Focus Cotton

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Pest resistance changing the face of cotton production in the Mid-South

The Mid-South region of the United States has been known for its vast cotton fields. However, as difficulties with pest resistance continue to increase, you may be seeing more soybeans this year.

The National Cotton Council reports that in the Mid-South this year, acres devoted to cotton production will decrease by about 23% compared with cotton acres in 2008 (National Cotton Council, 2009). Among the challenges facing the cotton industry today are the current global economic situation, a rise in competing crop prices, and higher input costs caused by pest resistance.

Insecticide resistance

The rising cost of spider mite control has become a limiting factor in cotton production in the Mid-South, according to Dr. Angus Catchot of Mississippi State University. He noted that the cost of spider mite control in the Mid-South was $1.56 per acre in 2004 but had risen to $8.23 per acre by 2007.

Normally cyclic, the spider mite population has remained high in the Mid-South for the past four years, according to Catchot. An increase in corn acres in the region over this period probably hasn’t helped things much as corn acts as a source to infest cotton fields with spider mites. Catchot speculated that the increased frequency of spider mites could also be attributed to delayed burndown of no-till or minimum-till fields or lack of field border management, hot and dry conditions.

Increasing cotton productivity by developing effective variety field tests

As an industry that will remain important to the global economy for years to come, cotton growers are always looking at new varieties that will create the best product and the highest yields. Experts predict that climate change will alter growing conditions in the future, which will only increase the importance of developing new varieties adapted to the conditions. Determining which new varieties of cotton will be the most successful requires a rigorous and thorough system of testing.

Dr. Christopher Main, a researcher at the University of Tennessee, recently conducted an extensive amount of fieldwork on cotton variety testing for the university. His work is aimed at developing the most effective field tests to make sure that producers are growing their crops in an efficient manner.

“We’re looking to the future,” Main said, “where we’re going to find this avalanche of new technology, new technology combinations, and new varieties coming into the market at a more rapid pace. And so we’re trying to label the groundwork ahead of time to see how we’re going to be able to effectively evaluate these varieties, not only from a genetics and physiological standpoint, but how we report that in our extension-type roles to our producers who use this information to continue their business and their way of life.”

During his research, Main utilized both Official Variety Trials and County Standard Trials to determine the...
Better soil-testing techniques could lead to savings on rotated cotton

For generations of cotton farmers in the United States, crop rotation has been one of the most valuable tools for ensuring healthy soil and high yields of production. Rotation is often overlooked for its many benefits, including pest prevention and control. Perhaps one of the least understood benefits, however, has been the management of soil fertility, but soil professionals today are increasingly learning more about how different crops used in rotation with cotton add to the nutrients in the soil. In order to best understand the effects on the soil, professionals suggest increased soil testing.

However, some soil sampling techniques, like composite sampling, may not accurately indicate where the land needs specific types of treatment. With composite sampling, as few as two different samples may be acquired over a 20- to 40-acre field. Often times, the samples will show a great variance in nutrient levels between the two, which can cause confusion as to the overall needs of a field.

As a way to confront these differentiations, Bob Griffin, an agriculture consultant from Jonesboro, AR, proposes a new system of smart sampling to more actively gauge the targeted needs of a large rotated field.

“Smart sampling is simply a manner of directing samples in a predetermined manner,” Griffin explained. “Sample site locations can be chosen based upon several criteria. Known areas of low yield, high yield, poor...”
conditions, decline of beneficial insects, increased use of insecticide seed treatments versus Temik, or development of insecticide resistance.

Dr. Gus Lorenz of the University of Arkansas Cooperative Extension Service agreed that insecticide resistance does pose a problem for cotton growers in the Mid-South.

“One of the biggest threats to plant bug management is the insecticide resistance issue,” Lorenz said. “The increased use of transgenics, eradication of the boll weevil, reduced acreage of cotton to other crops that are alternate hosts for sucker bug complex and lepidopteran pests, and conservation and similar types of tillage create the need to change our insect pest management strategy.

“What results is that you have a bunch of fields around cotton fields now supplying those pests that are causing the problems that we’re seeing, particularly plant bugs, stink bugs, and spider mites. We have to alter our sampling methods and use the most effective methods we can find to address the [plant bug] situation to effectively evaluate the population out there and when we need to take action.”

