Agronomy Day 2012

August 16
7 a.m.–2 p.m.

Crop Sciences
Research and Education Center (South Farms)

University of Illinois
Urbana, Illinois

agronomyday.cropsci.illinois.edu
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Welcome to Agronomy Day 2012

Agriculture is rapidly advancing to meet the needs of our growing world population. As our industry continues to evolve, the University of Illinois Department of Crop Sciences is prepared to educate tomorrow’s agriculture leaders while equipping today’s workforce with the latest technology and techniques to improve food and fuel production.

This 56th annual Agronomy Day—an event held every year since 1957—provides unparalleled opportunities for growers, industry representatives, business owners, researchers, and the public to discover the latest research findings from the Department of Crop Sciences. From plant breeding and pest control to biomass production and horticulture, our department is leading the way in education, research, and extension.

But don’t just take my word for it. Interact with our researchers and extension specialists and enjoy their presentations. Ask the crop sciences students on-site today to tell you about the courses and opportunities they are offered. When our students graduate, they often have more than one lucrative job opportunity waiting. The demand for U of I graduates is high, and the future looks even more promising.

Jonathan Baldwin Turner Hall, home to the Department of Crop Sciences, continues to play an essential role in training the next generation of scientists, whose ingenuity and insights will address the needs of a growing global population. Given that this building is now almost 50 years old, structural renovations, new equipment, and technology updates are needed. An exciting campus-wide initiative to renovate classrooms and laboratories is providing seed funding to transform Turner Hall’s crops and soils classrooms into state-of-the-art teaching spaces. However, state dollars alone cannot fulfill the vision and the need. Your investment in this public–private partnership is critical. Stop by our display in the large tent to find out more, or visit the Turner Hall Project website at advancement.aces.illinois.edu/turner.

Agronomy Day is a partnership among several academic units in the College of Agricultural, Consumer and Environmental Sciences (ACES). This event is our way of reporting directly to the citizens of Illinois on the scope, value, and importance of our programs.

We are delighted to have you join us today, and we hope to see you again soon!

Best regards,
Germán A. Bollero
Head of the Department of Crop Sciences
gbollero@illinois.edu, 217-333-9480

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The College of ACES Department of Crop Sciences gratefully acknowledges the generous contributions of our sponsors and supporters.

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AGRonomy Day 2012
Welcome to the Crop Sciences Research and Education Center

From the school’s beginnings, agronomic research has always been conducted on or near the University of Illinois. From 1876 to 1931, most field research was conducted on what we know as “campus proper.” This involved work on the Davenport Plots (sacrificed in 1930 to allow the expansion of Goodwin Avenue), which were located directly east of the Morrow Plots. From 1920 to 1936, the Department of Agronomy used the land west of the stadium to the Illinois Central tracks.

The development of the present research farm traces back to the turn of the 19th century; field operations began here in 1903. The original Agronomy Farm consisted of the 80 acres directly south of the Seed House, completed in 1930. Since then, the area, which became known as the South Farms, has expanded slowly but steadily to its present 1,300 acres. The Seed House still serves as the headquarters for farm operations.

In 1984, the farm operations of the Department of Agronomy were combined with those of the Department of Plant Pathology. In 1995, the college reorganized, merging those two departments into one: the Department of Crop Sciences. The research facility received a new name at the same time: the Crop Sciences Research and Education Center (CSREC).

The CSREC mission is to provide land, equipment, and facilities for plant and soil research in a field laboratory setting close to campus. The center provides scientists and extension personnel a central place from which to plan, coordinate, and conduct field research. It supports on-campus teaching with field laboratory facilities for graduate students and by educating undergraduates through work and field trips.

Extension and international agricultural efforts are strengthened by organized field days, specialized tours, and training sessions to meet the needs of the agricultural community. Agronomy Day creates a vital connection between the agricultural grower, the consumer, and the research scientist.

The first Agronomy Day was held on June 27, 1957, with the same objective as the one you are attending today—to communicate research results that benefit our constituents.

Enjoy your visit today. We invite you back at any time to view ongoing research projects.

Sincerely,
Robert Dunker
Agronomist and Superintendent
Crop Sciences Research and Education Center
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Simply go online at GrowCommunities.com and inspire a farmer in your community to support your cause. You'll need the name of your nonprofit organization and a brief description of your project. Plant your idea before November 30, 2012.

For a complete list of eligibility requirements, qualifying counties and official rules for the contest, please visit GrowCommunities.com. ©2012 Monsanto Fund
Transgenic corn hybrids have become the standard insect management tactic across the Corn Belt. Bt hybrids targeted at corn rootworms entered the marketplace in 2003. By 2011, 55% of all corn planted in Illinois was characterized as a stacked gene variety (statistic from the USDA Economic Research Service). These so-called “stacks” typically include hybrids that offer herbicide tolerance and express Bt proteins both aboveground (for stalk-boring insects) and belowground (for corn rootworm larvae).

In 2011, Dr. Aaron Gassmann of Iowa State University published a journal article describing the reduced susceptibility of progeny from adult western corn rootworms that were collected from producers’ fields in which Bt hybrids (Cry3Bb1) had been planted for several consecutive years \( (PLoS ONE, \text{ Vol. 6, No. 7, pp. 1–7, “Field-Evolved Resistance to Bt Maize by Western Corn Rootworm”}) \). Despite the requirement that producers plant a refuge to delay or prevent resistance development, the evolution of field resistance in Iowa to the Cry3Bb1 protein occurred in a relatively short period.

Thus far, the evolution of field resistance has not been detected for the European corn borer even though this species has been exposed to Bt proteins since 1996. Why? The primary reason relates to the use of hybrids that offer a high dose of Bt proteins for the European corn borer. The refuge (historically 20%) and high-dose events have worked in tandem very well to prevent resistance development in the European corn borer population. However, Bt hybrids that have been used for corn rootworm control are low- to moderate-dose events, ensuring some survivors in every field. When enough heterozygotes (individuals with a resistant and susceptible allele) survive and mate, a Bt-resistant population can begin to increase rapidly (assuming the fitness costs are not extreme).

The 20% structured refuge (separate fields, blocks, or strips) was developed based on the biology, mating behavior, and dispersal patterns of the European corn borer. This structured type of refuge is not as well suited for the western corn rootworm. In fact, the refuge-in-a-bag (seed mixture) approach is a preferable refuge strategy for corn rootworms. One approach or size is not optimal for all insect pests of corn when it comes to refuges. For the sake of convenience and familiarity, the 20% structured refuge was used for corn rootworms for many years following commercialization. From a historical perspective, this may come to be regarded as a mistake. Even though some Bt hybrids now utilize seed mixes as a refuge strategy, and pyramided hybrids (hybrids that express multiple Bt proteins against target insects) are increasingly used, it remains unclear whether these recent developments will keep resistant corn rootworm populations in check.

In August of 2011, I (Mike Gray) confirmed severe corn rootworm damage in a few producers’ fields that were planted to Bt corn expressing the Cry3Bb1 protein in northwestern Illinois (Henry and Whiteside counties). The following month, I again observed significant damage and lodging in a Bt field (Cry3Bb1), this time in LaSalle County. The fields in the three Illinois counties shared some common characteristics with the Iowa fields where resistance had been documented—they had been in continuous corn for many years, and the same Bt trait (Cry3Bb1) had been used consecutively for many growing seasons. Western corn rootworm adults were collected from the Illinois fields in August 2011 and provided to Dr. Gassmann.
The progeny from these adults will be subjected to bioassays and a determination made regarding their susceptibility to the Cry3Bb1 protein. These results will become available late summer 2012. Until then, the cause of the Bt failures in the Illinois fields remains unknown. On June 7, 2012, I (Mike Gray) confirmed severe corn rootworm damage to a field of Bt corn expressing the Cry3Bb1 protein in western Cass County (Figures 1 and 2). In addition, numerous western corn rootworm adults were present, about 1 month earlier than normal. The early emergence was the result of an unusually hot and dry spring.

In March 2012, 22 entomologists from land-grant universities and USDA sent a letter to the U.S. Environmental Protection Agency expressing concern over the development of western corn rootworm resistance to the Cry3Bb1 protein. In particular, these public sector scientists indicated that the durability of the Cry3/35Ab1 protein, used in conjunction with the Cry3Bb1 protein in pyramided Bt hybrids, could be compromised in areas where a resistant population of western corn rootworms is present. As the scientists noted, this concern is heightened because the refuge size has been reduced from 20% to 5% for these pyramided products. Additional concerns mentioned in the letter included the “insurance-based approach” to insect management—the standard practice across the Corn Belt.

In 2012, some experiments were deployed in producers’ fields where less-than-satisfactory performance of Bt (Cry3Bb1) hybrids occurred last year. Preston Schrader, a graduate student in the Department of Crop Sciences, will describe these studies and offer some comments regarding his future research plans.

At the time this paper was written, the level of corn rootworm damage in 2012 to Bt corn remained unclear. The larval hatch in 2012 was the earliest in 35 years, as reported by Larry Bledsoe (Purdue University entomologist). The early hatch could place more pressure on small root systems of corn plants, Bt or non-Bt. Considerations and recommendations for 2013 will be shared with producers at this stop during Agronomy Day.
Reality vs. assumptions about rootworm behavior in refuge and Bt corn

Since commercialization of the first rootworm-protected Bt (Bacillus thuringiensis) transgenic corn hybrids in 2003, “Bt corn” has changed the way corn insect pests are managed. Unfortunately, use of Bt crops against pests imposes selection for resistance to Bt. The development of pest resistance can be slowed if Bt crops are deployed in accordance with an insect resistance management (IRM) plan, as required by the US EPA. To slow pest resistance, growers planting Bt crops are required to set aside a percentage of each field’s area as a non-Bt “refuge” where Bt-susceptible insects can develop on plants that do not express the pest-killing Bt trait present elsewhere. The US EPA requires that corn growers in the Corn Belt plant a 5% to 20% refuge (depending on the traits expressed in the hybrid) within or adjacent to the rootworm-protected Bt cornfield; an integrated “refuge-in-a-bag” or “seed blend” refuge is also available for some hybrids.

