manure management system, are more common in Michigan.

ADs are enclosed tanks that decompose manure, food waste, or any organic material in an oxygen-free environment to produce and collect biogas. In the absence of oxygen, decomposing bacteria breaks down fats, proteins, and carbohydrates into biogas, which is 50 to 70 percent methane and 30 to 40 percent carbon dioxide. ADs can help farms produce energy, control odor from livestock, improve air quality, and reduce greenhouse gas emissions. They provide high-value by-products like irrigation water, nitrogen for fertilizer, low-phosphorus manure, and biofibers. Captured biogas can be flared or used to generate heat, hot water, electricity, or natural gas. Both the flaring and use of biogas for energy reduce...
methane emissions, allowing for the sale of carbon equivalents, which are tradable on the Chicago Climate Exchange. Any facility that processes animal manure, organic chemicals, milk, food, fiber, pharmaceuticals, municipal solid waste, or wastewater has the potential to produce biogas from organic waste matter. Waste streams can also be blended to increase or optimize digester feed stocks and potentially increase methane production.

The first step BAE engineers took to improve the success rate of ADs on Michigan dairy farms was to develop a sand-manure separator. Sand, commonly used for animal bedding in Michigan, mixed with manure and built up in a digester, contributed to Michigan's high, early digester failure rate. The separator also removes and rinses the sand, allowing more flexibility in manure handling and making it available for reuse.

The next step for BAE engineers was to construct a field-scale AD to demonstrate profitable energy production with implications for environmental protection, carbon sequestration, and sustainable agriculture. On June 30, 2005, the Michigan Public Service Commission (MPSC) awarded a $2 million grant to the Michigan State University's Biosystems and Agricultural Engineering Department to construct an anaerobic digester and related innovative manure treatment technologies at Green Meadow Farms, Inc. (Green Meadow Farms is a large dairy operation in Elsie, Mich., that has a unique affiliation with MSU’s Department of Veterinary Medicine and is home to the MSU College of Veterinary Medicine Training Center for Dairy Professionals.) This AD system was the first newly constructed digester on a Michigan farm in more than 20 years. The biogas is used to run an 800 kW generator set, which is connected to the grid. A center is currently in development, that will enable researchers to study cutting-edge technologies in a commercial setting as well research projects that rely on AD, such as the production of algae. This center will also facilitate the training of personnel in the operation and maintenance of a digester and associated systems. Consulting engineers, already knowledgeable in the design, construction, and operation of municipal and industrial wastewater treatment systems, will be able to extend their knowledge base to agriculture.

ADs can also help food processors institute protective environmental practices by diverting organic wastes from landfills for the production of green energy. This can protect Michigan's unique, extensive surface water resources and high ground water table. Comprehensive research on many AD-related topics is currently being conducted by BAE engineers to access the feasibility of digesting organic materials in food processing wastewater. The purity and concentration of the organic material could provide economical energy recovery and offset the capital cost of the system and its operation. Ongoing research entails waste blending to optimize feedstocks to maximize the production of commercial-grade methane in ADs. This project is funded by Project GREEEN, an acronym for Generating Research and Extension to meet Economic and Environmental Needs. It is Michigan’s plant agriculture initiative at Michigan State University and a cooperative effort by plant-based commodities and businesses in cooperation with the Michigan Agricultural Experiment Station, Michigan State University Extension, and the Michigan Department of Agriculture.

As a further measure to ensure the success of ADs, BAE engineers provide biogas potentials assays using anaerobic respirometry. They have developed tools to calculate how much methane can be produced from blending waste organic materials and are developing a GIS mapping tool to locate waste biomass in Michigan to help organizations choose the optimal placement of centralized digesters.

A facility like Scenic View Dairy, a Phase 3 Development in Fennville, Mich., demonstrates what the future of ADs can hold for Michigan. This dairy farm, with approximately 2,200 head of cattle, is the first to combine electricity generation with biogas upgrading to pipeline standards, providing a second option for revenue optimization by selling this energy to local power companies (Michigan Department of Agriculture Anaerobic Digester Case Study, Scenic View Dairy, Fennville, Mich., www.michigan.gov/documents/mda/AD_CaseStudy_221950_7.pdf). Scenic View Dairy has also replaced sand bedding with digested biofibers and utilizes the high-quality methane for on-farm use It is a model of an environmentally safe solution made possible by applying 21st century engineering to an old technology in order to solve complex modern challenges.

ASABE member Steven Safferman is associate professor, Department of Biosystems and Agricultural Engineering, Michigan State University, East Lansing, USA; safferma@msu.edu. Marianne Triponi is the communications manager in the Department of Biosystems and Agricultural Engineering, Michigan State University.
A coproduct of ethanol production could be used as a non-petroleum-based filler in plastics, based on preliminary studies by the USDA Agricultural Research Service (ARS) scientists and their cooperators.