The sweep net is the best way to assess plant bug populations prior to bloom, and black shake sheets are best after bloom, according to Lorenz. Evaluating square retention helps even more. Lorenz stressed that if changes in pests occur, then changes in sampling must occur to fit the pest.

“We need desperately to see some new modes of action and to effectively use some of the new insecticides because the old squirt-and-count method of going out and spraying and checking three days later to see where you are with plant bugs doesn’t necessarily work very well with some of these new chemistries like novaluron and flonicamid.”

In addition, Lorenz said we need to maintain the insecticides we have and find alternatives to chemical control such as those found in the area-wide pest management programs.

“We’ve seen a big change in pest status, and we’re going to have to address thresholds and sampling procedures and control tactics to meet those needs for our growers in the Mid-South.”

When it comes to cotton arthropod management in particular, Dr. B.R. Leonard of the LSU AgCenter said it’s critical that pesticide treatments are correctly timed.

“Missed application timing by a week can have disastrous consequences, allowing a low population to persist for a longer period, which can result in population growth and/or no foliage left,” Leonard said. “Missed timing is critical in determining how effective those products really are.”

Integrated pest management is complicated, Leonard pointed out, and it is rare that agricultural consultants can recommend products to control a single pest. He stressed that pest control failures are not always due to resistance and can be related to application methods, application and evaluation timing, product selection, pest identification, and pest pressure. Pest resistance, he said, must be determined in a laboratory.

Cotton diseases, weed resistance

Insect management is not the only aspect of cotton production that is evolving—cotton diseases are as well. Dr. Jason Woodward of the Texas AgriLife Extension Service said that emerging diseases such as Verticillium wilt, Fusarium wilt, reniform nematode, and Alternaria stem blight and leaf spot are threats to the cotton crop in West Texas.

Verticillium wilt, caused by the soilborne fungus *Verticillium dahliae*, was a major problem in Texas in the 1970s and 1980s and has re-emerged as a threat to cotton crops. It is currently the most economically important disease in West Texas and also infects peanut and chili pepper crops. Infections occur early in the growing season, and symptoms develop as plant water requirements increase. The fungus that causes the disease is long-lived in the soil, and chemical control options are limited.

Fusarium wilt—a disease that stunts the growth of cotton plants and causes loss of foliage—is also evolving.

“We’re seeing [Fusarium wilt] earlier in the season, indicating that there is some potential change in the biology of the pathogen,” Woodward said.

Weeds are changing as well, and many of them are becoming resistant to herbicides, according to Dr. A. Stanley Cul-
pepper from the University of Georgia. Of particular importance is glyphosate resistance due to the widespread adoption of Roundup Ready technology and conservation tillage. In the U.S., nine weeds are already resistant to glyphosate—common ragweed, common waterhemp, giant ragweed, hairy fleabane, horseweed, Italian ryegrass, johnsongrass, Palmer amaranth, and rigid ryegrass; seven of these weeds are present in the Mid-South. Palmer amaranth, or pigweed, poses a particularly important threat to cotton production.

“Palmer amaranth was already one of the most troublesome weeds of agronomic crops across the southern U.S.,” Culpepper said. “Resistance to glyphosate will only exacerbate the problem, especially in light of the widespread planting of glyphosate-resistant crops. Rapid growth rate and tall stature make Palmer amaranth extremely competitive with all crops, especially cotton.”

Research in Georgia during 2006 and 2007 showed that cotton yield was reduced by 23% when there were two glyphosate-resistant Palmer amaranth plants for every 20 ft of row that were emerging with the crop; one plant per square yard reduced the yield by 50%.

In order to win against weed resistance, one must first look to the plant’s biology, according to University of Arkansas scientist Dr. Kenneth Smith. A variety of factors may help predict whether or not a weed will become tolerant to glyphosate, including high genetic diversity, cross pollination, and high seed production. These factors may also influence how fast a resistant weed can spread.

In a Georgia study, for example, the resistant pollen of Palmer amaranth traveled up to a half mile in all directions with 10 to 15 mph winds, contaminating 20% of all progeny at 984 ft. The ability to cross pollinate, in addition to the ability to produce more than 250,000 seeds per plant, gives Palmer amaranth a significant reproductive advantage when establishing in an area.