Refuges are planted to assure that there are western corn rootworms (WCR) with Bt susceptibility produced near rows of Bt corn where potentially resistant WCR may emerge. It is expected that mate-seeking beetle movement from refuge to Bt corn will lead to mixed mating between susceptible and potentially resistant rootworms. Because many more WCR are produced in refuges than in Bt corn, nearly every potentially resistant WCR female will be mated by one of the abundant and susceptible refuge males (Figure 3). These pairings should dramatically dilute the potential for production of resistant offspring because it will be unlikely that any two resistant insects will mate with each other.

While grower compliance with refuge requirements is critical to IRM success, the insects also have a role to play. WCR ecology and behavior have been incorporated into the design of IRM plans; it is assumed that WCR movement, mating, and egg laying in Bt cornfields is no different from behavior in non-Bt corn. Observing what WCR actually do in refuge and Bt corn is a direct way to understand if the insects are doing their part to assure that refuges function as we expect. Our study was conducted to update information regarding the movement and mating behavior of WCR beetles within refuge and Bt corn. We have studied WCR emergence, movement, and mating within four refuge configurations: 20% block refuge, 5% block refuge, 5% seed blend, and 0% refuge.

We have observed that refuge configuration (block vs. blended refuge) affects WCR movement and mating in Bt cornfields and that some long-held general assumptions about WCR reproduction are not always accurate. It takes a long while for WCR populations to become evenly distributed across Bt cornfields with block refuges. The greatest period of their movement into Bt corn occurs before pollination; however, WCR populations are lowest at this time. Mating activity is concentrated in and near refuge blocks for most of the growing season. In contrast, seed blend refuges provide very uniform distributions of WCR adults and mating activity that do not vary significantly during the growing season.

The interaction between male and female beetle movement patterns and female emergence patterns may play an important role in establishing favorable or unfavorable circumstances for WCR mating. Our data suggest that females in cornfields with block refuges wait longer before they are found by a mate than do females in seed blend fields. When potentially resistant females in Bt corn are not mated quickly, there is a greater chance they may mate with a nearby, potentially resistant male. A blended refuge generates a more uniform distribution of moving and mating WCR that is a better mixture of insects from refuge and Bt corn. We expect that the consideration of pest behavior will play an increasingly important role in guiding grower options for sustainable deployment of Bt corn and other Bt crops.

This project is supported by USDA-National Institute of Food and Agriculture (NIFA) Grant #2009-65104-05976 to Joseph Spencer.

Figure 3. Mating western corn rootworm beetles. Courtesy of Joseph Spencer.
Evaluating new products and strategies for managing corn rootworm larvae

In 2003, Monsanto began offering YieldGard RW, the first commercialized corn hybrid containing a Bt toxin to control corn rootworm larvae. Soon after, other companies began offering their own Bt rootworm hybrids, under the trade names Herculex RW (Pioneer Hi-Bred and Dow AgroSciences) and Agrisure RW (Syngenta). Since their 2003 introduction, there has been a significant increase in the adoption of rootworm Bt hybrids throughout the Corn Belt.

The use of soil-applied insecticides in conjunction with rootworm Bt hybrids has become increasingly common. The benefits commonly cited for this combination include improved control of secondary subterranean pests, improved efficacy against high populations of corn rootworm larvae, and, ultimately, increased yields. However, the presence of secondary pests is often sporadic and varies greatly from field to field, and populations of corn rootworms have appeared to decline in many parts of the state (Gray 2011). Over the past few years, we have tested these product combinations and have found that significant benefits do not always exist.

In 2009 and 2010, trials included four rootworm Bt hybrids, with and without a soil-applied insecticide, and their near-isoline hybrids to determine whether these product combinations improved efficacy or offered a yield benefit. We also examined populations of two additional subterranean pests (Japanese beetle and grape colaspis larvae) to determine whether they contributed to differences in grain yield. We have also evaluated the overall effect of adding a soil-applied insecticide to rootworm Bt hybrids at four locations in Illinois, resulting in 18 site-years of data. Our results suggest that these product combinations rarely result in significant improvements in rootworm control, lodging, or yield.

The refuge-in-a-bag (RIB) concept has been developed by seed companies to simplify the often-confusing requirements associated with planting refuges for rootworm Bt hybrids. RIB products combine both rootworm Bt seed and refuge (non-Bt) seed in a single bag, ending the need to plant a refuge separately (Figure 4). RIB products have been commercially available since 2010 (Optimum AcreMax 1 by Pioneer). Since that time, new RIB products continue to join the marketplace and are likely to increase in popularity due to their convenience at planting time.

In 2011, we initiated a research project to compare the level of protection against corn rootworm larval injury (Figure 5) provided by a rootworm Bt hybrid, an RIB seed blend, and a soil-applied insecticide. Our results indicate that all of these products experienced less larval injury than the untreated check. Additionally, adding the soil-applied insecticide to either the rootworm Bt hybrid or the RIB seed blend did not improve root protection or yield. When evaluating root protection offered by the RIB seed blend, we were particularly interested in the performance of Bt plants immediately adjacent to refuge plants. While the refuge plants did experience some larval injury, the adjacent Bt plants continued to provide excellent protection.

We are continuing this project in 2012 and conducting other experiments focusing on RIB products. We look forward to sharing results from our research at Agronomy Day 2012, through newsletter articles (the Bulletin, bulletin.ipm.illinois.edu), and in our annual report (on Target, available at ipm.illinois.edu/ontarget).

Irrigating soybeans in Illinois

Soybean, like other grain legumes, tends to grow without irrigation in most places in the world. That’s certainly the case in Illinois, where much of the limited acreage of irrigated land is used to grow high-value crops such as vegetables. Still, the world record soybean yield of more than 160 bushels per acre was produced by Kip Cullers under irrigation in southwestern Missouri, and agronomists generally agree that water is typically the most limiting factor in soybean production, even on the deep, productive soils of Illinois.

Soybean is considered somewhat drought-tolerant due to its extended flowering period, during which relief of drought stress can result in more pods being set. By contrast, corn needs adequate water throughout the flowering process (pollination) in order to set enough kernels for high yields. Of the two crops, however, corn uses water much more efficiently; corn produces about 842 lb of dry matter compared with soybean’s 310 lb per acre-inch of water used. Over a season, a 200-bushel corn crop uses about the same amount of water (22 inches) as a 60-bushel soybean crop. This is partly a result of soybean seed’s having higher energy content than corn kernels, but corn is among the most water-efficient crops in the world, and soybeans, like other legumes, is not.

To see whether we could eliminate water as a limitation to high yields, Dr. Vince Davis and I have conducted irrigation trials over several years and at several sites, including at the South Farms near Urbana. In each of three years (2008, 2009, 2010), we set up a “solid-set” (not moveable during the season) sprinkler system and applied water to one set of plots when rainfall was not adequate. Next to each irrigated block was a nonirrigated block so we could make direct comparisons.

To see if other inputs might cause different responses in irrigated and nonirrigated soybeans, we placed about a dozen treatments within each block. Inputs differed slightly among years, but they included seed treatment in 2008 and seeding rates in 2009 and 2010, along with in-season nitrogen fertilizer (applied two or three times), foliar fungicides, foliar insecticides, and micronutrient mixtures. Combinations of treatments were also included.

Rainfall differed a lot among the three years: in 2008 there was above-normal rainfall in May, June, and July, but August was dry; in 2009 every month from May through August was wet; and in 2010, rainfall was very high in June but low in August (Figure 6).

Irrigation increased yield by 8 bushels per acre (from 60 to 68) in 2008, but it produced no significant yield increase in 2009 or 2010; in 2009 nonirrigated and irrigated soybeans yielded 79 and 80 bushels, respectively, while in 2010 nonirrigated and irrigated soybeans yielded 76 and 72 bushels per acre, respectively. It’s no great surprise that irrigation increased yields in the relatively dry year of 2008, or that irrigation did nothing to increase yields in the wet year of 2009. But 2010 was not a wet year, and yet irrigation may have decreased yield. Reasons for this are not obvious.

As with irrigation itself, responses to other inputs with and without irrigation did not follow a consistent pattern. None of the treatments significantly affected yield in 2008, nor was there an interaction between irrigation and treatment (Figure 7). Inputs such as fertilizer nitrogen appeared to produce more response with irrigation than without it, but this could have been due to random variability.

In 2009, the lower seeding rate (125K) yielded some 2 bushels more than the higher rate (250K) with irrigation, but the rates yielded the same in nonirrigated plots (Figure 8). Fungicide + insecticide seemed to produce more yield response without irrigation than with irrigation, at least at the lower seeding rate, but this difference could have been due to random variability.
In 2010, yield responded to in-season treatments, but not to seeding rate or irrigation. As we saw in 2009, there seemed to be more response to treatments in nonirrigated plots than in irrigated ones, with fungicide + insecticide producing the largest response (Figure 9).

We are doing a small irrigation study in 2012, including soil moisture probes to see if irrigation is providing enough water to avoid stress. It is somewhat mystifying why irrigation seems to provide such limited response even in a dry year, and why the response to other inputs seems to decrease with irrigation in years where rainfall is adequate.

Figure 8. Response of soybean to irrigation and other inputs at Urbana in 2009. F = foliar fungicide; I = foliar insecticide; N = N fertilizer applied as urea after flowering; M = micronutrients.

Figure 9. Response of soybean to irrigation and other inputs at Urbana in 2010. F = foliar fungicide; I = foliar insecticide; N = N fertilizer applied as urea after flowering; M = micronutrients.
Soil compaction practicum

Compaction of soil affects more than 83 million hectares worldwide, and recent estimates indicate that reduced harvests from compaction cost midwestern farmers some $100 million in revenue every year. In agricultural regions, most soil compaction is caused by vehicular or animal traffic; soil compaction is a direct result of tillage, and it has been a trade-off of agricultural productivity. Farm mechanization has advanced to such a scale and intensity that compaction problems have become important worldwide. As farm size increased in the United States, farmers continued their pursuit of labor-saving farm equipment. Increased size and weight of farm machinery has increased the likelihood of soil compaction.