The ethanol coproduct, called distiller’s dried grains with solubles (DDGS), has a high fiber content and a molecular structure suitable for binding — two attributes that make it a candidate for use as a filler in plastics, according to ASABE member and ARS agricultural engineer Kurt Rosentrater.

The researchers compressed molded blends of DDGS and phenolic plastic resin (ranging from 0 to 90 percent DDGS) and found that DDGS concentrations between 25 and 50 percent worked best as fillers in plastics. These findings were published recently in the *Journal of Polymers and the Environment* (JPE).

The preliminary study yielded only limited data on the resulting physical properties of the various DDGS/plastic blends, so follow-up tests are currently under way.

The data can then be used to develop new bio-based manufactured products. Rosentrater and Andrew W. Otieno, also with Northern Illinois University’s Department of Technology, have developed comprehensive guidelines that take into account the unique challenges encountered when manufacturing plastic composites that contain biological materials. This work has also been published in the JPE.

Fillers such as clay, talc, glass, paper, and metals are commonly used in plastics to increase strength and to save costs by reducing the amount of actual plastic resin used. Using bio-based fillers, such as bamboo, kenaf, corn stover, soybean hulls, or even chicken feathers, is receiving increased attention as a way to use less petroleum in plastic products. Thus, both DDGS and distiller’s dried grains are candidates for use as biofillers for plastics.

For more information, contact Don Comis, ARS public affairs specialist, Donald.Comis@ars.usda.gov.
PROFESSIONAL OPPORTUNITIES

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

Advertisements are $125 per column-inch length (column width is 3.5 inches) and include free placement on the ASABE Career Center at www.asabe.org/membership/careercenter.htm. The minimum ad size is two inches — approximately 100 words — to qualify for the free online listing. Ads are posted on the Web site within three business days of final approval and remain there for 30 days. If the insertion order is for two months, the cost is $110 per column inch per insertion and includes a 60-day free Web listing.

For more details on this service, contact Melissa Miller, ASABE Professional Opportunities, 2950 Niles Road, St. Joseph, MI 49085-9659, USA; 269-429-0300 ext. 317, fax 269-429-3852, miller@asabe.org, or visit www.asabe.org/resource/persads.html.

ASSISTANT/ASSOCIATE PROFESSOR
ENGINEERING, BIORESOURCE – MCGILL UNIV.

The Department of Bioresource Engineering (www.mcgill.ca/bioeng/) is seeking outstanding individuals for a tenure-track position at the Assistant or Associate Professor level. The intent of the position is to address a number of closely-related fields in the discipline, the overall target area being composed of the following: GIS and precision agriculture, mechatronics, agricultural robotics, machine design, automation, instrumentation and control, remote sensing, satellite imagery, and hyperspectral analysis. Candidates with expertise in other areas of bioresource engineering may also apply. Applicants will have an earned Ph.D. and an excellent publication record for their level of experience. The successful candidate will develop a strong, independent research program supported by external research funds, and teach at both the undergraduate and graduate levels in bioresource engineering. Applicants must be eligible for membership in a Canadian professional engineering association. The following materials should be included in the application: curriculum vitae, a statement of teaching and research interests, the names of three referees, and copies of relevant publications. Applications should be mailed to: Dr. Shiv Prasher, Chair, Bioresource Engineering, Macdonald Campus of McGill University, 21111 Lakeshore Blvd, Ste-Anne-de-Bellevue, QC, H9X 3V9, Canada. Deadline for applications is October 30, 2008; a start date of June 1, 2009, or earlier, is foreseen for the position.

McGill University is committed to equity in employment and diversity. It welcomes applications from indigenous peoples, visible minorities, ethnic minorities, persons with disabilities, women, persons of minority sexual orientations and gender identities and others who may contribute to further diversification. All qualified candidates are encouraged to apply; however, in accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada.

