November/December 2010

RESOURCE

Engineering & Technology for a Sustainable World

VISUAL CHALLENGE

Statements Without Words

PUBLISHED BY ASABE – AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS

from the President

Time for a Society Update

The first two months of my term as your president have been busy and exciting, so I thought it would be appropriate at this point to give you a quick update on several Society activities.

First, Darrin Drollinger, our new Executive Director, is settling into his position very nicely. I really like working with him, and I think he is off to a great start. Darrin is working on some key initiatives and has made a strong positive impact at headquarters. Long story short, we have chosen the right person to lead us into the future.

One of the first things that Darrin is tackling is the ASABE website. Many of you have expressed your concern about the quality of our site. Darrin was previously involved in the major rework of the AEM website, so he has knowledge and experience in this area. He has committed to having the revised ASABE website up and running by the annual meeting next year. To this end, he has appointed Jessica Stauffer, Executive Assistant to the Executive Director, to lead the project team. Jessica is excited about this new opportunity.

Secondly, Darrin has officially appointed Mark Zielke to serve as Senior Director of Finance, Meetings, and Human Resources. "Meetings" is added to his duties in human resources and finance. I think this is a great move, as Mark has been heavily involved in negotiating the financial contracts associated with our meetings. Mark will now be responsible for all aspects of our meetings and conferences, and he is charged with supporting the Meetings Council in their desire to hold specialty webinars.

Mark Crossley, Director of Membership, is working on using internet technology to support our drive for new members. By now everyone knows about the "Just One" campaign. I have challenged each of you to recruit just one more member. Talk up the benefits of being a member of ASABE and get that one more member signed up.

Dolores Landeck, Director of Public Affairs, and the E-07 committee are working with our partners in the American Institute for Medical and Biological Engineering (AIMBE) to develop a public policy agenda aimed at guiding the Society. Once set, this agenda will provide a framework that staff and the membership can use to educate legislators and public policy leaders on our goals and areas of expertise. This information will be combined with briefing papers and Capitol Hill visits to raise ASABE's profile and influence in the public policy arena.

There are many other important things going on in our Society, much more than I have room for here, and many people are working hard to support and improve our Society. If you have activities that you would like to share, or if you have any questions about Society activities, please feel free to contact me.

Ronald L. McAllister
ron.mcallister@cnh.com

events calendar

ASABE CONFERENCES AND INTERNATIONAL MEETINGS

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

2010

Nov. 14-17 **TMDL 2010: Watershed Management to Improve Water Quality.** Baltimore, Maryland, USA.

Dec. 5-8 **5th National Decennial Irrigation Conference.** Held in conjunction with Irrigation Show 2010. Phoenix, Arizona, USA.

2011

Jan. 5-7 **Agricultural Equipment Technology Conference.** Held in conjunction with AgConnect Expo 2011. Atlanta, Georgia, USA.

Aug. 7-10 **ASABE Annual International Meeting.** Louisville, Kentucky, USA.

Sept. 18-21 **International Symposium on Erosion and Landscape Evolution Conference.** Joint conference with AEG. Anchorage, Alaska, USA.

ASABE ENDORSED EVENTS

2011

Jan. 4-8 **SWAT-SEA 2.** Ho Chi Minh City, Vietnam. Contact Manuel R. Reyes, reyes@ncat.edu.

Jan. 17-19 **4th Annual ISAE Convention/International Symposium on Water for Agriculture.** Maharashtra, India. Contact Gajendra Singh, prof.gsingh@gmail.com.

March 2-4 **NFBA Frame Building Expo.** Indianapolis, Indiana, USA. Contact Dan Weinstock, dweinstock@nfba.org.

March 14-16 **BioPro Expo.** Atlanta, Georgia, USA. Visit www.bioproexpo.org.

April 18-20 **6th CIGR Section VI International Symposium: Towards a Sustainable Food Chain.** Nantes, France. Contact Da-Wen Sun, dawen.sun@ucd.ie.

Oct. 8-12 **2011 GSA Annual Meeting–Archean to Anthropocene.** Minneapolis, Minnesota, USA.

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Magazine Staff: Donna Hull, Publisher, hull@asabe.org; Sue Mitrovich, Managing Editor, mitro@asabe.org; Glenn Laing, Contributing Editor, laing@asabe.org; Melissa Miller, Professional Opportunities and Production Editor, miller@asabe.org; Sandy Rutter, Professional Listings, rutter@asabe.org.

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ON THE COVER

SPRAYING BACTERIA by Tye L. Lightfoot, Supervisory Engineering Technician USDA-ARS-Southwestern Cotton Ginning Research Laboratory Mesilla Park, New Mexico, tye.lightfoot@ars.usda.gov, submitted for Visual Challenge

Late-season insect pests can ruin the value of a cotton crop. They suck leaves' underside to mine protein from plant sap. Insects then excrete a sticky, sugary liquid, which accumulates on the exposed fiber. Even a small amount can impair the works at a spinning mill, causing shut down. To test a dry-powder product (consisting of bacteria that revives when mixed with warm water and eats insect sugars without harming cotton lint), application was done with a backpack sprayer.

American Society of Agricultural and Biological Engineers
2950 Niles Road
St. Joseph, MI 49085-9659, USA
269.429.0300, fax 269.429.3852
hq@asabe.org, www.asabe.org

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FEATURES

UPDATE

DEPARTMENTS

A recent article in *Resource* magazine suggests that test results from the Nebraska Tractor Test Laboratory (NTTL) show one manufacturer's series of tractors to be more fuel efficient than other tractors in this category. Nebraska Tractor Test reports contain a wide variety of tractor performance data, and statements of the type made can be made for many series of tractors by selectively choosing the data on which to make the comparison.

As the Director of the NTTL, I have several comments about NTTL test reports and testing practices.

First, the NTTL does not and will not endorse any tractor or tractor manufacturer. Our mission is to provide useful unbiased data in the form of test reports on all tractors that we test. We also translate tractor reports for tractors tested at other Organization for Economic Cooperation and Development testing stations into a similar format to allow easy comparisons to be made. The testing location is always reported, so it is a simple matter to see where a tractor was tested.

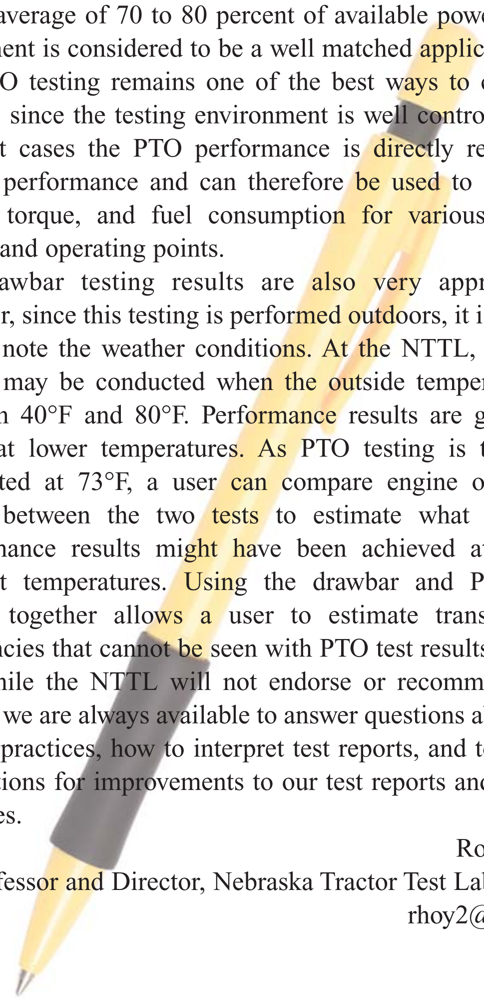
Second, we do not endorse the practice of picking out only certain data from test reports. We believe that viewing and considering the entire test report is the best way to evaluate a tractor.

Third, tractors are used in a variety of different applications. Considering how a tractor will be used along with the test report is important when judging a tractor's suitability and expected operating costs.

Fourth, all costs should be considered when judging operating costs. As new emission regulations take effect, we will see more tractors that consume diesel exhaust fluid (DEF). Our experience to date, which is limited, suggests that DEF will be used at rates of around 2 to 5 percent of the fuel rate, so this cost should also be considered along with fuel costs. Next year, Nebraska Tractor Test reports will include data on DEF usage during the PTO test, as we do today with fuel. Regenerating particulate filters may occasionally ignite diesel fuel in the exhaust manifold to raise exhaust gas temperatures to convert the collected soot to ash. We plan to provide information about this use of fuel in our reports as well.

Finally, NTTL reports include specific fuel consumption information (reported as hp-hr/gal and as lbs/hp-hr) for each measured operating point. For our cars, miles per gallon is one way of expressing efficiency, as efficiency is commonly determined as the desired output (miles traveled) divided by the input necessary to achieve that output (gallons of fuel). For tractors, the desired output is work done, typically determined as power output multiplied by the time over which that power was delivered (hp-hr). As with cars, the input is typically represented by the amount of fuel (gal or lb) burned to accomplish that work.

Specific fuel consumption (in hp-hr/gal) for a specific operating point is obtained by dividing the power output (hp) by the fuel consumption (gal/hr). Specific fuel consumption provides one method of comparing tractors with different power levels; however, it is important to choose appropriate operating points when comparing two or more tractors. Comparisons of specific fuel consumption at maximum power are normally not a good choice, as it is rare for tractors used in agriculture to deliver maximum power continuously. For most PTO and drawbar applications, a tractor that delivers an average of 70 to 80 percent of available power to the implement is considered to be a well matched application.



PTO testing remains one of the best ways to compare tractors since the testing environment is well controlled and in most cases the PTO performance is directly related to engine performance and can therefore be used to estimate power, torque, and fuel consumption for various engine speeds and operating points.