Soil compaction is a rearrangement of soil particles that decreases pore space and increases bulk density and soil strength. By reducing the volume of large pores in the soil, compaction also reduces water and air movement, thus altering water and nutrient dynamics. In turn, poor structure resulting from soil compaction may restrict root and crop growth and development, affecting crop productivity and sustainability. Compaction increases the susceptibility of soils to wind and water erosion and exacerbates pollution of surface and ground waters while lowering the efficiency of cultivation inputs.

Increased interest in soil compaction has focused on its contributions to soil erosion, greenhouse gas emissions, nutrient depletion, energy inefficiency, and environmental pollution. These issues call for remedial measures to increase and maintain current crop yields while maintaining agriculture’s most important resource—the soil. Subsoil compaction has been shown to be a persistent and costly problem, difficult to alleviate. Deep ripping, subsoiling, or deep chiseling may be used to break up the compacted layers, yet the costs are high and the results short-lived.

Compaction can be a significant problem in dry years, particularly for corn-on-corn rotations. Last year wet weather delayed planting, and when planters finally returned to the field, some cornfields were planted before the soils had adequately dried, creating compaction. In the spring of 2011, corn looked weak from the beginning, with cool temperatures and heavy rains aggravating the issue. Weak, and with restricted root growth from some degree of compaction, the early planted corn with short roots struggled for moisture once the dry weather set in. This year, with soil moisture accumulation well below average, we expect the effects of soil compaction to hinder yields even more noticeably.

During the tour, we will talk about compaction in farmers’ fields and its effects on crops, describe how to determine the presence of soil compaction, and discuss current mechanical and biological methods for loosening compacted areas in the field.
Goss's wilt of corn, caused by the bacterium *Clavibacter michiganensis* subsp. *nebraskensis*, was first observed in Illinois in 1980. For approximately 30 years, observations of Goss's wilt in Illinois were sporadic, but since 2009 they have been on the increase, with an all-time number of confirmations by the University of Illinois Plant Clinic in 31 counties across the state in 2011.

Leaf symptoms of Goss's wilt appear as large tan to gray lesions, with dark spots, often referred to as freckles, within the lesions. Edges of the lesions may appear “water-soaked,” and bacterial exudates may be visible on the surface of affected leaf areas, giving the lesions a shiny appearance (Figure 10). In severe cases, bacteria may enter the xylem and cause wilting. Because wounds on the plant tissue must be present for the Goss's wilt bacterium to cause infection, fields that have been subjected to hail, high winds, and heavy rainfall are more likely to be affected.

No in-season control options are available to protect against Goss's wilt or to reduce the spread of disease within a field. The primary management methods are planting corn hybrids with higher levels of resistance to Goss's wilt, rotating to nonhost crops (such as soybean), and tilling to bury and speed up the decomposition of affected residue.

The reemergence of Goss's wilt in Illinois is likely due to the introduction of the pathogen and a build-up of inoculum over time. The increasing corn-on-corn acreage in the state likely has sped the build-up of the bacterium. Also, many popular corn hybrids may be susceptible because Goss's wilt historically has not been a major problem in Illinois, which probably has contributed to a quicker build-up of inoculum as well.

In 2011, we initiated research to identify new sources of resistance to Goss's wilt. Over 1,000 corn inbred lines were screened in a Goss's wilt nursery. Results indicate that several lines had improved levels of resistance to Goss's wilt (Figure 11), and more research is being conducted this season.

We thank Dr. Snook Pataky for help with Goss's wilt research studies at the U of I.
Genetic factors underlying flaking grit yield in maize

Corn is an important human dietary component. In 2010, 6,415 million bushels of corn grain were directed to food, seed, and industrial uses in the United States, representing about 52% of the country’s corn harvest that year. Of this, 3.14% (197 million bushels) was used to produce cereals and other food products. Although a relatively small percentage of the annual maize yield is used directly for human consumption, the “corn cereal pipeline” is an excellent example of an agricultural production system that provides primary ingredients for dietary staples. U.S. consumers are exposed to maize-based foods and food ingredients every day, and their impacts on health-related issues, such as obesity and cardiovascular diseases, are controversial. It is a complex pipeline involving groups with different interests and expertise: seed companies, farmers, dry millers, food companies, and consumers. Commonly, corn hybrids are improved with respect to grain yield and other agronomic traits of economic importance. However, little effort has been made to improve corn hybrids for suitability for dry milling or for nutritional needs and consumer health.

A corn kernel is composed of endosperm, bran, and germ (Figure 12). The endosperm, which makes up over 80% of a corn kernel, consists of two types: the hard, translucent, horny endosperm and the soft, white, floury endosperm. The dry milling industry uses a four-step process to separate endosperm, bran, and germ. In the first step the grain is tempered, which creates a moisture gradient in the corn kernel. At the end of the tempering step the bran has a higher water content than the endosperm, and this difference is exploited in the subsequent steps to separate both tissues. In the second step, the grain is degemerminated by mechanically splitting the corn kernel into two fractions. The first fraction contains the flaking grits, germ, and bran (Figure 13A); the second contains small grits and flour (Figure 13B). In the third step, the flaking grits, germ, and bran fraction is roller-milled, and in the final fourth step, this fraction is screened to separate the flaking grits from the germ and bran. Flaking grits, the key ingredient in corn flakes and other breakfast cereals, are the most valuable end product of the dry milling process. It is interesting to note that flaking grits are exclusively composed of horny endosperm, and the amount of this endosperm type varies significantly among corn seeds.

Given the economic importance of flaking grits, we were interested in determining whether corn hybrids significantly differ in flaking grit yield. Hybrids, developed from inbred lines representing elite female and male heterotic subgroups used in the current U.S. corn commercial germplasm base, were evaluated for flaking grit yield as well as agronomic performance in a three-year experiment. Grain harvested from each hybrid was processed using a small-scale dry milling procedure that required a one-kilogram grain sample (Figure 14). Corn hybrids differed significantly for grain and flaking grit yields. Our results showed a positive relationship between flaking grit yield and test weight and a negative relationship between flaking grit and grain yield.

Outcomes of this work will include breeding strategies to simultaneously improve flaking grit yield and agronomic performance. Our data will also provide the basis for the development of methodologies to predict flaking grit yields in new corn inbreds and their hybrids. Moving along the corn cereal pipeline, we have already started setting up new experiments to investigate whether flaking grits produced from hybrids with different dry-milling processing characteristics vary in nutritional value. We anticipate that this information will enable the selection of corn hybrids with improved nutritional value and inform the design of improved processing protocols, as some effects related to nutrient content and stability may be not genetically based, but controlled by food processing conditions.
Changes in soybean varieties over the last 80 years

The development of improved soybean varieties has been a major emphasis for breeders in both the private and public sectors. The improvement of variety yield potential combined with better agronomic practices has resulted in the U.S.’s national average soybean yields increasing at a rate of 0.35 bushels per acre per year between the 1920s and today. In Illinois, the yield increase was even higher—0.38 bushels per acre per year (Figure 15). Despite these increases, growers have expressed frustration about the slow pace of yield improvements in soybean, especially relative to improvements in corn.

Over the last two years, we conducted experiments to determine the contribution of variety improvement to the observed yield increases, compared with the contributions of other factors, such as agronomic practices and climate changes. In 2010 and 2011, yield trials were conducted with 60 maturity group (MG) II, 59 MG III, and 49 MG IV soybean varieties that were released from the 1920s to 2008. These included varieties from the public sector as well as varieties developed by Monsanto, Pioneer, and Syngenta. The MG II and III varieties were grown at locations in eight states each year and the MG IV varieties at locations in 10 states.

What have we learned from the yield tests? Our primary finding indicates that a large portion of the yield increases observed over the last 80 years is the result of genetic improvements in soybean varieties. When these varieties from different decades were grown in common environments, the yield increases seen from variety improvement are 0.34 bushels per acre per year in MGs II and III and 0.3 bushels per acre per year in MG IV, which are almost identical to the national yield trend. In addition to the greater yield potential of modern varieties, these varieties stand better, mature later, and have less seed protein concentration and greater oil concentration than older varieties.

We also conducted studies to better understand how modern varieties are more productive than old varieties, which can provide clues on traits that could be targeted for further improvement. We found that, on average, modern varieties flower earlier than old varieties, resulting in a longer seed-fill period. Preliminary results also showed that new varieties have a greater photosynthetic rate than old varieties, meaning that they can fix more carbon into biomass. Finally, we found that new varieties put more of their total biomass into seed than old varieties.

Figure 15. Average yield of soybean in the U.S. and Illinois from the 1920s to the present time.
Edamame (pronounced eh-duh-MAH-may) are special cultivars of soybean that are harvested at a “green bean” stage and the plump, immature seeds consumed as a vegetable (Figure 16). Like grain-type soybean, edamame seeds are high in protein and low in fat. However, edamame requires almost no processing and is easy to prepare, versatile, and delicious. If you live in Illinois—a leader in soybean production—here are three things you should know about edamame.

Fact #1
Although edamame is historically a crop of Asia, its production in the United States isn’t new. In 1855, the Country Gentleman published an article that mentioned vegetable soybean in Ohio. During World War I, USDA scientists tested edamame as a source of protein for troops fighting in Europe. William J. Morse and P.H. Dorsett collected over 100 edamame varieties from Japan in 1929 and grew them in the USDA’s Arlington Farm in Virginia. By 1939, J.W. Loyd and W.L. Burlison of the University of Illinois published Eighteen Varieties of Edible Soybeans, (Figure 17) and the varieties were widely grown in wartime victory gardens. By the mid-1980s, Jim Lambert of Minnesota began growing edamame, producing 750,000 pounds by 1994.

Despite multiple attempts to grow edamame domestically, today we import nearly all of what is consumed in this country. Can we not grow edamame in the United States? We grow some 75 million acres of grain-type soybean, and edamame is a type of soybean, after all. Challenges include improved varieties adapted to various U.S. growing regions and advancements in mechanization and processing. Though previous attempts at domestic edamame production have fizzled, domestic consumption continues to grow. Finally, a number of major vegetable processors are actively investigating the prospect of feeding the growing domestic demand with domestic product.