ASSISTANT/ASSOCIATE PROFESSOR
(INTEGRATED WATER RESOURCES MANAGEMENT)
ENGINEERING, BIORESOURCE – MCGILL UNIVERSITY

The Department of Bioresource Engineering (www.mcgill.ca/bioeng/) is seeking outstanding individuals for a tenure-track position at the Assistant or Associate Professor level. The intent of the position is to address a number of closely-related fields in the discipline, the overall target area being composed of the following: agricultural water management, water quality, integrated water resource management, watershed systems engineering, or ecohydrology. Applicants are expected to have a Ph.D. in one of the above areas, and an excellent publication record for their level of experience. The successful candidate will have the opportunity to lead a graduate-level program in integrated water resources management, develop a strong, independent research program supported by external research funds, and teach at both the undergraduate and graduate levels. (S)he can also affiliate with McGill’s Brace Centre for Water Resources Management, one of Canada’s leading water research centers (www.mcgill.ca/brace/). Applicants must be eligible for membership in a Canadian professional engineering association. The following materials should be included in the application: curriculum vitae, a statement of teaching and research interests, the names of three referees, and copies of relevant publications. Applications should be mailed to: Dr. Shiv Prasher, Chair, Bioresource Engineering, Macdonald Campus of McGill University, 21111 Lakeshore Blvd, Ste-Anne-de-Bellevue, QC, H9X 3V9, Canada. Deadline for applications is October 30, 2008; an actual start date of June 1, 2009 is foreseen for the position.

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The ASABE Career Center

The most comprehensive CAREER AND RECRUITING SITE for the agricultural, biological, and food engineering industries is now available for your use. The Career Center offers extensive résumé and position databases, and powerful and user-friendly searching capabilities, which allow you to find the job or candidate you seek!

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ASABE cares about your career development. Lifelong learning is a pre-requisite to any successful career – and we are committed to providing resources to help our members grow. Start making your career connections at the ASABE Career Center, visit www.asabe.org/membership/careercenter.htm.
Position Title: Professor or Associate Professor, and State Extension Specialist, Agricultural Bioprocesses

Position Description: This is a tenured or tenure-track position in the Division of Food Systems & Bioengineering. Primary responsibilities include leadership for the MU Extension energy program and development of extension and research programs in the Bioprocessing area, especially as it relates to development of alternate fuel resources and environmentally sound use of biomass, water and other natural resources.

The successful candidate will provide leadership for program efforts in developing and managing agriculturally based energy resources. Expertise in all aspects of bioenergy, from farm to fuel, is sought. Research interests can include but are not limited to: conversion of biomass to energy, fuels and/or chemicals in liquid and/or vapor form, growth, harvesting, storage, transportation and related processing of biomass for energy-related applications, and processing food and animal waste streams for the purpose of capturing portable energy and minimizing environmental contamination. In this effort, the successful candidate will be part of a team of Food Science and Biological Engineering faculty who are developing integrated teaching, research, and extension programs in the energy systems area. The individual hired for this position will collaborate with University Extension Regional Specialists, government and other agricultural industry partners, and report to the Food Systems and Bioengineering Division Director.

Qualifications: A Ph.D. in biological engineering, agricultural engineering, chemical engineering or related fields and relevant experience are required. Experience in the development of extension and/or classroom curricula related to bioprocessing, and a documented record of publishing and grant procurement on related topics are highly desirable, as are excellent interpersonal and communication skills. Preferred: Professional Engineering (PE) license.

Applications: Electronic submissions are encouraged. After initial screening, additional information may be requested. Initial screening and review of applications will begin immediately. However, applications will be received until a suitable candidate is selected. Applicants should send letter of interest, curriculum vita with 3 professional references, and educational transcripts to:

Search Committee Chair - Bioprocessing
University of Missouri, 215 Ag Engineering Building,
Columbia, MO 65211-5200
e-mail: RatliffDe@missouri.edu

Position Title: Extension Assistant Professor and State Extension Specialist, Manure Management and Air Quality

Position Description: This is a professional-track (non-tenure) extension position in the Division of Food Systems & Bioengineering. This person is a member of the University of Missouri Extension Commercial Agriculture (CA) program, which is funded by the state as part of the university base budget. The CA program develops and implements educational programs that assist Missouri livestock producers and related agri-businesses to increase production efficiencies, reduce impact on air and water quality, improve their competitive positions, and increase profitability. Primary responsibilities include development of programs related to manure and odor management for livestock operations, and membership in interdisciplinary CA Livestock Focus Teams for swine, dairy, beef, and environmental issues.

The successful candidate will lead Focus Team efforts addressing air emissions and odor control from livestock production, and development of environmentally and economically sound practices for animal waste management. In this effort, the specialist will develop appropriate educational programs and materials, conduct training, and provide technical assistance related to interdisciplinary systems in production management. Other team members include veterinarians, agricultural engineering and livestock housing specialists, agricultural economists, nutrient management specialists, and animal production specialists. The individual hired for this position will collaborate with University Extension Regional Specialists, government, and other agricultural industry partners, and report to the Commercial Agriculture Program Director and the Food Systems and Bioengineering Division Director.

Qualifications: Required: PhD or MS degree with comparable experience in biological systems engineering, agricultural engineering, or related fields. Required: Prior training in manure management and/or air quality and odor control at the graduate level (or equivalent experience). Required: Excellent interpersonal and communication skills. Preferred: Professional Engineering (PE) license, or the ability and necessary credentials to obtain PE license as soon as feasible after the initial date of employment.