Drawbar testing results are also very appropriate; however, since this testing is performed outdoors, it is important to note the weather conditions. At the NTTL, drawbar testing may be conducted when the outside temperature is between 40°F and 80°F. Performance results are generally better at lower temperatures. As PTO testing is typically conducted at 73°F, a user can compare engine operating points between the two tests to estimate what drawbar performance results might have been achieved at higher ambient temperatures. Using the drawbar and PTO test results together allows a user to estimate transmission efficiencies that cannot be seen with PTO test results alone.

While the NTTL will not endorse or recommend any tractor, we are always available to answer questions about our testing practices, how to interpret test reports, and to accept suggestions for improvements to our test reports and testing practices.

Roger Hoy
Professor and Director, Nebraska Tractor Test Laboratory
rhoy2@unl.edu

Freezing Instead of Drying High-Moisture Corn

A system design

Steven Eckhoff

Corn stover can be more effectively utilized as an animal feed if it's collected before in-field dry-down. At corn kernel moisture contents of 35% and above, the stover is not fully lignified, making it easier to digest, both in ruminant animals and in biomass conversion to ethanol. Larry Berger at the University of Nebraska has shown that the digestibility of corn stover collected at physiological maturity had twice the digestibility of stover collected after in-field dry-down. When the stover was mixed with dried distillers grains with solubles (DDGS) from corn ethanol refineries, the combination was almost as nutritious as whole corn. While it would be beneficial to utilize wet stover as an animal feed, the question of what to do with high-moisture corn remains.

The first thought is to dry the corn using conventional commercial drying technology, but drying corn from 35% or 40% moisture using air temperatures above 70°C is both energy intensive and damaging to the corn. Drying at temperatures in the range of 70°C requires approximately 1400 Btu per pound (Btu/lb) of water removed, resulting in using 24,724 Btu per bushel (Btu/bu), which is over 29% of the higher heating value (HHV) of ethanol.

Alternatively, the high-moisture corn could be frozen to prevent microbial deterioration. After all, frozen foods rarely spoil. The key is keeping it frozen. By storing the frozen corn in a large insulated pile, it is conceivable that, like a large block of ice, the edges will begin to thaw but the thermal mass will maintain a frozen state. If the edges of the corn pile could be periodically refrozen, then the entire corn mass could be preserved. Because the latent heat of fusion is 144 Btu/lb, compared to the latent heat of vaporization of water, which is 970 Btu/lb, there is an opportunity to save energy by freezing (see below). To adequately utilize freezing as a storage technique, we must address the high cost of commercial freezers, the length of the desired harvest period, and the reliability of the freezing system.

Energy needed to freeze corn

A bushel of corn at 14.5% moisture has 47.88 lbs of dry matter and 8.12 lbs of water. An equivalent bushel at 35% moisture has 25.78 lbs of water. To freeze all that water will require: 25.78 lb × 144 Btu/lb = 3,712 Btu/bu.

The specific heat of water is 1.0 Btu/lb, that of ice is 0.5 Btu/lb, and that of shelled corn is 0.48 Btu/lb, so in cooling from 90°F to -10°F, the amount of heat removed is:

90°F - 32°F × 1 Btu/lb × 25.78 lb/bu =	1,495Btu/bu
32°F - (-10°F) × 0.5 Btu/lb × 25.78 lb/bu =	541 Btu/bu
100°F × 0.486 Btu/lb × 47.88 lb/bu =	2,688 Btu/bu
Total specific heat =	4,724 Btu/bu
Total latent heat =	3,712 Btu/bu
Total heat =	8,436 Btu/bu

Increasing the harvest period and field-to-fermenter harvesting

The cost of commercial freezers dictates that the harvest time be extended as long as possible. One way to extend the harvest time is to use shorter-season hybrids to allow for an earlier start and to stagger production so that maturity occurs over an extended period. Normally, in central Illinois, corn producers use 110- to 120-day hybrids, so-called full-season hybrids, which maximize yield potential. However, the use of 80-day hybrids in central Illinois may allow for double-cropping of corn. Double-cropping is not used in this area, generally because there are too little heating degree days. However, a recent study of the last ten years' heating degree days showed that 80-day hybrids harvested at 35% to 40% moisture content will allow for double-cropping of corn as far north as northern Illinois. Irrigation may be necessary in some areas to ensure a second crop.

There are few data on growing short-season hybrids in Illinois. A 2007 study looked at nine short-season hybrids ranging from 90 to 99 days and seven mid-season hybrids ranging from 100 to 105 days and compared them to two popular full-season hybrids: Pioneer 32R25 (116 days) and Syngenta N79-L3Bt (118 days). The researchers found that the average yield loss in growing the short-season hybrids in warmer environments was only 12.3%. The five mid-season hybrids fared better, with an average yield reduction of only 5%. Yield is not affected by dry-down. In fact, unpublished data have shown that the dry weight of corn stalks and attached leaves decreases by approximately one third during the dry-down period, as shown in figure 1 (moisture content is shown in figure 2), but dry matter is constant for the corn grain after reaching 40% moisture.

The potential for increasing the amount of ethanol produced on an acre of corn is tremendous. Assuming that full-season corn yields 220 bu/acre (in central Illinois), then an 80 to 90 day hybrid would yield 193 bu/acre during the first crop. Few data are available on how the second crop of corn will yield, but at least one Nebraska farmer has reportedly attempted double-cropping corn (behind wheat) and has been successful. His yields varied from 139 to 179 bu/acre. Based on these data, total per acre yields of 300 to 400 bushels look possible. Only part of the grown corn will be double-cropped, as a continuous supply of freshly harvested high-moisture corn will be needed over a four-month period. Figure 3 shows a production and harvest timeline suggesting that five months of harvesting may be possible. Double-cropping of corn may be able to supply 2.5 to 3 months of the just-in-time delivery of high-moisture corn.

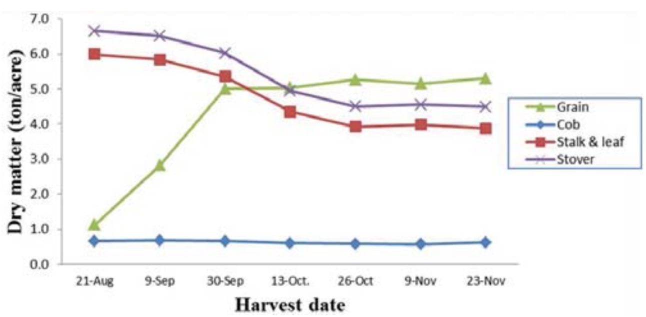


Figure. 1. Dry matter of corn grain and various stover fractions at seven harvest dates.

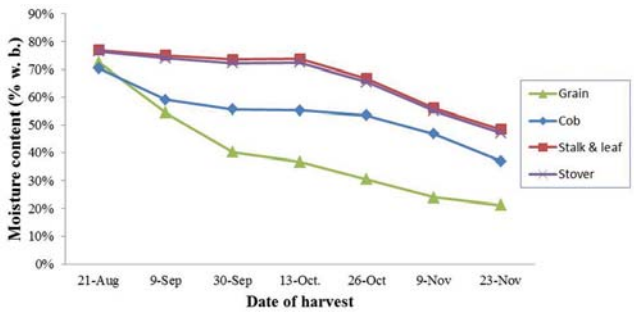


Figure. 2. Moisture content of corn grain and various stover fractions at seven harvest dates.

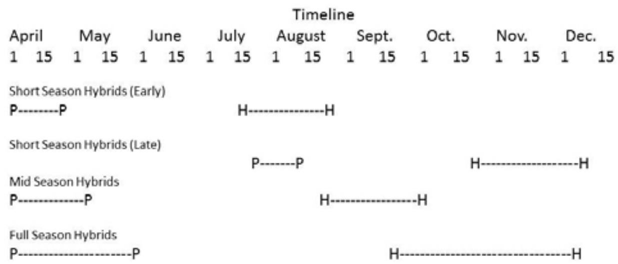


Figure 3. A proposed timeline for planting and harvesting to provide for five months of corn harvest.

Corn harvested fresh will save $0.35 to $0.90 per bushel in drying costs. It will also reduce water demand by the ethanol refinery. To increase energy efficiency, the heat from the corn freezers can be used to dry one-third of the corn, and corn stover can be burned to supply additional heat. The frozen corn can be used to supply cooling for the refinery.

Proof-of-concept system design

To show the economic viability of this concept, a system design for a 100 million gallon per year corn ethanol refinery was undertaken. A 100 million gallon per year ethanol plant will consume 36.36 million bushels per year of corn, or 103,900 bushels per day.

By the dividing the corn supply across 12 storage and processing sites, each site will process and store three million bushels: one million bushels of frozen corn, one million bushels of dried corn, and one million bushels of corn that goes directly from the field to the ethanol plant. Freezing of the corn will be done using mechanical refrigeration equipment and commercial freezers. The size of the freezers depends on the rate of harvest and the capacity needs of the ethanol plant.

The number of acres needed per site can be calculated as: 3 million bushels / 220 bushels per acre = 13,636 acres. If double-cropped corn accounts for two months of the just-in-time corn, then the number of acres can be decreased. Depending on the size of the producers, each site will accommodate 8 to 15 producers. The 12 sites have to be within trucking distance to the ethanol plant. A practical trucking distance would be 30 miles (optimally, facilities will be about 15 miles from the plant). This is an area of 2,826 square miles, or 1,808,640 acres, of which 180,000 acres, or 10% of the total surface area, will be needed with no double-cropping. With double-cropping, the percent coverage will be reduced to 7.8% of the total acres. Realistically, with 15% of the surface given to non-cropland uses and a 60-40 corn soybean split, 19.5% of the corn acres in the area will be needed without double-cropping and only 15.3% will be needed with double-cropping. Increasing the area utilization factor (AUF), which is the maximum density of acres used in an area, will decrease the cost of transporting corn to the processing site.