Fact #2
Weeds and diseases are major threats to U.S. edamame production, so we are researching ways to improve pest management. For the last two years, we have evaluated more than 120 entries of commercial or public edamame germplasm. Entries have been evaluated for response to herbicides being considered for use on the crop, disease resistance, and agronomic traits important to commercial production. Additional field studies are being used to quantify effectiveness of different integrated weed management systems. Results underscore the importance of improved pest management systems before edamame can be successfully grown on a commercial scale.

Fact #3
Pesticides registered for use on soybean are not necessarily registered for use on edamame. The period of time from pesticide application to harvest can be much shorter for edamame than for soybean, and the U.S. Environmental Protection Agency considers edamame a different crop. Edamame is in crop subgroup 6A—edible-podded legume vegetables—along with snap beans and snow peas. At the time this abstract went to press, only four herbicide active ingredients had a federal label for use on edamame: clathomid, linuron, s-metolachlor, and trifluralin. An up-to-date list of registered herbicides can be found at ir4.rutgers.edu/food.html.
Persistence, patience, and perseverance in the battle against waterhemp

Waterhemp has become a bane to weed management practitioners in many areas of the Midwest. The species has many characteristics that suit it to thrive under contemporary agronomic production practices, including the proclivity to evolve resistance to herbicides from various site-of-action families. Resistance to herbicides from five site-of-action families has been documented in various Illinois waterhemp populations. Resistance to any site of action is troubling, but multiple resistance, or resistance within a population to more than one site of action, is of particular concern. Data generated from recent surveys indicate this type of resistance is becoming increasingly common in Illinois waterhemp.

In years past, new herbicide active ingredients were frequently commercialized for the soybean market, but that has changed dramatically. It is unlikely that new active ingredients for effective postemergence control of waterhemp will be introduced into the soybean market during the next few years. If the effectiveness of currently available postemergence soybean herbicides for waterhemp control continues to be reduced, waterhemp management may reach a new level of difficulty, at least for the foreseeable future.

One way to reduce the selection of herbicide-resistant waterhemp biotypes is to integrate multiple control tactics, such as soil-applied and postemergence herbicides, mechanical cultivation, or all three. Research by University of Illinois weed scientists in the mid-1990s demonstrated that many soil-applied corn and soybean herbicides provide effective waterhemp control, but few consistently provide control all season. Our recommendation has been, and will continue to be, that the most consistent programs for waterhemp management include soil-applied (Figure 18) and postemergence herbicides, along with mechanical cultivation where feasible. Experience has shown that continued heavy reliance on a single herbicide active ingredient, to the exclusion of other management tactics, ultimately speeds the selection for herbicide-resistant weeds.

Are there other “nontraditional” practices that might help in the ongoing battle against the pesky and persistent Amaranthus? Could we exploit herbicide synergism and possibly even antagonism to control waterhemp populations with resistance to multiple herbicides? Do the rotary hoe and cultivator represent the last bastions of hope to keep these weed populations at manageable levels? Will multiple applications of soil-residual herbicides become the norm?

One strategy for improved waterhemp management is to enhance the activity of existing herbicides by synergizing them with other herbicides or even other pesticides. This has been documented previously in triazine-resistant Amaranthus by combining postemergence HPPD-inhibiting herbicides (such as Callisto, Impact, or Laudis) with atrazine. Another method for synergizing activity on waterhemp is to combine postemergence herbicides with insecticides that inhibit herbicide metabolism. However, a common consequence of this type of synergistic interaction is unacceptable crop injury; for example, tank-mixing organophosphate insecticides with Accent or Callisto leads to stunted or bleached corn plants (Figure 19). If synergistic tank-mixes could be selectively applied to corn, however, this could offer new and improved strategies for managing multiple-resistant waterhemp populations in Illinois. Research by U of I weed scientists in the summer of 2012 investigated whether selective waterhemp control could be achieved with synergistic tank-mixes while avoiding corn injury.
Herbicide-resistant weeds: Current challenges, new tools

The ongoing evolution of herbicide-resistant weeds poses a significant challenge to current weed management practices. Recent and particularly worrisome examples in Illinois include biotypes of waterhemp (*Amaranthus tuberculatus*), Palmer amaranth (*Amaranthus palmeri*), and horseweed (also known as marestail—*Conyza canadensis*) resistant to glyphosate; a waterhemp biotype resistant to HPPD inhibitors; and waterhemp populations/biotypes that display multiple resistance to herbicides spanning several site-of-action groups. In fact, data from surveys suggest that the majority of waterhemp populations now exhibit multiple herbicide resistance (Figure 20).

While it is true that concerns about herbicide-resistant weeds were suppressed among many weed management practitioners by the great success of glyphosate-resistant crops, it is equally true that the now-increasing occurrence of glyphosate-resistant weeds has awakened those concerns. As a consequence, there has been a revitalization of R&D efforts to find new tools for weed management.

Within the next few years, we anticipate the availability of new herbicide-resistant crops. Specifically, these likely will include crops with genetically engineered resistance to 2,4-D, dicamba, or HPPD-inhibiting herbicides. Furthermore, these crops will be stacked with other forms of resistance (e.g., with resistance to glyphosate and/or glufosinate).

Dow AgroSciences anticipates introducing its Enlist Weed Control System in corn in 2013, with soybean to follow later. Essentially, the Enlist system includes metabolic resistance to 2,4-D that will be stacked with glyphosate resistance. Coupled to the Enlist system is a new formulation of 2,4-D.

Monsanto is also developing crops with resistance to synthetic auxin herbicides stacked with glyphosate resistance, but their crops will be resistant to...
dicamba rather than 2,4-D. Monsanto has recently announced that they are on track for a 2014 launch of dicamba-resistant soybean.

Both Syngenta and Bayer are evaluating crops resistant to HPPD inhibitors. The most significant such crop in the Midwest would be soybean, but it likely will not be available for at least a couple more years.

Note that although these new herbicide-resistant crops will increase herbicide options for a given crop, the herbicide options will not include novel site-of-action chemistries. In other words, the new crops entail the use of old chemistry (or new formulations or variations of old chemistry). And, importantly, weed biotypes already exist that are resistant to these herbicides (Figure 21). Thus, one would be naive to expect any of these new weed control tools to solve all of our current weed resistance problems.

Another potential new tool to assist in weed management, recently announced by Monsanto, is BioDirect Technology. This technology is intriguing in that it is a biologically rather than chemically based approach. It is still in very early stages of development, but it will be interesting to follow because it may eventually yield a novel approach to weed control. Regardless of how novel the technology is, however, it—like herbicides—will not be immune to resistance evolution.

One of the things we learned from the Roundup-Ready era is how to overuse something that seemingly is almost too good to be true. If and when we begin adopting new weed control options, we must not forget this lesson. Any weed control option must be used wisely and judiciously—and as but one component of an integrated weed management strategy—if its effectiveness is to be preserved.

---

<table>
<thead>
<tr>
<th>Herbicide group</th>
<th>Example herbicides</th>
<th>Number of resistant species worldwide</th>
<th>Resistant species in Illinois</th>
<th>Other resistant species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glyphosate</td>
<td>Roundup, Touchdown</td>
<td>23</td>
<td>Waterhemp, Palmer amaranth, horseweed</td>
<td>Common ragweed, giant ragweed, johnsongrass</td>
</tr>
<tr>
<td>Glufosinate</td>
<td>Ignite, Liberty</td>
<td>2</td>
<td>None</td>
<td>Goosegrass, ryegrass</td>
</tr>
<tr>
<td>Synthetic auxins</td>
<td>2,4-D, dicamba</td>
<td>29</td>
<td>None</td>
<td>Waterhemp, field bindweed, kochia, lambsquarters</td>
</tr>
<tr>
<td>HPPD inhibitors</td>
<td>Callisto, Laudis, Impact</td>
<td>2</td>
<td>Waterhemp</td>
<td>Palmer amaranth</td>
</tr>
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</table>

Figure 21. Current status of weed resistance to herbicides associated with major current and anticipated herbicide-resistant crop technologies.
Nutrient removal rates of new hybrids and varieties

Every year as crops are harvested, nutrients contained in the seed are exported out of the field. Normally farmers applying a maintenance rate of phosphorus (P) and potassium (K) fertilizer multiply their yield in bushels by a factor representing the fertilizer equivalent in pounds (lb) present in the harvested seed. In Illinois, the standard values were established over three decades ago: for corn, 0.43 lb P₂O₅ and 0.28 lb K₂O; for soybean, 0.85 lb P₂O₅ and 1.30 lb K₂O. Many changes in hybrids, management practices, and technology have occurred since these standards were set, so we conducted a study to reevaluate the standard values. We produced a robust database by analyzing approximately 5,000 seed samples representing nearly 290 corn hybrids and 650 soybean varieties grown in 2009 throughout the state (DeKalb, Monmouth, Urbana, and Belleville for both corn and soybean and one additional location at Harrisburg for soybean). In each location all treatments were replicated three times. All locations had adequate fertility, and management practices were conducive to maximizing yield. Across locations, the average corn yield was 215 bushels per acre; the average soybean yield was 62 bushels per acre.

Various factors can affect the amount of nutrient removed; fertility of the field and hybrid can have some influence on the nutrient concentration of the seed, but the most influential factors are the actual crop grown and the yield level. Nutrient concentration in the seed is a fairly conserved trait. Sometimes when the fertility of the field is high, plants accumulate more nutrients than needed in their vegetative tissues, but rarely is that accumulation reflected in a proportional...
increase in nutrient concentration in the seed.

During our preliminary analysis, we were unable to explain the range of concentrations measured for the different nutrients by location or corn hybrid (Figure 22) or soybean variety (Figure 23). Further, we observed no correlation between seed yield and seed nutrient concentration. In other words, there was no indication that an increase in yield would cause seed concentration to increase or decrease. As expected, since there was no relationship between seed yield and seed nutrient concentration, as yield increased the total nutrient removal also increased.