Applications: Electronic submissions are encouraged. After initial screening, additional information may be requested. Initial screening and review of applications will begin immediately. However, applications will be received until a suitable candidate is selected. Applicants should send letter of interest, curriculum vita with 3 professional references, and educational transcripts to:

Search Committee Chair - Commercial Agriculture
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Take the agricultural engineering PE exam

Did you know that only 16 percent of the 485 agriculture-degreed engineers who registered to take the professional engineering exam took the agricultural engineering PE exam administered from October 2005 through October 2007? You may be scratching your head wondering, “What happened to the other 406 registered agricultural engineering examinees?”

Statistics from the National Council of Examiners for Engineering and Surveying show that 62 percent of the registered examinees with agricultural engineering degrees took some form of the civil engineering test, while 11 percent took the environmental engineering exam, and 6 percent took some form of the mechanical engineering exam. What does this mean for our profession?

In some ways, it places the profession in jeopardy because there is some potential that the exam may be discontinued.

What is keeping our engineers from taking our test? Some feel the test is too broad; others feel they have no help with which to study for the exam. However, in their college experience, our engineers often don’t realize that they don’t have to have a 70 percent to pass the test. Instead, this is a test of competency; one can excel in some areas and “not so much” in others — and still pass.

Over the last few years, the writing committee has focused on improving question selection to be appropriate for testing competency. Additionally, ASABE is addressing the content and breadth of the test. The test content goes through a review every six to eight years, and this process may result in redefining the test, making it more reflective of what our practicing engineers are doing in the world today, and narrowing the focus. ASABE has also produced a study guide and is constantly working to improve it. (In some ways, the study guide is more challenging than the exam! If one can master the study guide, then one should do extremely well on the actual exam!)

Some do better on the exam if they can find one-on-one guidance rather than going it alone. For this reason, ASABE has provided PE exam seminars at the ASABE annual meetings; however, the one-day sessions often did not cover all the material necessary, and individuals found it difficult to travel in order to receive such help.

ASABE heard member concerns and now provides on-line webinars to assist in preparing for the test. The webinars are live, online sessions presented by instructors from across the United States. Each two-hour session focuses on one of the topic areas of the exam. And better yet, it is free to those registered to take the exam. For more information about the webinars, visit www.asabe.org/pei/PEwebinar.html.

There is no greater honor in the field of engineering than being recognized by your peers as a professional engineer. As Jay Harmon, committee chair of ED-414 Engineering Licensure for ASABE, says, “Stand proud of your profession and sit for the exam, which says to the public, to state engineering boards, and to employers that our field is one of high standards. We’re a broad field … but we are capable of many things.”

Consider signing up today to take the agricultural engineering PE exam. Information about registering for the PE exam can be found at www.els-examreg.org/

ASABE member Sherry Hunt is YPS Publication Council Representative and a research hydraulic engineer, USDA-ARS, Stillwater, Okla., USA; sherry.hunt@ars.usda.gov.
These study aids can help ensure your success:

- Free webinar series — courses taught by subject matter experts
- Study guide with sample problems
- DVD set of a recent full-day PE Exam study workshop
- Reference books in the ASABE Online Technical Library; visit http://asae.frymulti.com

Webinar Series

Free, live, online sessions will be presented by instructors from across the United States. Each 2-hour segment will focus on one topic, providing basic refreshers on the range of topics addressed by the Agricultural Engineering PE Exam. Fundamental principles will be reviewed and example applications demonstrated in problems similar to those that might appear on the exam.

Participants must have at least a bachelor’s degree (or equivalent) in engineering, several years’ experience applying engineering principles, and some exposure to most of the topic areas on the exam. For more information on the webinar series visit www.asabe.org/pei/PEwebinar.html.

A Guide to Professional Licensure for Agricultural, Food and Biological Systems Engineers

This guide helps with typical questions surrounding the Principles and Practices Examination for Agricultural Engineers. You will find details on the licensure process, including qualifying and applying for the Principles and Practice (PE) Exam, preparing for the exam, exam format, what to expect on exam day, and more. Detailed solutions to 80 sample problems unique to agricultural and biological engineering are included. A 3-DVD set of the PE Exam workshop is included. To order, see www.asabe.org or call 800-606-2304.

**Book/DVD combo:** 84-page book (8 1/2 x 11 inches, spiral-bound) and DVD, Order No. C0405. Member: $35; List: $60.

**DVD only:** Order No. C0906. Member: $15; List: $23.

The webinar series and study guide are ongoing projects of the Professional Engineering Institute of ASABE (PEI).