The spread of resistant weeds and other pests can happen quickly if not managed properly. Culpepper noted a key component of Palmer amaranth biology, for example, that may allow for better management. Palmer amaranth germinates at a very specific depth in the soil—36 to 44% of the seeds germinate at 0 to 1 inch, 7% at 2 inches, and 2% at 3 inches. Management practices such as deep turning can reduce the incidence of Palmer amaranth as can cover crop residue in some situations.

Residual herbicides in the Corn Belt are critical for preventing and managing glyphosate-resistant Palmer amaranth, Culpepper said. Preventative management programs relying heavily on residual herbicides with multiple modes of action have proven effective in slowing the spread of resistance and managing light infestations of the plant. However, in fields with severe infestations, weed management programs relying exclusively on herbicides are often not effective, especially in dryland production areas, according to Culpepper. Those with severe infestations are being forced to utilize hand removal, cultivation, incorporated di-nitroaniline herbicides, deep turning of land, cultivars with tolerance to glufosinate, or other crops that provide greater weed management options.

Prevention and early action if a resistant weed is found is key, according to Culpepper. He hopes that the adoption of forceful and proactive programs will reduce the rate that resistant weeds are spreading and begin to slowly reduce the number of resistant seeds present in the soil seed banks of heavily infested fields.

“The biggest problem we had was convincing our growers to accept the seriousness of the situation,” Culpepper said. “It is critical that you take those approaches and be aggressive on the front end versus the rear end.”

Chuck Farr of Mid-South Ag Consultants offered words of advice for agricultural consultants and cotton growers alike:

“Times have changed for weed control. Those that are in resistant weed areas are struggling for control; those that do not have resistance issues at this present time should do everything they possibly can to preserve the technology that they currently use today.”

References

most effective ways to grow different varieties of cotton under a producer’s conditions. He acknowledges that the optimum plot size for cotton variety testing is between two and four rows, each stretching between 30 and 40 ft.

For the Official Variety Trials, Main used five different locations, being careful that each site was tested under uniform conditions.

“We do uniform management on every site, from the day it’s planted to the day it’s harvested, so we know we’re doing everything the same at all these locations. I use these trials to measure the genetic horsepower of a variety. It lets me get a good look at what they’re going to do in a high-input environment.”

The Country Standard Trials utilized strip trials of the various cotton breeds in multiple large-plot environments. Main has developed an extensive network of fields to conduct these tests.

“My County Standard Trials go out to 14 to 15 locations—we’ll have one or two tests depending on the varieties that we get. These are set up based on the grower’s configuration. Usually picker width determines how many rows we have, depending on the size of the field.”

Evaluating different management techniques is also a part of the Country Standard Trials process, as different producers are given trials to manage.

“These are producer managed, so when I put them on a producer’s farm, he manages them the entire year. So I can get 14 or 15 different management schemes on these varieties. What I use this test system for is to get a broad measure of adaptability. I want to see how it works in different environments, different management systems with different producers.”

Each method of testing presents its own challenge, whether it’s maturity differences between the different varieties or problems in obtaining soil uniformity, where difficulties can occur even in small-plot testing during dry years.

“You start going to these field-scale plots,” Main said, “and you run into soil differences, differences in moisture, differences in the way the crop is managed and goes across the field.”

In testing the different varieties, Main emphasizes that knowing a field well is also important to conducting an effective test. For the testing he conducted on producer-managed fields, he had plenty of previous experience in working that particular soil.

“We have a long history with our growers, and I would say that 95% of fields that we use, we used before, and we have a very good feeling for the variability in the field. In the case of our [Official Variety Trials], we’ve used the same fields for 10 years, so I know those fields like the back of my hand as far as variability, from front to back and side to side.”

Finally, harvesting methods also play a key role in effective evaluation of variety testing. Even if all variables are carefully managed during the testing, mishandling of the harvested product can spoil the final results.

“Whenever you’re out harvesting a county plot, bring those 8-lb samples back, weigh them in immediately, and get them in the storage area,” Main advised. “That way, you’ve got everything as equal as possible for seed cotton storage because any differences that happen in that process can dramatically alter what we get off of our load chart.”