Practical harvesting scenario

The producer has to harvest at a rate that feeds the plant high-moisture corn and also feeds the freezer and dryer. The timeline in figure 3 shows the harvest spreading out to over five months. However, after November 15, central Illinois can be hit with snowstorms, so a five-month harvest period is not going to be possible every year. If we harvest wet corn starting on July 15 and finish harvesting wet corn on November 15, then there are fully four months, or 120 days, for harvesting. On the average, bad weather will affect seven days per month from July through October, so that leaves 92 good harvesting days to bring in a whole year's crop. Ninety-two days × 20 working hours per day = 1840 hours. So we need a combine capable of harvesting 1,630 bushels per hour, or 8 acres per hour, which can be achieved by most modern corn combines. If there are 8 to 15 producers, then the number of combines required among them can be reduced from 15 or 30 combines to 4 or 5. This could be a tremendous savings for the producers.

Harvesting must be done at a higher rate than freezing because the freezing system can operate 24 hours a day, seven days a week. As the harvesting gets ahead of the freezing system, a part of the refrigeration can be diverted to cool the incoming 35% to 40% moisture corn. If this incoming corn can be cooled to 40°F or 50°F, it will have a storability of 2 or 3 days. The freezing system should be designed to cool all incoming corn to 45°F. Since the corn, once it's cooled, will not likely warm up appreciably, there should be no appreciable increase in cooling demand. Assuming the freezer can be kept busy, we would need to freeze at a rate of 1.0 million bushels / 120 days / 24 hours per day = 347 bu/h. The refrigeration system must be able to freeze 347 bu/h × 78 lb/bu = 27,066 lb/h of wet corn. Energy use is 347 bu/h × 8436 Btu/bu = 2,927,292 Btu/h = 244 ton/h. To have some reserve capacity, we increase the design demand to 254 ton/h.

Energy used to dry corn

To dry corn from 35% to 23%, the system has to remove 11.48 lb of moisture per bushel, which requires 11.48 lb/bu × 1,400 Btu/lb = 16,072 Btu/bu. The total energy needed = 347 bu/h × 16,072 Btu/bu = 5,576,984 Btu/h.

This is 59% more than we generate with the refrigeration system (see next section), so we need an additional 2,068,821 Btu/h. At $7.00 per million Btu for natural gas, the cost is an additional $0.042 per bushel.

For this example, we'll assume that the dryer is a Sukup T16 dryer with 450 bu/h capacity at a 10% moisture differential. This dryer has a 20 hp (14.9 kW) three-phase fan. If it dries 347 bu/h, then the cost of the fan is 14.9 kWh × $0.09 per kWh = $1.34 per 347 bushel = $0.004 per bushel. The 23% moisture corn will be transferred hot into fifteen 72 ft diameter drying bins, allowed to temper, then cooled, and layer dried. Low-temperature drying costs about $0.03 per percentage point, so to dry the corn from 23% moisture to 15% moisture will cost $0.24 per bushel.

On the average, we freeze one million bushels (at $0.22 per bushel), dry one million bushels (at $0.28 per bushel), and one million bushels are delivered direct, for a total average energy cost of $0.17 per bushel.

Frozen corn storage

Figures 4 and 5 show the general layout of a frozen corn storage facility. The bunker silos are designed to hold a total of one million bushel of frozen corn. There are four such silos, sharing common walls. Each silo is 30 ft deep, 275 ft

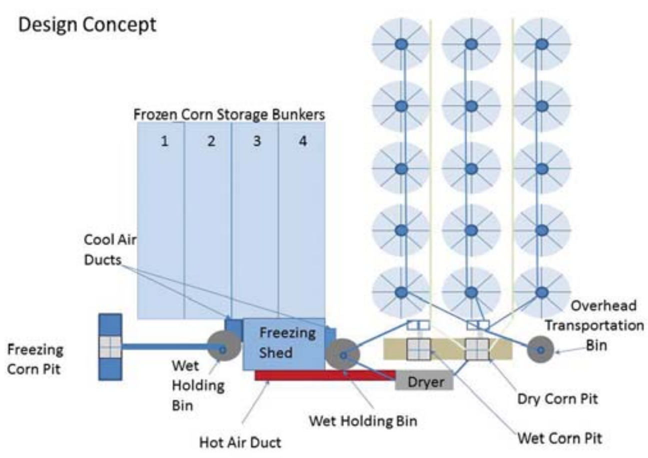


Figure 4. Layout of a 3 million bushel corn accumulation and processing center.

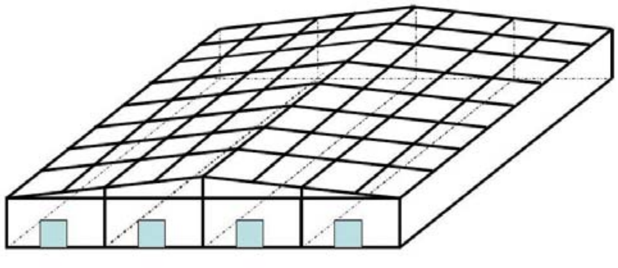


Figure 5. Frozen corn storage facility.

long, and 50 ft wide, for a total volume (not counting any mounding) of 412,500 ft^3 per silo × 4 silos = 1.65 million ft^3 of frozen corn. At a density of 1.4 ft^3/bu, this equals 1,178,714 bushels.

One end of the bunker has doors that allow entrance into the silos. The silos are insulated on all sides with 4 to 6 inches of polyurethane foam. The top of the bunker is a metal superstructure that holds insulated panels and sheds water. Frozen corn is pneumatically conveyed from the refrigeration center into the storage bunker. A portable pneumatic conveyor can be used to remove frozen corn from the bunker.

Refreezing option

A pipe distribution system will be implemented along the walls for circulating liquid CO_2 or liquid nitrogen to cool the edges of the thermal mass. A computer simulation model of the system has been developed. Results showed that the frozen corn can be stored for a year with only the outer 2 feet needing to be refrozen. Each time the corn is refrozen, approximately 91,000 lbs (45.5 tons) of CO_2 will be required. At a cost of $0.10 per lb, this is $9,100 per event. Assuming that six treatments will be needed per year, the cost of the procedure is $54,650 per year. This translates to an additional charge of $0.05 per bushel. Amortized over the 3 million bushels, the amount becomes $0.03 per bushel.

Basic economics

The viability of the proposed system can be evaluated by performing some simple economic comparisons. Excessive capital costs could limit the practicality of the system and can even make the system fail.

Capital costs per bushel: Assuming that the system can be amortized over the whole 3 million bushels produced, then $5,803,875 / 3 million bushels = $1.93 per bushel. Assuming that the system can only be amortized over the 2 million bushels processed with it, then $5,803,875 / 2 million bushels = $2.90 per bushel.

Cost of capital: The cost of capital is the amount of money that needs to be returned to investors to keep the investors happy. Ethanol refinery investors want to average 20% to 30% return on investment (ROI), but corn producers are more likely to receive 15% ROI. The average Iowa corn farmer has a long-term ROI of approximately 6% to 8%, although progressive farmers may achieve 10% to 15% ROI. Assuming a 15% ROI and amortizing across the 3 million bushels yields the cost of capital: 0.15 × $5,803,815 = $891,581, and $891,581 / 3 million bushels = $0.29 per bushel. Add to this the cost of energy and the cost of refreezing for a total processing cost of $0.49 per bushel.

Cost comparison of drying to freezing: The cost of the freezing system is $3,131,305, and the cost of the drying system is $2,672,510. Treating each separately by assuming that 2/3 of the corn will be frozen and 1/3 will be just-in-time, the cost of capital for doubling the freezing system is $0.31 per bushel, with $0.15 per bushel average energy cost plus $0.03 per bushel refreezing cost, for a total cost of $0.49 per bushel. For drying, the cost of capital is $0.27 per bushel, with an average $0.19 per bushel energy cost, for a total cost of $0.46 per bushel. Drying looks less expensive, but if the freezing is not done, then approximately another $0.04 to $0.05 per bushel of natural gas energy will be needed for drying. In addition, freezing may be less capital intensive if two or more backup compressors are maintained for the twelve accumulation and processing sites instead of two for each site as currently projected. This could shave $300,000 off the capital cost of the freezing system for each site, which would decrease the capital cost by $0.03 per bushel.

Advantages and disadvantages of freezing

If the producers make the investment in the storage and processing sites, they will need to have a solid contractual agreement with the ethanol refinery to buy their corn. The agreement needs to be beneficial to both parties, and it should account for all the savings for both parties. It is imperative that the corn be priced on a dry solids basis and not on any arbitrary moisture basis. The corn must not be docked for excess moisture.

The advantages to the producers are:

- The producers don't have to dry the corn going into the freezer or direct to the refinery, which could cost as much as $0.55 per bushel if it were to be elevator dried. At a minimum, the producers would save storage costs for the corn going directly to the processor, estimated at $0.10 to $0.30 per bushel.
- The producers have less handling costs because the corn never goes into storage or drying.
- The producers use the equipment that they own more efficiently, covering more acres with the same machine per year.

- The producers can get by with smaller equipment and less equipment on the same acreage.
- Potentially, the producers can double-crop corn if they used short-season hybrids. Estimates are that they may increase total corn production by 50% to 75%. This could more than double their profits.
- Double-cropping, use of hybrids of various season lengths, and lengthening the harvest spreads out the work load over a longer period of time.
- The longer planting window and the spreading out of the pollination period decreases the producers' weather risk.

The advantages to the corn ethanol refinery are:

- The refinery won't need corn buyers.
- The refinery can dictate the hybrids that the producers grow in order to minimize variability.
- The refinery will need less water.
- The frozen corn can be used as a heat sink for the refinery process.
- Just-in-time delivery to the refinery means that on-site storage can be reduced to 1 or 2 days run. Savings of approximately $0.12 per bushel in capital cost and $0.03 per bushel in operational costs are possible.

There is also a disadvantage for the refinery. The refinery needs to be designed to accommodate dry, wet, and frozen corn. These represent three different raw material forms, so it will be difficult to baseline the plant for more than four months.