Of greatest interest is that the P and K removal values used in Illinois for many years no longer seem adequate for the corn and soybean crops currently being grown. Removal values for both P and K for corn (Figure 24) and soybean (Figure 25) are lower than the traditional standards. For P the overall average shows that for both corn and soybean, the removal rate is 0.16 lb P₂O₅ per bushel lower than the standard. For K, the removal rate for corn is 0.09 lb K₂O per bushel lower than the standard, while for soybean it is 0.13 lb K₂O per bushel lower than the standard. This is an important finding, as a corn crop of 200 bushels per acre would be removing 32 lb of P₂O₅ and 18 lb of K₂O per acre less fertilizer than previously estimated. Similarly, a soybean crop of 60 bushels per acre would be removing approximately 10 lb of P₂O₅ and 8 lb of K₂O per acre less fertilizer than previously estimated. When only maintenance fertilizer rates are needed, these new standards can translate to substantial savings in fertilizer cost. While there is convincing evidence that P and K maintenance rates should be reduced, as shown in Figures 24 and 25, the traditional removal standards are, overall, below the high end of the ranges we measured. Additional analysis of the data might allow us to identify variables that could be used to more closely estimate when a substantially lower-than-average or substantially higher-than-average removal rate may be more appropriate.

We express gratitude to the Department of Crop Sciences Variety Testing Program for their assistance in collecting seed samples and to the Illinois Fertilizer Research and Education Council for providing funds for nutrient analysis.

### Table

<table>
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<tr>
<th>Location</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Range</th>
<th>Median</th>
<th>Mean (std. dev.)</th>
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<tr>
<td>Pounds of P₂O₅ per bushel</td>
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<td></td>
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<td>0.52</td>
<td>0.40</td>
<td>0.26</td>
<td>0.26 (±0.048)</td>
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<td>0.41</td>
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<td>Urbana</td>
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<td>0.19 (±0.026)</td>
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</table>

* Number of samples used for the calculation.

Figure 24. Descriptive statistics for the pounds of P₂O₅ and K₂O removed per bushel of corn yield for different Illinois locations, averaged across all hybrids tested.

### Table

<table>
<thead>
<tr>
<th>Location</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Range</th>
<th>Median</th>
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<td>0.49</td>
<td>1.18</td>
<td>1.17 (±0.074)</td>
</tr>
</tbody>
</table>

* Number of samples used for the calculation.

Figure 25. Descriptive statistics for the pounds of P₂O₅ and K₂O removed per bushel of soybean yield for different Illinois locations, averaged across all varieties tested.
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Dr. Patrick Tranel

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Dr. George Czapar

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Dr. Brian Diers

Advance registration and payment are required – deadline is Friday, August 17.

Register online at internationalagronomyday.org
Reducing nutrient loss from agricultural fields is a challenge that continues to face producers and is a focal point for potential regulations and lawsuits. As the value of Illinois cropland and cash rents increase, economic considerations become more critical, and competition between conservation practices and production may become more intense. In addition, new tile drainage systems are being installed throughout Illinois, and their effects on crop productivity, water quality, and water balance need to be considered (Figure 26).

Best management practices (BMPs) and stewardship programs that promote correct nutrient rate, timing, placement, and source can help improve water quality. To be successful, however, these practices must also be economically sustainable and adaptable to individual farm operations. The challenge of balancing production and environmental protection is especially important in tile-drained watersheds. Practices such as controlled drainage, edge-of-field bioreactors, constructed wetlands, and cover crops are being evaluated for both environmental and economic benefits (Figures 27 and 28). Integrated projects that involve research, education, and outreach in the Upper Salt Fork Watershed and the Embarras River Watershed seek to evaluate practices that reduce nitrate loss but also maintain crop productivity. In addition, the projects are trying to identify barriers to adoption and necessary incentives to promote practice changes at the watershed scale.

There is also growing interest in cover crops to help reduce soil erosion, improve soil quality, and sequester nutrients (Figure 29). New approaches for planting and managing cover crops will be required, and the effects on water quality and water balances are being explored.

In most cases, a combination of approaches is needed to achieve water-quality goals, and the suggested practices may vary depending on soils, topography, and individual farm operation. Unfortunately, there is no quick and easy solution for addressing water-quality impacts of agriculture; rather there is a need to continually refine management practices to improve nutrient use efficiency and minimize nutrient loss.

Funding for this work was provided by the National Integrated Water Quality Program, USDA-NIFA.
Breeding soybeans for tomorrow’s atmosphere

Carbon dioxide and ozone are two important gases in the atmosphere with direct effects on crop production. In the last 250 years, atmospheric carbon dioxide concentration ([CO₂]) has risen from 280 to 390 parts per million (ppm). Atmospheric [CO₂] is projected to continue rising to at least 550 ppm by 2050. As CO₂ concentrations increase, photosynthetic rates increase in C₃ crops such as soybean and wheat, so when soybean is grown at elevated [CO₂] (~550 ppm), yield is stimulated by about 15%. Like CO₂, ozone has also become more abundant in the atmosphere, increasing from a pre-Industrial Revolution concentration of less than 20 parts per billion (ppb) to a current concentration of 40 ppb during the summer growing season in the northern hemisphere. Current ozone concentrations are damaging to both human and plant health. In plants, ozone enters the leaves through the stomata and forms other reactive oxygen species, which in turn damage proteins, membranes, and cellular function. Ozone is responsible for significant reductions in crop yields, with global economic losses estimated to cost $14 to $26 billion annually. In the United States, ozone is estimated to cost soybean growers $1.8 to $3.6 billion in lost yields per year.

To maximize future yields, it is important to breed for soybean that take maximum advantage of the increase in atmospheric CO₂ and that are tolerant to ozone. The University of Illinois and the USDA Agricultural Research Service have a unique facility (SoyFACE) for studying the effects of rising ozone and carbon dioxide concentrations on crops. The SoyFACE experiment (www.soyface.illinois.edu) enriches the concentration of ozone or carbon dioxide around a plot of soybeans without using any enclosures (Figure 30). SoyFACE, which began in 2001, was designed to discover the effects of atmospheric change on the agronomy and productivity of midwestern crops as well as to find solutions that will lead to crops better adapted to this future. Current experiments include season-long warming, heat wave simulations, and drought stress treatments in addition to elevated carbon dioxide and elevated ozone concentrations.

We have tested the response of a number of soybean lines (genotypes) to elevated CO₂ and elevated ozone at the SoyFACE facility since its inception. There is clear variation among different genotypes (Figure 31), and we are using that variation to identify the genetic basis for differences in response to CO₂ and ozone. We are developing a hybrid population from a cross of HS93-4118 and Loda to use for testing the genetic basis for variation in soybean response to elevated CO₂.

Figure 30. (Top) Aerial view of the SoyFACE experiment where soybeans are exposed to elevated carbon dioxide and ozone concentrations under standard field conditions. (Bottom) One of the ozone plots at the end of the growing season in 2009. Photos courtesy of Dr. Andrew Leakey.
A hybrid population developed from a cross of Dwight and Pana is being screened under ambient and elevated ozone concentrations. Results from the first year of field trials confirmed that Pana was more sensitive to ozone than Dwight, evidenced by a greater decrease in total seed yield, 100 seed weight, and stem diameter (Figure 32). Transgressive segregation (more extreme phenotypes in the progeny than the parents) was also observed, with some lines showing less yield loss than either parent. The 192 Dwight x Pana hybrid lines are being genotyped using a commercial array of single nucleotide polymorphism markers. This information will be used to generate a genome-wide linkage map. Then the linkage map will be used to identify ozone response regions of the genome (quantitative trait loci) related to ozone tolerance.

While drought, temperature variation, pests, and diseases have challenged agriculture throughout time, the changes in atmospheric composition represent both a challenge and an opportunity for agriculture in the future. These experiments represent a first step toward breeding for tomorrow’s atmospheric environment.

This project is supported by the Agriculture and Food Research Initiative Competitive Grants Program grant no. 3952010-65114-20355 from the USDA National Institute of Food and Agriculture.
Gasifier using various Illinois feedstocks for heat/power applications

Engineers are showing off a small-scale biomass gasifier at this year’s Agronomy Day (Figure 33). This gasifier, built for demonstration and teaching, is a downdraft, partial oxidation type, similar in design to the venerable Imbert made for wood chips. It converts low-moisture, solid carbon-containing biomass into a mixture of combustible and inert gases, plus high molecular weight tars and ash. The gas mixture can be used like natural gas or fuel oil to heat a steam boiler or to run an internal combustion engine or turbine.

The goal for our tour stop is to take some of the mystery out of the term “gasification” and help producers and industry decide whether gasification fits in their view of the biomass energy supply chain.

Compared to a direct-fired boiler, a gasifier effectively separates the fuel from the boiler and allows some cleanup of the gas before it enters the boiler section. Gasification allows use of a wider range of feedstocks and a range of moisture contents, because feedstock is converted at a lower temperature (about 700–900°C, due to the restricted air:fuel ratio) and the producer gas can be cleaned up prior to use. By comparison, a furnace, which is a combustion appliance with no steam boiler involved, operates with excess air (a higher air:fuel ratio than a gasifier). The combustion products that result can be corrosive or can produce ash “clinkers” that clog the device.

For converting very large quantities of biomass, such as crop residues or dedicated energy crops, large-scale gasification may be a good candidate. Solid fuels are hard to manage in small-scale and mobile applications, so gasifiers will probably be confined to stationary heat and power use in the near future. Woody biomass, perennial grasses, crop residues, poultry litter (dry barn bedding plus poultry manure), and other fairly dry carbon-based feedstock are all candidates for gasification. The shape of the fuel particles is important, as long, stringy material that is not flowable and that may bridge above the “hearth” area cannot be used in this type of downdraft gasifier. For some feedstocks, the methods for material preparation can therefore be critical.