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In summary

This preliminary assessment of freezing as an alternative to drying indicates that freezing may be a way to preserve high-moisture corn so that minimally lignified corn stover or corn stalks can be harvested for animal feed or conversion into ethanol. The system has not been optimized for refinery size, number of storage faculties, or ratio of frozen corn to dry corn. The proposed system would freeze one-third of the corn, dry one-third of the corn, and just-in-time deliver one-third of the corn. There does not seem to be any major downside to the corn producers, and there may be significant benefits for both the producers and the ethanol refinery, but the refinery will need to be designed to accommodate dry, wet, and frozen corn.

ASABE member Steven Eckhoff is a professor in the Department of Agricultural and Biological Engineering, University of Illinois at Urbana-Champaign, Urbana, USA; seckhoff@illinois.edu.

For further reading

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DDGS

The least talked about story in corn ethanol production

Klein Ileleji

The Renewable Fuel Association (RFA) 2009 Ethanol Industry Outlook estimated that about 25 million megatonnes (Mt), or 27.5 million tons, of dried distillers grains with solubles (DDGS) were produced in the United States in 2008-2009. DDGS is a high-nutrient feed, consisting of the unfermentable components of the corn kernel (protein, fiber, fat, ash, and minerals) after the corn starch has been extracted by fermentation during ethanol manufacturing using the dry-grind process. About 80 percent of ethanol produced in the United States uses the dry-grind process. From a bushel of corn, one-third is converted to ethanol, one-third to DDGS, and one-third to carbon dioxide.

Corn ethanol is one of the two most popular biofuels in the United States today, and one that has attracted much controversy, primarily related to the food-versus-fuel debate and the sustainability of using corn to meet the U.S. Energy Independence and Security Act (EISA) 2007 mandate. The EISA mandate stipulates the ethanol fuel supply for liquid transportation at 36 billion gal (136.3 billion L) per year by 2022, of which 15 billion gal (56.8 billion L) is from corn feedstocks. This has caused the utilization of corn for fuel ethanol to increase exponentially, peaking at 2.2 billion bushels (55.5 million Mt) in 2007-2008. This constitutes only 15.4 percent of the total U.S. corn supply, leaving about 12.2 billion bushels of corn (303.8 million Mt) available for other uses. At the same time, the use of whole corn as livestock feed is decreasing, as corn is being replaced by DDGS.

While most ethanol plants are seen by the public as only fuel ethanol plants, the least talked about story in the biofuels industry is how ethanol coproducts are increasingly being included in livestock diets, replacing corn and soybean meal as major feed ingredients. So, not only does your car consume ethanol, chances are that some of the protein on your dinner table is from a fuel ethanol plant, too. This message needs to be told to the public, so that the food-versus-fuel debate can be put in the right perspective.

The use of manual labor to unload a railcar caked-up with DDGS is not only time consuming and expensive, but it is also risky.

Challenging beginnings

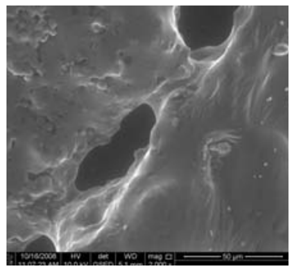
The exponential growth in fuel ethanol production in the last few years has brought some attention to the increased supply of DDGS. However, the stories about DDGS have not been glamorous. The variable quality of DDGS has been one of the primary concerns of livestock nutritionists, who are finding it challenging to increase DDGS levels in livestock feed rations and still maintain carcass quality and weight gain. Since DDGS is a commodity, ensuring its consistent quality would increase product acceptability and benefit the industry as a whole. So far, only a few producers have attempted to differentiate their product in the market, such as Dakota Gold sold by POET Nutrition.

Another major issue is the challenges that merchandisers face in handling DDGS. In particular, DDGS has a tendency to cake up when it is transported in bulk, which makes unloading DDGS from hoppers or containers difficult and expensive. In fact, two major Class A carriers have made it their policy not to carry DDGS because of the damage incurred to their hopper cars by aggressive handling when the cars were being unloaded. In addition, the difficulties encountered in unloading railcars cause turnaround delays, making transportation relatively more expensive, which can make DDGS unattractive to potential end users. Other logistics-related issues have also arisen, such as low or variable bulk density during loading and particle segregation in handling. Variable density can impact the cost when less material per volume is shipped, and particle segregation affects the product quality. These issues have created a rough beginning for DDGS, and the negative attributes of this product have tainted its prospects. Thus, the positive aspects of DDGS remain another one of the untold stories of how the corn ethanol industry is both fueling and feeding America.

Breaking barriers through research

Research by industry, government, and universities is providing new insights into how to efficiently produce, handle, transport, and feed this high-nutrient coproduct to livestock, including beef and dairy cattle, poultry, swine, and aquaculture. A few breakthroughs have occurred recently in the quality and handling of DDGS as a result of research by agricultural and biological engineers at Purdue University, and some impressive work is being done by engineers and scientist at other U.S. land-grant universities and USDA-ARS labs.

Research at Purdue has confirmed the major causes of DDGS variability in the industry and also quantified the factors that result in nutrient variability during DDGS production. This published work (Kingsly et al., 2010, see For Further Reading) describes how process variables affect both the physical properties (particle size, particle size distribution, particle density, bulk density, and color) and the chemical properties (protein, fat, fiber, glycerol, ash, and essential amino acids) of DDGS. The bottom line is that DDGS quality can be controlled in the production process. In related studies, the moisture sorption profiles of DDGS, which vary chemically, were both experimentally developed (Kingsly and Ileleji, 2009a) and modeled by artificial neural networks (ANN) using the chemical composition of DDGS (Kingsly and Ileleji, 2009b). The ANN method showed the relative importance of the various chemical components in the caking process. This study will help in predicting the potential for a given DDGS product to cake during transport given the prevailing environmental conditions, and thus aid in logistics planning.



Liquid bridging formation between two DDGS particles observed under ESEM in a humidifying condition at 95% RH and 5°C.

Current studies of single-particle imaging using environmental scanning electron microscopy (ESEM) to observe the evolution of liquid bridging, which leads to bulk caking, will provide fundamental insight into the caking process and help provide innovative solutions. Two recent research breakthroughs have involved the contributions of particle segregation to nutrient and bulk density variability, and the results were recently published (Clementson et al., 2009, and Clementson and Ileleji, 2010). The former study stresses the importance of appropriate sampling of DDGS piles for accurate chemical composition determination, while the latter study provides insight into why the bulk density of DDGS can vary during loading of railcar hoppers. Finally, a method to densify DDGS into spherical granules of high bulk density and uniform nutrient composition (provisional U.S. Patent No. 65095.P1.US) has been developed at Purdue University. These spherical granules of DDGS are designed to have improved flow characteristics and could potentially be used as biobased carriers for the dispersal of chemical and biological molecules. Ongoing studies at Purdue are targeting these end uses.

Spherical granules of DDGS produced using drum agglomeration.

It's more than just ethanol

We need to raise the awareness of the feed coproducts of the ethanol fuel industry. DDGS has grown from a product that was once considered waste, and that had to be disposed off, to a valued commodity that contributes up to 20 percent of the income stream of corn ethanol plants depending on the cost of corn and petroleum. Yet many still do not realize that this golden brown, granular, high-protein feed is a product of ethanol manufacturing. While the food-versus-fuel debate has put the U.S. fuel ethanol industry at odds with some groups, especially in the developing world, little has been said in the industry's defense with respect to the feed value delivered in DDGS when ethanol is manufactured from corn. In fact, it would be technically correct to classify fuel ethanol plants as fuel and feed plants, because they really produce both.

Research is underway to increase the levels of DDGS and its utilization efficiency in the diet rations of various livestock species. These species are the source of the protein that ends up on our tables. Likewise, researchers are working to resolve the various logistical barriers to lower transportation costs and make DDGS more marketable and competitive with other ingredients. However, to date, these research efforts have not benefited from national support by federal granting agencies, and thus breakthroughs have been slow in coming. The national focus on producing liquid transportation fuels from non-food feedstocks, while ignoring the value-added feed coproducts that could help the productivity of this evolving industry, has not helped to raise the awareness of DDGS. As a result, only a few researchers in U.S. land-grant institutions and USDA-ARS labs are working on the challenges of utilizing DDGS. A recent interdisciplinary study at Purdue (funded by the Indiana State Department of Agriculture, Purdue, and The Andersons, Inc.) demonstrated how research in DDGS production, handling, and feeding, including the environmental impact of manure from livestock fed with DDGS, could create a holistic approach to efficient utilization of this ethanol coproduct. Increasing funding in this area would provide a huge economic benefit to the industry and an environmental benefit to society.

> ... the real success of **corn ethanol** will not depend on how well corn ethanol does as a **fuel,** but on how well its **coproduct,** DDGS, does as a **feed.**

Using lab-scale studies, Klein Ileleji, the author, and Purdue's researchers were able to control and understand how process variables affected DDGS properties. (*Photo by Tom Campbell, courtesy of Purdue Agricultural Communication*)

While the debate and wisdom of using a food crop, such as corn, for biofuel will be discussed for many years to come, the real success of corn ethanol will not depend on how well corn ethanol does as a fuel, but on how well its coproduct, DDGS, does as a feed. After all, the way to a man's heart is through his stomach.

ASABE member Klein Ileleji is an associate professor and extension engineer in the Department of Agricultural and Biological Engineering, Purdue University, West Lafayette, Ind., USA; ileleji@purdue.edu.

For further reading

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Farming on Urban Land

How agriculture can remake Detroit

Mike Score

Photo supplied by Hantz Farms.

If you haven't been to Detroit, Mich., lately, you probably cannot imagine the city's current condition. While Detroit was once a world leader in industry and manufacturing, it has long since fallen on hard times. Detroit's population, which peaked near 1.8 million in the 1950s, is now listed at around 800,000. Fifty-five percent of the city's population lives below the poverty level. Forty of the city's 139 square miles have become tax-foreclosed properties. Abandoned buildings fill entire city blocks. Vacant land is abundant. Property values are plummeting. Buyers show no interest in Detroit real estate. And the costs of urban services continue to rise for the remaining residents.