The energy product of this type of gasification is “producer gas” (formerly called town gas or water gas based on the municipal gasification works in the early 20th century). It contains carbon monoxide, a little methane, hydrogen, and some volatile organic compounds (VOCs), which are combustible; nitrogen, carbon dioxide, and water vapor, which are essentially inert; small amounts of compounds of nitrogen (NOx), elements such as potassium and chlorine, and tars and particulates. The energy content of producer gas is low—20% to 40% by volume compared with natural gas, which is mostly methane.

Gasifiers can be classified based on the direction of gas flow: downdraft, updraft, crossdraft, or hybrid variations. Our demonstration gasifier is downdraft, which is the configuration often used to produce gas for internal combustion engines because the tars and particulate material are less than in simple updraft gasifiers. Fluidized-bed gasifiers are updraft, with the fuel being introduced into a bed of sand or other inert material and the bed “fluidized” by gas flowing up through the bed. In large-scale stationary applications, fluidized-bed gasifiers can be more efficient and cleaner-burning than other types.

The ash from a gasifier contains phosphorus and potassium—both valuable crop nutrients—and some carbon. Researchers are studying the best way to close the loop on fertilizer constituents going back to cropland that supplies feedstock to gasification facilities.

Gasifier enthusiasts and engineers who are considering gasification as a means of energy conversion for biomass materials need to look into the prior experience with the technology, since much was learned in the 20th century about how to build and operate a successful, efficient unit. Our studies are aimed at adapting proven gasifier designs—like our Imbert downdraft—to dedicated energy crops and other feedstocks that are of major interest in the Midwest today.
Looking for a fast-paced, exciting career that truly makes a difference? Interested in a high starting salary and multiple job offers when you graduate?

Visit the University of Illinois and the Department of Crop Sciences to find out how you can land a great future in agriculture, biology, biotechnology, ecology, genetics, horticulture, or another growing profession.

To set up a visit, contact Fred Kolb, the department’s teaching coordinator, at 217-333-4256, 217-333-9485, or f-kolb@illinois.edu; or Wendy White, undergraduate student recruiter, at 217-244-0484 or wgwhite@illinois.edu.
What causes the continuous corn yield penalty?

You may be one of the many farmers in Illinois who is increasing your corn acreage this year by moving to continuous corn and corn–corn–soybean systems and away from the traditional corn–soybean rotation. If so, you’re probably aware that there is usually a yield penalty (10–25 bu/acre) for corn after corn compared to corn after soybean. And maybe you have heard from other farmers, as we did, that the yield penalty goes away after 4 to 6 years, resulting in equal corn yields for continuous corn (CC) and corn–soybean rotation (CS). We were interested in the cause(s) of the continuous corn yield penalty (CCYP) as well as how yields change over time in CC systems. We also wanted to know if the CCYP could be reduced or eliminated by increasing nitrogen (N) fertilizer rates. This study was conducted from 2005 to 2010 in Champaign County beginning with corn produced in a 3rd-year CC system or a CS rotation at six N fertilizer rates.

We calculated the agronomic optimum N rate (AONR, which is the N rate at which corn yield increases associated with additional N application begin to decline) for each system (CC and CS) each year of the study and defined the yearly CCYP as the corn yield difference between the CS and CC systems at their respective AONRs. We found that CC systems required more N fertilizer than the CS treatments to reach the AONR, and CC produced lower yields at that N rate (Figure 34), demonstrating that CC systems require more N fertilizer to produce lower yields than CS rotations. Averaged across all years, yield at the AONR for CC was 167 bu/acre and for CS was 192 bu/acre, resulting in a CCYP of 25 bu/acre; CCYP values ranged yearly from 8.9 to 42.0 bu/acre.

To explore the causes of the CCYP, we tested a number of different weather- and yield-related measurements for their relationships with the CCYP. We found that we could estimate the CCYP with almost 100% accuracy with just three predictors: unfertilized CC yield, years in CC, and the difference between CC and CS delta yields.

The best predictor of the CCYP was unfertilized CC yield; in years when unfertilized CC yields were relatively high, the yield penalty was low, and vice versa. Unfertilized CC yield is an indicator of how much N the soil is supplying to the corn crop either from residual fertilizer N or from decomposition of previous crop residues and other soil organic matter sources (N mineralization). The second predictor of the CCYP, years in CC, was also very well correlated with the CCYP and demonstrated that the CCYP got worse with each additional year in the CC system through the 7th year. This conclusion contrasts with testimonies of many farmers in the Corn Belt who claim that corn yields in CC eventually attain the same level as CS rotations. On average, the
Figure 34. Corn yield response to nitrogen fertilizer application rate for each year, 2005 to 2010, for continuous corn (CC) and corn–soybean rotation (CS). Coefficients of determination ($R^2$ values) are provided in legends. CC treatments were in the 3rd, 5th, and 7th years of continuous production for 2005–06, 2007–08, and 2009–10, respectively. Agronomic optimum N rates (AONR) and corresponding yields are indicated by cross symbols.

CCYP in this study increased by 186% from 3rd-year CC to 5th-year CC and 268% from 3rd-year CC to 7th-year CC. We believe that yields declined with time in CC as a result of large amounts of accumulated corn residue in these systems. The final predictor of the CCYP, difference in delta yields (which is the maximum yield under non-N-limiting conditions minus the yield without N fertilizer) between CC and CS, is probably a function of weather conditions, particularly during critical growth periods such as ovule determination and grain fill. Some weather conditions, such as drought and heat stress, can disproportionately reduce yields of the CC system relative to the CS system.

This study suggests that the continuous corn yield penalty (CCYP) persists for at least 7 years. However, we found that during very favorable growing seasons, increased N rates can overcome the CCYP. Higher N rates do not reduce the CCYP during average or poor growing seasons, however. This study concludes that the primary causes of the CCYP are N availability, corn stover accumulation, and weather. Given that weather cannot be controlled and the optimum N fertilizer rate can only be determined after crop harvest, managing corn stover has the greatest potential for reducing the CCYP.
Is it a racehorse or a workhorse?

Selecting appropriate corn hybrids remains one of the most important and challenging decisions that a corn grower makes each year. Seed corn guides are filled with terms like “racehorse” and “workhorse,” but what do these descriptors really mean? The common perception of a racehorse hybrid is that it requires increased management of inputs like nitrogen (N) and seeding rate. As a result, it is believed that a corn grower will be disappointed with the yield of a racehorse hybrid if it is not managed properly. In contrast, a so-called workhorse hybrid might have less yield potential, but its maximum yield could be achieved with less attention to agronomic management.

Hybrid selection for corn growers who seek to increase their profitability through intensive crop management is particularly complicated due to the importance of identifying genetics with high yield potential and responsiveness to agronomic inputs like N and increased plant density. Unfortunately, information is lacking on the N and plant density responses of available hybrids. To address this, the Crop Physiology Laboratory is characterizing the management yield potential of corn hybrids using carefully selected N and plant density treatments.

The treatments that we use to characterize hybrids consist of three fertilizer N rates (0, 60, and 240 lb N/acre) and two plant densities (32,000 and 45,000 plants/acre). The N treatments allow for measuring the check plot yield (yield achieved with 0 lb fertilizer N/acre), the initial N response (yield gain achieved with 60 lb fertilizer N/acre), and the maximum N response (yield gain achieved with 240 lb fertilizer N/acre). Hybrids are evaluated at both plant densities within each N level. Although 45,000 plants/acre exceeds the range of densities typically used by corn growers, it provides an excellent indication of the stress tolerance of a hybrid and its potential to respond to more plants per acre. Above-average responses to both N and plant density constitute a racehorse hybrid (one with high-management yield potential), while above-average check plot yield and initial response to N indicate a workhorse hybrid (Figure 35). The significance of above-average check plot yield and initial N response is that these characteristics allow a hybrid to better tolerate N loss due to leaching or denitrification of applied fertilizer N.

Under more typical agronomic conditions (32,000 plants/acre and 240 lb N/acre), grain yields of the top 16 hybrids evaluated in 2011 were statistically similar, averaging 186 bushels/acre. Grain yield under “standard” conditions does not indicate which hybrids have the potential to respond to increased plant density or which might better tolerate nitrogen loss, so we calculated scores for response to plant density (RTP) and response to nitrogen (RTN) and combined a hybrid’s individual scores into a management yield potential index to identify the hybrids that are suitable for extra management.

Based on that index (values ≥ 15), only 5 of the 24 hybrids that we evaluated in 2011 possessed both high-RTP and high-RTN characteristics. Similarly, we calculated scores for check plot yield and initial N response (yield gain achieved with 60 lb fertilizer N/acre) to identify hybrids that might tolerate N loss or reduced application of fertilizer N. Based on the subsequent N loss tolerance index (values ≥ 15), only 4 of the 24 hybrids had exceptional tolerance of low N. Two of the four hybrids were classified into the high-management yield potential category as well as the N loss–tolerant group, suggesting that some hybrids can have good yields under low-input management systems and even higher yields with extra management. Hybrids that fell into both categories had the common characteristic of possessing high grain yield without application of N fertilizer.

Based on these results, we conclude that “racehorse” hybrids, or those that respond well to both N and increased seeding rate, are often good hybrids under normal and intensive management systems. In contrast, there is greater risk to planting a hybrid at too high a plant density, because not all hybrids can tolerate plant densities exceeding those commonly practiced. We recommend that corn growers who experiment with intensive management practices should question their seed providers on the N and plant density response characteristics of available hybrids in order to fully realize the yield potential of increased agronomic management.