John Hantz, a successful entrepreneur, is a long-time resident of the city of Detroit. His love for the city, and his hope that Detroit could become more livable, led him to search for some way he could contribute to reshaping the city's landscape and economy. Specifically, Hantz's interests are in creating a sense of scarcity, and thereby increasing the value, of the vacant land within Detroit's urban boundaries. Hantz plans to invest up to $30 million over ten years to help put foreclosed properties back on the tax rolls and clean up blight. In making this investment, Hantz wants to pursue new land uses to carry the investment forward without creating a drain on the invested capital. After considering various potential business ventures that line up with these investment objectives, he selected the creation of a large-scale urban farm.

With limited background in agricultural production, Hantz turned to Michigan State University and the Kellogg Foundation for advice and technical support. Through these sources, a business plan for a viable farm venture was developed. The business plan accounted for the variability of urban soils, potential soil contamination issues associated with urban environments, the need to fit farms between the remaining urban residences, and the realities of producing farm goods using methods that allow the urban infrastructure to remain in place.

Over the past two years, dozens of production plans and associated financial models have been created to determine potential farm performance on several prospective sites. These models consistently suggest that once the one-time startup costs are accounted for, a Detroit farm venture should provide a modest 2 to 5 percent return on equity. In business terms, this level of return is very modest. It certainly is not investment grade. However, Hantz's interest in contributing to the revitalization of Detroit's economy, making neighborhoods more livable, and exploring innovation through involvement in a new industry have allowed him, and the 600 employees of the Hantz Group, to defy conventional business decision-making processes and pursue this vision.

© Mitchell Barutha/Dreamstime.com

From this ....

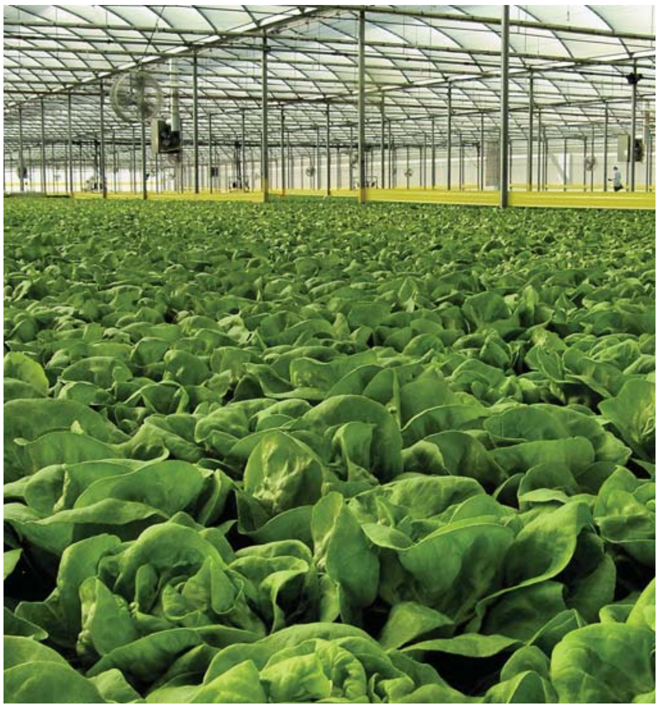
As the planning process moved forward, it became clear that establishing a farm production center creates other platforms through which financial performance can be improved. A farm within an urban area transforms blighted areas into livable neighborhoods, which attract tax-paying residents. The farm itself becomes an education and tourism destination where natural beauty can be enjoyed and where consumers can strengthen their connection to food production and the agricultural ecosystem. And additional business enterprises that depend on the farm can increase the net income for the overall farm operation.

A model for the global future

Hantz's plan to reshape Detroit's economy and redeploy underutilized land resources has captured the world's attention. Global population forecasts suggest that by 2050 the world will have a total population approaching 9 billion. At that point, it is also projected that 70 percent of the population will live in urban centers. In other words, the urban population in 2050 will equal the world's current population, and we will need to produce more food using no more resources than are currently consumed by the agriculture and food industries. As businesses plan for these dramatic changes, the food industry has identified a need for a global innovation center for urban agriculture. Such a center would teach us how to produce fresh, healthy food in reclaimed urban environments and how to integrate urban farm products into transportation and distribution centers.

Leaders from around the world have evaluated different cities, looking for the optimal location for such an urban agriculture hub. In a contest like that, Detroit's liabilities suddenly become assets. Expansive areas of vacant land, a readily available workforce, restructured wages, and new political leadership make Detroit the best choice for a global innovation center for urban agriculture. Unlike some other candidate cities, Detroit has an excellent, underutilized transportation and communication infrastructure. In addition, Michigan State University, one of the world's premier land grant research and education institutions, is nearby and keenly interested in partnering with regional leaders to pursue urban agriculture.

The required capital is in place. Local communities are supportive. Political leadership is indicating that there is room in Detroit's economy for this new global industry. Food system and agribusiness corporations are embracing Detroit as a logical starting point for research and product development related to urban agriculture.



... to this.

But there's still work to do

Farm enterprises are inspired by imagination, but they are shaped by current realities. For example, there is interest in exploring the advantages and possibilities of vertical agriculture, but initially most production will use systems similar to more conventional horizontal models. Roads and buried infrastructure will be left in place, and the farm will work around them. Hantz Farms is interested in site planning that will result in zero net stormwater discharge. Discussions are underway that could result in partnerships with alternative energy companies interested in demonstrating how renewable energy can offset or reduce dependence on conventional energy sources. As new levels of innovation are achieved, there will be new models for what urban agriculture can achieve.

Hantz Farms is not a perfect venture. Most concerns shared with Hantz Farms management center around the realization that large-scale urban agriculture introduces change and unknown outcomes. Still, the residents of areas targeted for establishing a proof-of-concept site are overwhelmingly supportive of this new approach to resource management. More than 90 percent of area residents directly affected by the proposed farm have signed petitions encouraging city leaders to allow the farm to move forward. Supporters envision safer, more livable communities. They look forward to a transition from blight to beauty. They expect the limited number of initial jobs to expand with the farm's success.

A successful farm venture will allow Detroit to start over, and to recast its image in the global marketplace—from an obsolete industrial center to a model for economic health and long-term sustainability. Detroit could be a world leader once again.

Mike Score is president of Hantz Farms LLC, Detroit, Mich., USA. Previously, he served as an agricultural educator and counselor with the Michigan State University Product Center for Agriculture and Natural Resources; contact@hantzfarmsdetroit.com. The Hantz Farms website is available at www.hantzfarmsdetroit.com.

IMAGES of AGRICULTURAL and BIOLOGICAL ENGINEERING

VISUAL CHALLENGE

To call attention to and celebrate the visual aspects of agricultural and biological engineering, two issues ago *Resource* asked readers to submit examples of their work in visual form. The goal was to illustrate what agricultural and biological engineering is all about, to show the world "this is what we do."

That opportunity must have appealed to our readers because we received more entries than we can publish here, although we'd like to publish them all. On the following pages, we are delighted to present the best entries received for the Agricultural and Biological Engineering Visual Challenge. As you can see, the images range widely in scale and subject matter, which underscores the diversity of this profession.

Congratulations to all the contributors, and our sincere thanks to each of you for your entry, for your work, for your visual imagination!

Season's greetings from ASABE's *Resource* staff, and may the new year bring you more beautiful images.

Photographer: JIM DOOLEY

President, Forest Concepts, LLC, Auburn, Wash., USA; ASABE past president

FORESTRY TRIO

Title, top left: EMERGING LOBLOLLY

Subject: Loblolly pine tree germinating in forest nursery at Magnolia, Ark. Seed was planted with precision seeder.

Title, top right: BALER COMPLEXITY

Subject: Woody biomass baler hydraulic controls.

Title, immediate left: BALING BRUSH

Subject: Baling urban brush and trimmings for shipment to bioenergy facility.

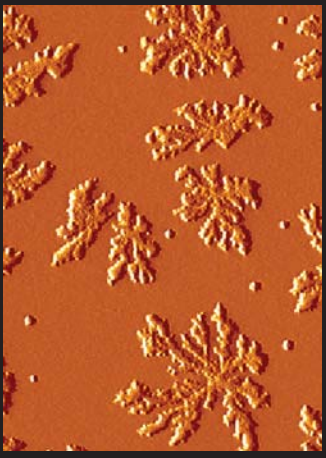
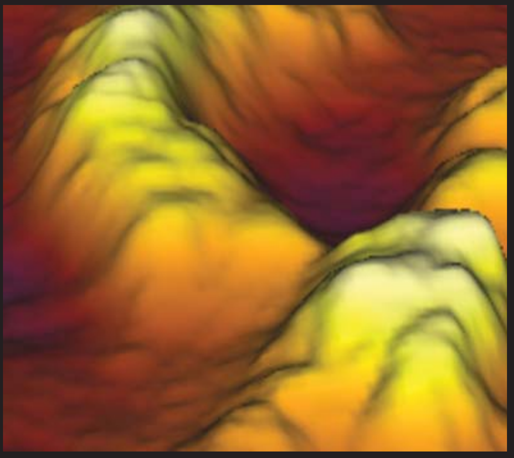
Photographer: MILICS GÁBOR
Assistant Professor, Institute of Biosystems Engineering, University of West Hungary

Title: CONSIDERING FINE DETAILS DURING WORK
Subject: "During precision fertilization, a caterpillar hangs on to a human hand by a fine, silky thread, a powerful tractor in the background: symbolic of the relationship between man, living organisms, and the machine—and suggesting the overlapped planes of agricultural and biological engineering activities and interests."

Photographer: ANDREW LANDERS
Senior extension associate, pesticide application technology specialist, Barton Lab, Cornell University, Geneva, N.Y., USA

Title, directly above: APPLES IN FOG
Subject: Cropland orchard sprayer with SARDI fans, Cornell University deposition trail.

Title, right: MIND-BENDING MACHINE Subject: John Deere orchard sprayer.

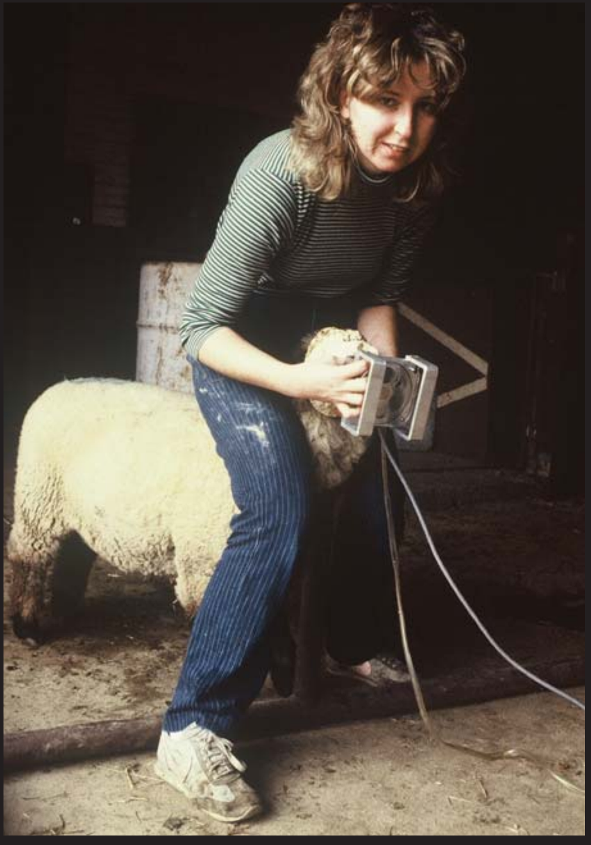

Photography: NANOBIOTECHNOLOGY LABORATORY
National Food Research Institute, Tsukuba, Ibaraki, Japan, submitted by Suresh Neethirajan

SOLUTIONS FROM THE NANO WORLD

Title, top left: PLATINUM FLOWERS
Subject: Surface morphology of platinum nanocrystals observed from nanowater using atomic force microscopy. Scan size: 4 microns.

Title, top middle: GREAT SAND DUNES
Subject: Three-dimensional surface reconstructed atomic scale images of plant chromosomes. Scale: 200 nanometer.

Title, top right: MARTIAN CRATERS
Subject: Atomic scale image of complex crater (5 microns) on starch granule surface prepared from buckwheat seeds.



Photographer: ART JOHNSON
Bioengineering professor, University of Maryland, College Park, USA

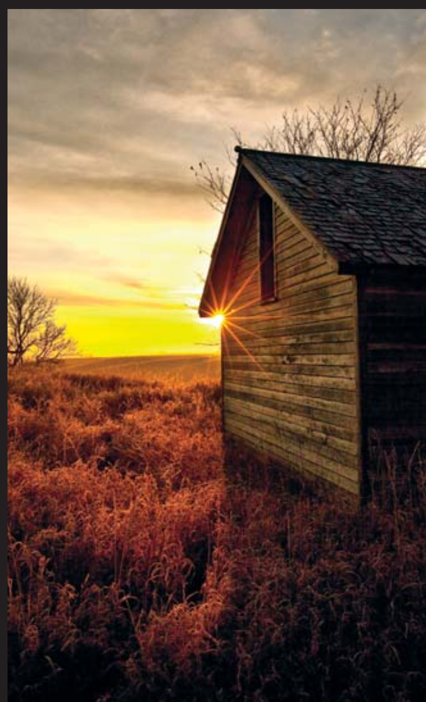
Title: HOLD STILL
Subject: Graduate student Patricia Lehtola measures respiratory resistance of a sheep with an airflow perturbation device, currently in development.

Photographer: CHARLES SUKUP

President, Sukup Manufacturing Co., Sheffield, Iowa, USA; ASABE past president

Title and subject, top: GRAIN STORAGE SYSTEM SURROUNDED BY MILO

Title and subject, top right: DRIED GRAIN BEING LOADED INTO A SEMI FOR DELIVERY



Photographer: ROY REIFFENBERGER

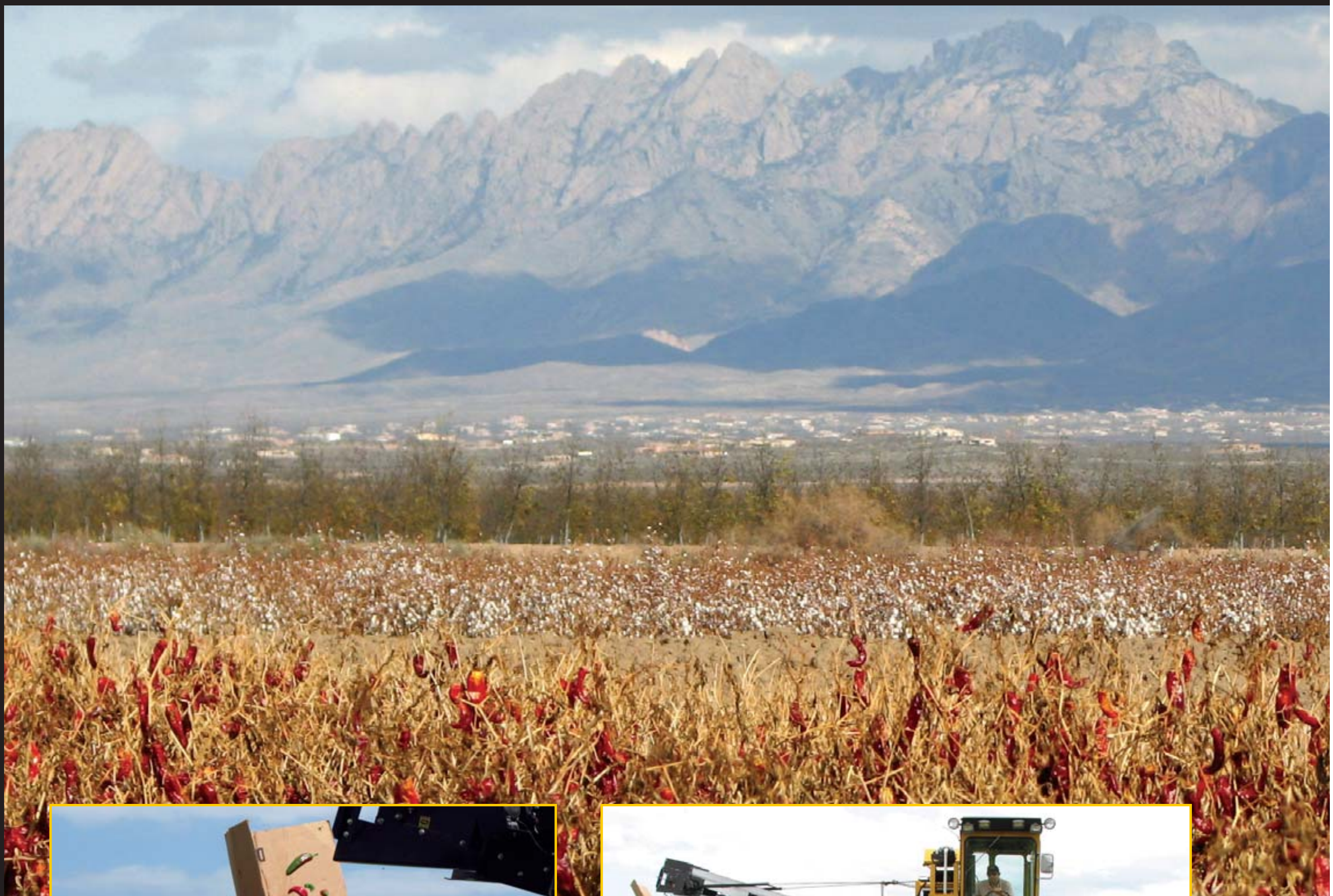
Prairie preservation photographer, Sioux Falls, So. Dak., USA

PRAIRIE TRIPTYCH

Title, above left: NATURE'S CALLIGRAPHY   Subject: Curly golden grass.

Title, above middle: PRAIRIE COLORS   Subject: Fence line on southeastern South Dakota prairie.

Title, above right: SEASONED HOMESTEAD   Subject: Log cabin from the 1880s, on the prairie preserve of A.J. Swanson, Canton, So. Dak.



Photographer: PAUL FUNK

Research agricultural engineer, USDA Agricultural Research Service,
Southwestern Cotton Ginning Research Laboratory, Mesilla Park, N.M., USA

Title and subject, above top: FIELD OF DRY RED CHILE AND COTTON,
New Mexico State University, Leyendecker Plant Science Research Center,
Las Cruces, N.M., USA
Title and subject, above left: FLYING CHILI PEPPERS
Title and subject, above middle: CHILI HARVEST RESEARCH EQUIPMENT
Title, above far right: BEFORE ENLIGHTENING
Subject: An open boll of "sticky" cotton shows mold growing on it before excreted insect sugars were sprayed. *See cover image and table of contents description on page 3.*
Title and subject, immediate right: THERMAL COTTON DEFOLIATOR,
near Helm, Calif., USA
Title and subject, far right: COTTON IMAGING

Photographer: A.J. BOOTH

Associate extension specialist, Rutgers University, BioEnvironmental Engineering, Department of Environmental Sciences, New Brunswick, N.J., USA.

Title and subject, above: BOOM IRRIGATION SYSTEM OPERATING IN A GREENHOUSE

Title, below: MODERN HYDROPONIC LETTUCE GREENHOUSE

Subject: Troughs containing plants are moving slowly from one end of the greenhouse to the other to coincide with the growth rate of the crop. The spacing between troughs is adjusted mechanically to accommodate the increase in plant size as the crop matures.

Don’t Let Skills Go to Waste

When people ask me what I do as an agricultural engineer, my answer varies a bit, depending on who is asking. Sometimes I say conservation engineering, sometimes I say I work on feedlots and dairies, and sometimes I just say that I work for the government. In truth, though, I work with waste. I am currently an agricultural engineer on a nutrient (a.k.a. waste) management team for the USDA-NRCS. Stationed out of Brookings, South Dakota, I have the opportunity to work with livestock producers in the state who have a need for engineering assistance to better manage the waste products generated by their livestock feeding operations.