Figure 35. Response to plant density (RTP) plotted versus maximum response to nitrogen (RTN). The horizontal dashed line is the average response to increased plant density (-4 bushels/acre) and the vertical dashed line is the average response to 240 lb fertilizer N/acre (99 bushels/acre). Hybrids located within the top right quadrant (average yield of 184 bushels/acre) have racehorse hybrid characteristics because they possess above-average responses to both plant density and nitrogen. Hybrids located within the top left (average yield of 183 bushels/acre) and bottom right (average yield of 186 bushels/acre) quadrants have similar yields; however, they differ in their management requirements. Hybrids in the top left quadrant have low responsiveness to nitrogen but tolerate increased plant density, so they are best managed with extra seed. In contrast, hybrids in the bottom right quadrant do not tolerate high plant density but require extra nitrogen.
Agricultural Safety and Health and AgrAbility Unlimited

Providing farmers practical techniques to reduce risks and hazards on the farm

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University of Illinois Extension safety specialists offer the most recent data and circumstances involved in Illinois farm-related fatalities and injuries. Important practical techniques help farmers reduce the hazards on their farms and the risks that they, their families, and their farm visitors encounter from daily work situations in production agriculture. Through AgrAbility Unlimited, farmers, their families, and their agricultural workers can continue to enjoy their way of life. The program seeks to help those with disabilities overcome them by conducting various activities, including a toll-free information and referral hotline, networking with local agricultural and rehabilitation professionals, coordinating community resources, and providing information on equipment modification.

Center for Advanced BioEnergy Research (CABER)

One-stop shop for Illinois bioenergy information

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The Center for Advanced BioEnergy Research (CABER) in the College of ACES provides a framework for bioenergy-related research and scholarship. It helps facilitate cross-disciplinary research, education, and outreach to promote the use of bio-renewable resources. CABER also provides science-based information to external stakeholders in the bioenergy industry and to consumers. For a daily review of bioenergy news and research throughout the world, visit our blog: bioenergyuiuc.blogspot.com.

In the CABER Bioprocessing Laboratory, researchers and commercial partners can test scale-up and commercialization steps for new feedstocks, biofuels production, and biochemical production. Progress in this lab will create opportunities and new crops for farmers and help produce sustainable renewable energy sources.

In educational offerings, CABER coordinates the Professional Science Master’s degree in bioenergy, a 16-month program that combines science and business classes and an internship. CABER’s Advanced Bioenergy Topics seminar series, held during the spring semester, is open to the general public, and an online class in bioenergy is also offered each spring.

The Illinois Biomass Working Group discusses opportunities for farmers, industry, academia, and the financial industry to work together on biomass issues, including logistics, market creation, research, and small- to large-scale heat and electricity projects. For more information, visit www.illinoisbiomass.org.

College of Agricultural, Consumer and Environmental Sciences: Academic Programs

Imagine ACES

Holly Herrera, Coordinator for Transfer Recruitment, Academic Programs, holly10@illinois.edu, www.aces.illinois.edu, 217-333-3380

Do you know students who are interested in agricultural, consumer, or environmental sciences? Take-home information is available at the College of ACES display, which offers a diverse array of majors that prepare students for exciting careers across the agricultural spectrum and beyond. Stop by to learn about admissions, scholarships, careers, and more. Staff are on hand to chat about the resources available to help our students thrive and succeed in the College of ACES and in life after graduation.
Whenever a pesticide is applied, the primary goal is to eliminate the target pest. Of equal importance are making the application safely and reducing drift. The size of the spray droplets has a major impact on these goals. When choosing the correct droplet size for an application, remember that droplet size is a compromise between reducing drift and covering the target. Increasing droplet size reduces the risk of drift but also reduces coverage; a smaller droplet size increases coverage but also increases the risk of drift. The pesticide being applied, the target pest, and the type of crop and its developmental stage all affect the best droplet size for an application. The droplet size created during an application is a function of the nozzle type, orifice size, fan angle, and operating pressure along with the various pesticides and adjuvants in the spray solution.

Infrared heaters are used in the field (T-FACE) to simulate temperatures that are 7°F higher than current temperatures and to investigate the effects of a 10°F heat wave lasting for three days. In the drought experiment (DriFACE), retractable awnings are deployed to divert nighttime rain, which eliminates as much as 85% of the water available to the plant throughout the growing season. An elevated ozone experiment is investigating the effect of pollution on soybean yield by fumigating plants with increasing concentrations of ozone. Results suggest that losses due to ozone are already costing Illinois farmers 10% of their potential yields. If pollution continues to rise, an additional 5 bushels per acre will be lost by the year 2050. The results of these studies are being used to influence plant breeding programs, with the goal of maintaining high-yielding varieties in the face of a changing climate.

Farmdoc
Improving farm decision-making through education and research

Farmdoc (www.farmdoc.illinois.edu) provides Illinois farmers with comprehensive and integrated risk management information and analysis to help improve their decision making. Publications, decision tools, and databases related to a variety of risk management issues are found throughout the site, which is maintained by the Department of Agricultural and Consumer Economics. Topics include finance, marketing and outlook, management, law and taxation, and policy. Specialty sections are devoted to the AgMAS (Agricultural Market Advisory Services) project, crop insurance, farmland owners, prices and weather, and agricultural web resources.
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Approximately 25,000 acres of pumpkins are produced annually in Illinois, and more than 90% of U.S. processing pumpkins are grown and processed in Illinois. In 2010 and 2011, severe leaf and fruit symptoms typical of bacterial spot caused by Xanthomonas cucurbitae were observed in pumpkin fields, which resulted in yield losses from 3% to 90%. Leaf infection was observed from the time of spreading vines until harvest, and infection of fruit occurred from when fruit weights were 0.5 pound until harvest. Leaves had small (2 to 4 mm), angular, yellow spots (Figure 1, A and B). The upper surface of fruit had small (1 to 3 mm in diameter), slightly sunken, circular spots, each with a beige center and dark brown halo (Figure 1, C and D). In wet conditions, fruit infection led to fruit rot (Figure 1, E and F).

A survey in 2010 showed that bacterial spot occurred in 40 of 50 commercial pumpkin fields, with symptoms on 3% to 94% of fruit in a field (average 34%). A survey in 2011 showed fruit with bacterial spot symptoms in 57 of 65 pumpkin fields, with lesions on 3% to 87% of the fruit in a field (average 24%). X. cucurbitae was isolated from infected leaves and fruit. The identity of the pathogen was confirmed by culturing on yeast extract-dextrose-CaCO3 (YDC) agar (Figure 1, G), carrying out chemical tests, and using primers (RST2 and RST3). Studies are underway to determine survival of X. cucurbitae in the field and develop strategies for management of the disease.

Field and Furrow Club
An agricultural club for students

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The Field and Furrow Club exposes members to every aspect of agriculture and develops the leadership skills needed to be a success. The club, open to any student, aims to gather students of a variety of majors to create a well-rounded and diversified agricultural club. Since celebrating the club’s 75th anniversary in 2010, the group has become more involved and active than ever before. In 2010 and 2012 we were named the outstanding club in the College of ACES. In addition to serving breakfast at Agronomy Day for more than 30 years, we sponsor fundraising events throughout the year and participate in various social and philanthropic activities. Our money is used for our monthly meetings and to attend regional and national conferences in conjunction with the American Society of Agronomy.
Horticulture Club

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The Horticulture Club advances knowledge, fosters professional development of its members, and encourages good fellowship among students and faculty. The club actively promotes horticulture as a part of gracious living.

The Horticulture Club has been part of student life at the U of I for more than 100 years. The club hosts the annual Mom’s Day flower show that attracts thousands of visitors to view the garden displays. The club recently hosted the 57th show with a garden theme of “A Day at the Movies.”

Illinois Farm Business Farm Management (FBFM) Association

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The FBFM program in Illinois is a cooperative educational-service, record-keeping, and business analysis program for operating farmers. There are 9 local associations in the state, with 5,775 participating farmers, or cooperators. The Pioneer FBFM Association is the oldest, in existence since 1924. The most recent, the Shawnee FBFM Association, started in the early 1960s.

As members of the association, the cooperators elect representatives to serve on a board of directors to provide for services and establish policy. The local board employs field staff to deliver the services, each working with about 100 cooperators. Field staff have the opportunity to work closely with commercial farmers on financial management, accounting, and tax concerns.

Our 60 professional staff all have at least a bachelor’s degree in agricultural economics or a closely related field. They meet with clients four or five times a year to discuss the business analysis for the farm, income tax planning, agronomic analysis, estate planning, and other topics related to operating and managing the farm business.

Illinois Soybean Association

Increasing opportunities for soybean producers

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The Illinois Soybean Association (ISA) invests checkoff dollars to increase demand for Illinois soybeans at home and abroad. In fact, our mission is to ensure Illinois soy is the highest quality, most dependable, sustainable, and competitive in the global marketplace.

While much of our effort focuses on increasing yields and profitability, ISA also works proactively on global trends that affect our long-term competitiveness. For example, we are working with the entire food value chain to increase the quality of Illinois soybeans—specifically through increased protein and oil levels—and working with international buyers and trade organizations to deliver positive news about Illinois sustainability efforts.
Richard Weinzierl, SARE coordinator, Department of Crop Sciences professor, and University of Illinois Extension entomologist, weinzierl@illinois.edu, 217-244-2126

Since 1988, the Sustainable Agriculture Research and Education program (www.sare.org) has advanced profitable and environmentally sound farming systems that are good for communities through a nationwide program of research and education grants. SARE offers grants for travel to educational programs and mini-grants to advance knowledge and skills of the agricultural professional. There are three professional development initiatives for Illinois in the coming year: scaling up local food systems, increasing the efficiency of organic production, and participating in the 2012 Regional Training Program on Carbon, Energy and Climate. Among these, scaling up local food systems is our top priority and greatest emphasis. For more information on Illinois SARE, visit illinoissare.org, go to our Facebook page at www.facebook.com/ILSARE, or find us on Twitter at twitter.com/#!/IllinoisSARE.

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The Center for Nanoscale Science and Technology, a leader in groundbreaking nanotechnology research, works toward a seamless integration of interdisciplinary studies, from atoms and materials to devices and systems. Established in 2001, the center brings together campus faculty members, graduate and undergraduate students, industry partners, and collaborating scientists from government laboratories and higher education institutions around the world.