While it is a given that there are times when my job stinks (literally), I still find it rewarding! My job gives me the opportunity to improve an operation for a producer while simultaneously improving the environment in which we all live. Being an outdoor enthusiast, I find it satisfying to know that my daily work is improving water quality. Further, my job encompasses many of the different skills that I gained through my earlier study and work as an agricultural engineer.

Becoming a licensed Professional Engineer was something I aspired to from early on in my studies at Iowa State University. I took the FE exam back then, which in hindsight was a good decision because it’s never any easier to complete that first step than at the culmination of a college career. I began my full-time work with the NRCS in Iowa, starting out in the southwest part of the state working on flood control dams. I had a supervisor who was licensed in three states at that time, and he provided mentoring that convinced me that being a licensed PE would be beneficial for my career and would provide a way to show commitment to my profession.

As my work took me into South Dakota, I reached the experience level that was needed to take the PE exam. I knew that I would attain this level in 2006. So in late 2005, I began to investigate the details of taking the exam. I found that the agricultural exam was offered in the fall, and as luck would have it, I could take it only three blocks from my office in Brookings. I didn’t seriously consider taking any of the other discipline versions of the exam. I have always considered myself an agricultural engineer, so that was the avenue I chose for becoming licensed.

The study process is not easy for the agricultural exam, but PEI and ASABE provide enough resources, so it’s really just a matter of taking the time to prepare. One of my best preparations was finding a study partner who happened to be well versed in power and machinery, which is outside of my area. In turn, I had experience that my study partner lacked, so each of us gained knowledge in areas that were outside of our typical work duties. The exam day was a long one, but it was a great feeling of relief when it was over. My best Christmas present in 2006 was the letter that came in the mail with my PE certificate and registration number!

Becoming a licensed Professional Engineer has provided many benefits for me. As far as my official duties go, my license allows me to stamp plans that need to be sent to state or federal regulatory agencies for approval. It also allows me to have more credibility when dealing with producers, industry representatives, and peers in my area of expertise. Even though I have not yet chosen to pursue any other professional opportunities, being a PE will be a benefit when or if that time comes. Even if I hadn’t passed, going through the process of studying for the exam also was beneficial because it reinforced some of the basic concepts of agricultural engineering that I don’t typically deal with. I also gained knowledge of some new reference materials that I now use frequently in the projects that I work on.

My advice to someone who is hesitant about taking the agricultural engineering PE exam is simple: just go for it. The exam is broad in scope, but it’s long enough and there are enough questions that you can skip a few and still complete it successfully. And studying for it is not that bad either. I found that studying involved putting together the reference materials and knowing where to find information as much as it involved memorization or working on problems. Really, if you check out the information from ASABE and PEI, find a friend or mentor who has taken the exam or will be taking the exam, and take the time to prepare, then passing the exam should be no problem. So don’t let your skills and knowledge go to waste—become a licensed agricultural engineer.

JUSTIN BONNEMA

Agricultural Engineer
USDA-NRCS Agricultural Nutrient Management Team
Brookings, So. Dak.

AGE: 30

RECENT READ: *Staying the Course: A Runner’s Toughest Race* by D. Beardsley

HOMETOWN: Inwood, Iowa

VACATION CHOICES: Canada fishing trips and destination marathons

Analysis of air-dried algae from an algal turf scrubber showed that the algae captured most of the nitrogen and phosphorus in the manure. With additional processing, the dried algae could be sold as a slow-release organic fertilizer or as an animal-feed supplement. ***(Photo by Edwin Remsburg)***

Algae advances as a green alternative for improving water quality

In Brief: *Algae—already being eyed for biofuel production—could be put to use right away to remove nitrogen and phosphorus in livestock manure runoff, according to an ARS scientist. That could give resource managers a new eco-friendly option for reducing the level of agricultural pollutants that contaminate water quality in the Chesapeake Bay.*

Microbiologist Walter Mulbry works at the ARS Environmental Management and Byproduct Utilization Research Unit in Beltsville, Md., which is located in the Chesapeake Bay watershed. In 2003, Mulbry set up four algal turf scrubber (ATS) raceways outside dairy barns in Beltsville. The shallow 100-foot raceways were covered with nylon netting that created a scaffold where the algae could grow.

For the next three years, from April until December, a submerged water pump at one end of the raceways circulated a mix of fresh water and raw or anaerobically digested dairy manure effluent over the algae. Within two to three weeks after the ATS system was started up every spring, the raceways supported thriving colonies of green filamentous algae.

Algae productivity was highest in the spring and declined during the summer, in part because of higher water temperatures and also because the raceways provided snails and midge larvae ample opportunity to graze on the algae.

Mulbry and his partners harvested wet algae every four to 12 days, dried it, and then analyzed the dried biomass for nitrogen and phosphorus levels. Results indicate that the ATS system recovered 60 to 90 percent of the nitrogen and 70 to 100 percent of the phosphorus from the manure effluents. They also calculated that the cost for this capture was comparable to other manure management practices—around $5 to $6 for each pound of nitrogen that was recovered and around $25 for each pound of phosphorus that was recovered.

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

Campylobacter **requires complex media for growth. Biological technician Sharon Fanklin searches a blood agar plate for typical colonies. (*Photo by Keith Weller, courtesy of USDA-ARS*)**

Hyperspectral imaging speeds detection of *Campylobacter*

***In Brief:** ARS scientists have developed a way to identify the foodborne pathogen* Campylobacter *less than 24 hours after the bacteria have been plated through hyperspectral imaging, a combination of digital imaging with spectroscopy.*

A type of high-tech imaging can be used to distinguish the foodborne pathogen *Campylobacter* from other microorganisms after a sample has been plated on solid media in a Petri dish. Researchers used hyperspectral imaging technology to provide hundreds of individual wavelength measurements for each image pixel.

Microorganisms grown on solid media carry unique spectral fingerprints in specific portions of the electromagnetic spectrum. A hyperspectral imager identifies these fingerprints by measuring light waves that bounce off or pass through these objects.

Hyperspectral imaging can detect visible light as well as light from the ultraviolet to near-infrared regions. Hyperspectral imaging may also be applicable to other pathogen detection studies.

Campylobacter infections in humans are a major cause of bacterial foodborne illness. Growing *Campylobacter* directly on solid media has been an effective method to isolate this organism, but distinguishing *Campylobacter* from non-*Campylobacter* microorganisms is difficult because different bacteria can often look very similar.

A research team led by ARS electronics engineer and **ASABE member Seung-Chul Yoon** at the Quality and Safety Assessment Research Unit in Athens, Ga., developed the imaging technique to detect *Campylobacter* colonies on solid media in 24 hours. Normally, isolation and detection for identification of *Campylobacter* from foods like raw chicken involve time-consuming or complicated laboratory tests that may take several days to a week.

This sensing technology, which is nearly 100 percent accurate with pure cultures of the microorganisms, could be used for early detection of presumptive *Campylobacter* colonies in mixed cultures. The researchers are working toward developing a presumptive screening technique to detect *Salmonella* and *Campylobacter* in food samples.

Other ARS team members included research leader **Kurt Lawrence,** agricultural engineer **Bosoon Park,** animal physiologist **William Windham, all ASABE members,** and food technologists John Line and Peggy Feldner.

For more information, contact Sharon Durham, public affairs specialist; Sharon.Durham@ars.usda.gov.

Kevin Keener developed a rapid egg cooling system that uses circulated carbon dioxide to create a thin layer of ice inside an egg's shell that cools the inside of an egg within minutes. (*Photo by Keith Robinson, courtesy of Purdue Agricultural Communication*)

Egg cooling would lessen *Salmonella* illnesses, scientist says

In Brief: *While people across the country were sickened by a late-summer outbreak of* Salmonella *poisoning possibly linked to eggs from Iowa producers, a Purdue University food scientist believes the poultry industry could implement a rapid egg cooling technology to reduce future outbreaks.*

ASABE member Kevin Keener, an associate professor of food science, said quick cooling of eggs after they are laid would significantly reduce the ability of *Salmonella* to grow inside eggs and potentially keep consumers from getting sick. There are no federal guidelines for how quickly eggs should be cooled, but current industry procedures can take as long as six days to cool eggs to 7°C (45°F), the temperature at which *Salmonella* can no longer grow. Keener's rapid-cooling technology would take two to five minutes.

Keener said eggs can be more than 38°C (100°F) after washing and packaging in cartons. Thirty dozen eggs are then packed in a case, and 30 cases are stacked onto pallets and placed in refrigerated coolers. The eggs in the middle of the pallet can take up to 142 hours to cool to 7°C (45°F). He said scientists estimate that one in about every 20,000 eggs has *Salmonella* naturally inside.

"The eggs in the middle of a pallet may take up to six days to cool, and if the one in 20,000 that has *Salmonella* is in the middle, the bacteria will grow," Keener said. "In reality, some eggs don't cool to 7°C (45°F) until they're in the refrigerator in your home."

Keener said Food and Drug Administration studies show that if eggs were cooled and stored at 7°C (45°F) or less within 12 hours of laying, there would be an estimated 78 percent fewer *Salmonella* illnesses from eggs in the United States each year.

Keener's cooling technology uses carbon dioxide "snow" to rapidly lower the eggs' temperature. Eggs are placed in a cooling chamber, and carbon dioxide gas at about minus 43°C (minus 110°F) is generated. The cold gas is circulated around the eggs and forms a thin layer of ice inside the eggshell. After treatment, the ice layer melts and quickly lowers the egg's internal temperature to below 7°C (45°F).

The eggshell does not crack during this process because the shell can resist expansion from a thin ice layer.

Previous studies have shown the cooling treatment would increase shelf life by four weeks.

Keener has a prototype of his rapid-cooling technology in his Purdue laboratory and is working to optimize its function.

For more information, contact Brian Wallheimer, bwallhei@purdue.edu; Kevin Keener, kkeener@purdue.edu; or Paul Brennan, pbrennan@purdue.edu.