In recent years the center has led campus-wide efforts to obtain funding from multiple federal agencies to leverage nanotechnology for agricultural, biological, environmental, and food applications. Among its recent research and development projects:

- Nanomedicine for Cancer Research Using Medicinal Plant Extracts (USAID project, jointly with the University of Karachi)
- Detection of Soybean Rust Spores Using Biophotonic Crystal Sensors
- Pathogenesis of Crop Fungi Using NEMS
- BioMEMS/NEMS for the Detection of Food Pathogens (USDA project, jointly with Purdue University)
- Integrated Wireless Sensors for Nitrate Sensing
- Carbon Nanotubes for Bigger and Better Soybeans (pilot study)
- Improving Sensitivity Detecting Gene Changes Using Microarrays

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The National Soybean Research Laboratory (NSRL) at the University of Illinois explores the genetics of soybeans, responds to marketplace challenges, and helps expand the scope and size of the U.S. soybean industry along with the profitability of U.S. soybean farmers. We develop and implement strategic research, education, and outreach programs to serve the needs of soybean producers, processors, and consumers in the areas of soy production, nutrition, and international development.

NSRL production research embraces all aspects of soybean production that will enhance soybean quality and yield. Studies span the gamut from diseases, pests, and weeds to hybridization, genetics, and nanotechnology. NSRL ensures that research complements and benefits producers and ultimately consumers. NSRL’s international activities provide nutrition support in areas around the world that face the extreme challenge of malnutrition, with sustainable solutions and enduring value chains being our focus. Through more than 35 programs in 20 countries, we work to incorporate soy into local cuisines by providing nutritional support for the world’s growing protein requirements.
Online M.S. in Crop Sciences Program
Continuing education opportunities for professionals

Anna Mehl, program coordinator, annamehl@illinois.edu, 217-244-7023, www.cropsci.illinois.edu/ocgs

Online & Continuing Education, in conjunction with the College of ACES, offers opportunities for professionals to add to their educational portfolio. The Online M.S. in Crop Sciences program strengthens students’ education part-time through online courses and optional site-based programming in crop production, plant breeding, entomology, plant pathology, horticulture, and crop management. Students may enroll in courses for personal or professional advancement, complete a certificate of professional development in Crop Sciences, or apply for admission to the master’s degree program.

After successfully completing three qualifying courses, students may receive a Professional Development Certificate with an emphasis in Crop Sciences or Horticulture. The program in Crop Sciences also works with the online M.S. programs in Natural Resources and Environmental Sciences and Agriculture Education to offer diverse courses.

Online courses typically follow a blended distance education model consisting of “live” class meetings in a virtual setting that maintains high student–faculty interaction. An asynchronous (independent) component for course assignments is also part of many courses.

Sustainable Student Farm

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The Sustainable Student Farm (SSF) began in 2009 as a collaboration of the Student Sustainability Committee, the Department of Natural Resources and Environmental Science (NRES), the College of ACES, and University of Illinois Dining Services. Initial funding for the farm came with a grant from the Student Sustainability Committee, a student-run organization that collects fees from all U of I students and then awards grants and loans to foster sustainability on campus. The SSF is now merged with Crop Sciences.

The SSF is located in the new U of I fruit farm at the southeast corner of Lincoln Avenue and Windsor Road. We grow vegetables on six acres of land; roughly three acres are in production and 2+ acres are fallow. We grow a variety of salad green mixtures nearly year-round in addition to seasonal vegetables such as tomatoes; all kinds of peppers; cucumbers, sweet corn, and squash; and fruits including melons, pumpkins, and apples. We sell our produce at a farm stand on the University of Illinois Quad every Thursday from June until November, but our main outlet is UIUC Dining Services. They serve 9,000 students daily and purchase as much of our produce as possible. This relationship allows students to taste the quality, freshness, and extra flavor that is inherently part of locally grown food.

Our goals include increasing the amount of locally grown food consumed on campus, educating students about food systems; exposing students to the real world farming environments and providing extension-education opportunities to growers, master gardeners, and campus visitors. We employ two student interns each summer and rely on over 100 student volunteers who enjoy the opportunity to work on the farm!

For more information on the farm or to volunteer, please visit our website, thefarm.illinois.edu, for more information.
**University of Illinois Arboretum**

*Join us for a tour on Agronomy Day!*

**Diane Anderson**, horticulturist, arboretum grounds supervisor, arboretum.illinois.edu, 217-333-8817 or 217-333-7579

Enjoy guided tours of the U of I Arboretum’s 57 acres of scenic beauty during Agronomy Day.

**Miles C Hartley Selections Garden**, developed to evaluate annual flowering plants and showcase winners, contains more than 1,000 labeled varieties in row trials and designed beds. Select plants for your garden or enjoy the beauty from shaded benches surrounding the 2-acre Hartley garden.

**Idea Garden**, a project of the Master Gardeners of Champaign County, showcases annuals, perennials, fruits, vegetables, and shrubs. Visit the children’s garden, sensory garden, small fruit garden, and more. Tour the Hartley and Idea Gardens at 8 a.m., 9 a.m., and 10 a.m.

**Japan House** gardens, typical of Japanese style and designed for harmony, surround Japan House. Visit both the tea garden and dry (raked gravel) garden at 10 a.m. A tea ceremony will be available at 9 a.m. The charge for the tea ceremony is $8 per person.

**Pollinatarium**, a museum and science center highlighting the ecological importance of pollinating species to the reproductive needs of a vast diversity of flowering plants, resides in the former Bee Research Facility north of Windsor Avenue and east of Lincoln Avenue. The Pollinatarium is open from 8:30 a.m. to noon. Tours will take place at 10 a.m. and 11 a.m. No bus will be available for travel to the Pollinatarium, but parking is available.<br>
A bus will leave the Seed House for the Arboretum at 8 a.m., 9 a.m., and 10 a.m., and will return at 9 a.m., 10 a.m., and 11 a.m. Stop by our table for help planning your visit during Agronomy Day. The Arboretum is open dawn to dusk daily. Contact us to schedule future group tours.

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**University of Illinois Arboretum**

*Join us for a tour on Agronomy Day!*

**Diane Anderson**, horticulturist, arboretum grounds supervisor, arboretum.illinois.edu, 217-333-8817 or 217-333-7579

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Suzanne Bissonnette, plant clinic and extension IPM coordinator, sbisson@illinois.edu, 217-333-2478

Bring a troubled plant sample to the U of I Plant Clinic display and we will diagnose it as you wait (one per person, please). The clinic is the Illinois representative in the North Central region of the National Plant Diagnostic Network (NPDN). The network’s goal is to provide rapid, accurate diagnoses of exotic pests, select agents, and other introduced insects, pathogens, and weed threats, and it provides funding to improve the capability of member clinics. The U of I Plant Clinic offers the public unbiased diagnoses of plant problems and access to opinions of specialists in multiple disciplines. A support fee is charged for all plant samples. Find more at web.extension.illinois.edu/plant clinic, follow us on Facebook (www.facebook.com/#!/UofIPlantClinic), check out our blog (universityofillinoisplantclinic.blogspot.com) or listen to podcasts at web.extension.illinois.edu/podcasts/plantandpest.

Adam Davis, USDA-ARS research ecologist and Department of Crop Sciences associate professor, asdavis1@illinois.edu, 217-333-9654

Our research group seeks to understand how human practices can limit the growth and spread of pest plant populations in both agricultural systems and wild lands. We are pursuing several research projects to develop management tools to control weeds and invasive plants. Bioenergy crops show promise in reducing our dependence on petroleum, but their invasive potential is unknown. By creating simulated invasions of Miscanthus x giganteus in Illinois floodplains and successional fields, we study the potential consequences of bioenergy crop escape. The resistance of crop weeds to herbicides is a growing concern. We evaluate the impact of agronomic practices on the spread of glyphosate-resistant common water-hemp (Amaranthus tuberculatus) in south-central Illinois. Several of our new projects will help predict the consequences of global climate change on crop weed populations and their ability to reduce crop yields. Results from our research will be implemented to ultimately lessen the economic cost of unwanted plant populations in Illinois.

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Department of Crop Sciences at the University of Illinois
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Two names, you have known and trusted for many years, Arends Brothers and Hogan Walker LLC are now Arends Hogan Walker (AHW). Some places, same faces, the same great customer service you have relied upon in the past have merged to provide Tomorrows Solutions Today. With the merger AHW will be better able to provide superior support for John Deere agricultural, residential, turf and commercial equipment from 10 locations in Northeastern and Central Illinois.

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Thank you for attending the 2012 University of Illinois Agronomy Day. Your support of our programs is greatly appreciated. We encourage you to stop by any time to view ongoing research projects. And please plan to join us again next year!

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e-mail: cropsci@illinois.edu

IFCA’s mission is to assist and represent the crop production supply and service industry while promoting the sound stewardship and utilization of agricultural inputs.

IFCA is the principal voice for the agricultural input industry, influencing legislative and regulatory policies and providing assistance to our members on many issues that impact their business.

IFCA also lends key leadership to the “Keep it for the Crop by 2025” nutrient stewardship program. Designed around the 4R’s of Nutrient Stewardship: Right Source, Right Rate, Right Time, Right Place, KIC promotes nutrient practices that can enhance crop yields and protect water quality.

We encourage IFCA members to support the 4R’s and the KIC program. To learn more, contact Dan Schaefer, Director of Nutrient Stewardship, at dschaefer@illinoiscbmp.org

To become a member of the IFCA, visit our website at www.ifca.com or give us a call at 309.827.2774.
Sustainability from the Ground Up

Illinois soybean farmers are opening their doors and reaching out to customers so the world can see their commitment to sustainability:

**Social Responsibility.**
We support consumers through education programs, local food donations, emerging global market assistance and more.

**Environmental Stewardship.**
We make efficient use of our land and energy, soil and water and we monitor our activities for greenhouse gas emissions.

**Labor Practices, Labor Relations & Worker Conditions.**
We comply with guidelines and regulations as they affect our business.

**Best Management Practices.**
We use BMPs to farm better and smarter, address challenges and develop and refine farming goals.

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We invest in production research, manage risk on the farm, and concentrate on delivering high quality products.

Illinois soybean farmers are taking the lead on sustainability. We have made a commitment to meeting customer needs, today and into the future. We are looking at other global efforts for responsible soy production, and we are drawing ideas from numerous organizations to achieve our sustainability goals. Won’t you join us?

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