Tracking phosphorus runoff from livestock manure

In Brief: *Scientists develop application of rare earth elements to control phosphorus runoff from livestock manure.*

Nutrient runoff from livestock manure is a common source of agricultural pollution. Looking for an uncommon solution, a team of scientists has developed an application of rare earth elements to control and track runoff phosphorus from soils receiving livestock manure. In addition to reducing the solubility of phosphorus, this method shows particular promise for researchers interested in tracking the fate of manure nutrients in agricultural settings.

Led by Anthony Buda, scientists from the USDA-ARS and the Chinese Academy of Sciences applied two rare earth chlorides (lanthanum chloride and ytterbium chloride) to poultry, dairy, and swine manures. The goals were to evaluate the effects of rare earth elements on phosphorus solubility in manures and to describe the fate of phosphorus and rare earth elements in surface runoff when manures were surface-applied to packed soil boxes and subjected to simulated rainfall.

Common uses for rare earth elements include industry, technology, and agricultural production, but there is a growing trend for use in environmental research, particularly to label and track soil erosion and sedimentation during storm events on agricultural and rangeland watersheds.

The results of the study showed that rare earth elements have a remarkable ability to reduce soluble phosphorus in livestock manures. In particular, adding lanthanum resulted in maximum reductions of water-extractable phosphorus from dairy and poultry manures.

While these soluble phosphorus reductions were comparable to using other chemical treatments such as alum and lime, widespread use of rare earth elements in this manner would likely be cost prohibitive.

The potential benefit of rare earth elements lies in their ability to label phosphorus in livestock manures, a boon for researchers. A rainfall simulation experiment clearly showed that rare earth elements precipitated greater than 50 percent of the dissolved phosphorus in runoff. The results revealed that rare earth elements can be used to track the fate of phosphorus and other manure constituents from soils treated with manures. This study has introduced rare earth elements as a potentially valuable new tool for research in agricultural phosphorus management. Extending this technique to field, landscape, and small watershed scales will contribute to testing and validating phosphorus management strategies, including critical source area management. Agriculture—particularly the dairy, poultry, and swine industries—stands to benefit from improved nutrient containment of manure-treated soils.

For more information, contact Sara Uttech, suttech@agronomy.org.

Test finds *E. coli* in beef faster

In Brief: *Infrared spectroscopy can detect* E. coli *faster than current testing methods and can cut days off investigations of outbreaks, according to a study at Purdue University.*

Lisa Mauer, an associate professor of food science, detected *E. coli* in ground beef in one hour using Fourier transform infrared spectroscopy— in much less time than the 48 hours required for conventional plating technology, which requires culturing cells in a laboratory. Mauer said spectroscopy could be done in the same laboratories, just in much less time. The spectroscopy method also differentiates between strains of *E. coli* 0157:H7, meaning outbreaks could be tracked more effectively and quickly. Current tests are multi-step and take almost one week to get results.

"Even with all the other bacteria present in ground beef, we could still detect *E. coli* and recognize different strains," said Mauer.

Mauer demonstrated two methods for separating bacteria from ground beef for testing. An antibody-capture method, which binds bacteria to antibodies attached to magnetic beads, gave results in four hours. A filtration method achieved results in about an hour.

Infrared spectroscopy could detect as little as one *E. coli* cell if the bacteria were cultured for six hours. Conventional plating techniques used for *E. coli* detection require culturing cells for 48 hours.

E. coli has a specific infrared spectrum that can be read with a Fourier transform infrared spectrometer. Infrared light is passed over a sample. The spectrometer reads the spectrum created by the combination of energy that has been absorbed and energy that has been reflected back. "Energy is only absorbed by certain components of a sample," Mauer said. "If that component isn't there, the energy is reflected back."

Mauer's testing methods also can differentiate between living and dead *E. coli* cells, something current testing methods cannot do. "If the cells are dead, they're not harmful, but the presence of that dead population could tell you something about the quality of the product," Mauer said.

For more information, contact Brian Wallheimer, bwallhei@purdue.edu, or Lisa Mauer, mauerl@purdue.edu.

ASABE's 5th National Decennial Irrigation Conference

Held in conjunction with the Irrigation Show 2010, Phoenix Convention Center

December 5-8, 2010 • Phoenix, Arizona USA

Held only once a decade, the National Irrigation Conference is hosted by the American Society of Agricultural and Biological Engineers in partnership with the Irrigation Association. Free with your full registration to the Irrigation Show, the conference highlights research and case studies on irrigation technology and management in the United States.

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To register for the Irrigation Show, which includes access to the conference, go to http://www.irrigationshow.org. You'll find the ASABE conference program listed under the Education link.

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CHAIR, DEPARTMENT OF AGRICULTURAL AND BIOSYSTEMS ENGINEERING (ABEN) NORTH DAKOTA STATE UNIVERSITY

Position Description: The College of Agriculture, Food Systems, and Natural Resources (CAFSNR) and the College of Engineering and Architecture (CEA) at North Dakota State University (NDSU) invite applications and nominations for the position of Chair, Department of Agricultural and Biosystems Engineering (ABEN). The Department has responsibility for two academic programs (Agricultural Systems Management in CAFSNR, and Agricultural and Biosystems Engineering in CEA), research and extension programming. This position is administered through CAFSNR, but the Chair reports to the Deans of the colleges for each of the respective academic programs. The Chair has appointments in the CAFSNR, the North Dakota Agricultural Experiment Station, the NDSU Extension Service, and is responsible for administrative, budgetary, and personnel actions within the Department consisting of 12 faculty members and 13 academic/support staff serving 12 graduate students, 175 undergraduates, and research/extension clientele. The Chair oversees curriculum design and delivery, facility planning, resource allocation; takes an active role in recruiting students and faculty; maintains departmental records and prepares reports including ABET accreditation inputs; serves as a mentor and evaluator of the faculty; facilitates a collegial and productive work environment for faculty and staff; expedites relevant research and promotes extension programming; solicits external funding; and collaborates with other departments and Research-Extension Centers in achieving goals. The Chair is expected to interact with clientele and lead the faculty, staff and students in departmental quests for excellence in education, research and extension; have long-term goals for the department and a vision for attaining these goals. The Chair is responsible for building relationships with industrial/agricultural supporters and alumni and for representing the department to university administration, other NDSU units, outstate Research Extension Centers, other universities, state and federal agencies, and commodity/agribusiness organizations. The position is a full time, 12-month appointment. The chair will have an opportunity to teach and exercise leadership that enhances all facets of the Department.

The University: North Dakota State University, established in 1890, is a nationally respected leader among Land Grant institutions, and has a long history of quality education, leading research and outstanding service. Students from across the region, nation, and world have chosen NDSU as their place to study and prepare for life careers. With more than 14,400 undergraduate, graduate and professional students, NDSU has set enrollment records for 11 straight years. NDSU is a diverse and challenging learning community.

Minimum Qualifications: Ph.D. is Agricultural and Biosystems Engineering or a closely related engineering field; proven record of excellence in scholarly achievements in teaching, research, and extension with the credentials appropriate for appointment at the rank of Full Professor and tenure in the Department; demonstrated capacity to successfully manage budgets; demonstrated effective leadership and excellence in interpersonal skills as evidence by appropriate communications, teamwork, problem resolution, effective utilization of human resources, and negotiation of solutions in a culture of acceptance and collegiality; excellent English proficiency including oral and written communication skills.

Preferred Qualifications: Administrative experience; experience in innovative curriculum development, implementation, and assessment; experience with ABET accreditation requirements; service leadership in professional societies, including elected boards, editorial boards of journals, and program committees or international conferences; demonstrated success in acquiring and managing grants; record of successful student guidance; familiarity with the Land Grant system; registered as a Professional Engineer.

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ASABE

Feed the People

Almost **every week**, there is a new article, a new documentary, a new commentary that is **critical** of the way we farm. They don't like **"factory farms."** Not organic. They don't like commercial fertilizer or **biotechnology.** It's **not natural**. They want to turn back the clock. Send everyone **back to the land.**

I'm happy to acknowledge that we probably could be better. However, someone has to answer this question: "What is better?"

What is the objective of food production? First and foremost, I think it is to feed the people. We are doing that. Americans spend less than 10 percent of their income on food. In 1960, it was 20 percent. That sounds like progress to me.

People in many developing countries spend 40 percent of their income on food. Why is it that they fail to measure up to the American farmer? Because they don't employ the best technology. Their plants aren't genetically engineered to protect against suffocating weeds and destructive insects. They don't have modern precision machinery to reduce the labor cost. They don't use commercial fertilizer to feed the plants. After all, that's what fertilizer is. Fertilizer is feed for the plant so it can reach its maximum level of production.

The critics of modern commercial farming would have us farming like we did 100 years ago. They don't think today's practices are sustainable, but what about sustaining the world population? We could not feed the billions of people without modern technology.

Thanks to modern agriculture, food is inexpensive, and it tastes good. Unfortunately, that's why we eat too much. But the answer isn't to make the prices skyrocket through unrealistic policies.

Our critics argue that our increases in food production have come at the expense of the soil and the environment. I could not disagree more. Our soils are more fertile than ever because they are tested and fed according to their needs. Our soil conservation practices protect the environment.

We're not perfect, but the critics don't have a better answer because they simply couldn't feed the world's people.

John Block is the luncheon keynote speaker for ASABE's Agricultural Equipment Technology Conference (AETC), Jan. 5-7, in Atlanta, Ga., USA. He will address this year's conference theme, "Meeting the Needs of a Growing World."

Senior Policy Advisor in the law firm of Olsson, Frank, and Weeda, Secretary Block has dedicated his professional career to the fields of agriculture, food, and health. He served as Illinois's Director of Agriculture, 1977-1981, and Secretary of the U.S. Department of Agriculture,1981- 1985. He is Chair of the Citizens Network for Foreign Affairs Agribusiness Alliance, a member of the Board for the Friends of the World Food Program, and a Non-resident Senior Fellow with the National Center for Food and Agriculture Policy.

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