Above: Photo by Scott Bauer (USDA-ARS). Left: Photo by John D. Byrd, Mississippi State University, Bugwood.org.
Soil testing | FROM PAGE 5

Because of this, you can't just continue doing the same thing over and over anymore. We can't just continue doing this just because grandpa or dad did it."

Griffin has discovered an immediate benefit to his farmer clients who have implemented this smart sampling method.

"I found last year on several fields that we were able to reduce just P and K applications by a hundred dollars an acre. That's substantial savings in my opinion. And we didn't reduce yields—in many instances we actually increased yields."

Robert Lemon of AgriThority, an independent data developer for the agriculture industry, also stresses the importance of soil testing rotated cotton fields on a regular basis. In his research, he finds that it is not enough to take samples at the surface; rather one should obtain samples at depths of up to 4 ft, given the cotton plant's impressive ability to utilize nitrogen at these depths. Lemon cites research conducted with Dr. Frank Hons, professor with Texas AgriLife Research at Texas A&M University, who studied the uptake of labeled nitrogen fertilizer at different depths by cotton plants.

"With fertilizer placement, when that fertilizer was placed in the surface, we had about an 82% recovery of that, and these are samples that we're taking in early bloom," Lemon said. "The nitrogen that was placed at 6 inches, or what we would consider to be that zero to 12-inch depth, we were about 75% efficient in recovery of that. When we got down to 18 inches, almost 70% recovery. And then going down deeper at 30 inches and on down to 42 inches, you see the precipitous drop in the efficiency of the plant in the utilization of that N. So obviously that nitrogen that we find with depth at least down to a couple of feet is certainly beneficial to the system and certainly nitrogen that we can credit."

Through comprehensive testing, cotton farmers will be able to effectively understand more precisely how they need to fertilize their fields in order to maximize their money spent on these products.

"Nitrogen, phosphorus, and potassium prices...have tremendously gone up during the last couple of years," Griffin said. "And even though nitrogen has gone down substantially during the last [few months], phosphorus and potassium prices are still two to three times what they were just a couple of years ago. My main point here is that I don't think we can afford to keep putting out fertilizer whether we need it or not."

Utilizing new technologies for soil testing could be the key to learning how to most effectively rotate cotton crops, making sure that fertilizer is used in optimal amounts.

"We must be willing to adapt new technology that allows us to just place fertilizer where it is needed in optimum rates, and this new technology can allow us to do that," Griffin said. "We don't want to get stuck in a rut doing the same thing over and over anymore. We can't just continue doing this just because grandpa or dad did it."
The 2008–2009 world economic crisis has major impacts on U.S. agriculture. Declining incomes around the world as a result of the evolving worldwide recession combined with the short-term appreciation of the dollar result in significant declines in U.S. agricultural exports and sharply lower agricultural prices, farm income, and employment, compared with those in 2007–2008. Agricultural households also suffer from declining income from off-farm jobs, as the economic recession in the United States ripples through to rural-based businesses and loss of tax revenue puts pressure on rural government employment and social services. Because the U.S. farm sector went into the crisis with record-high exports, prices, and farm income, the declines, although substantial, will bring agriculture back to trend outcomes. While there is a great deal of uncertainty concerning the full magnitude of the U.S. and global recession, the effects of the crisis are expected to be less severe for U.S. agriculture than for many other sectors of the U.S. economy.

Declining farm income

In 2007 and 2008, U.S. net farm income equaled $87 billion and $89 billion, respectively, with each year establishing a new nominal record. Even when adjusted for inflation, these amounts reflect the highest net farm incomes since the early 1970s. Depending on assumptions about the extent of the economic downturn, this analysis projects that U.S. net farm income in 2009 could fall by 26% to $66 billion—a level similar to the average of $65 billion earned in the previous 10 years—and in the worst case scenario to $60 billion (a drop of 33%).

The projected decline in farm income in 2009 is not expected to have much effect on national agricultural land values. Land value trends that emerged in 2008 could continue in states that showed the largest declines in rural housing values and abate in states that enjoyed double-digit increases in land values due to strong crop receipts. The economic crisis could also reduce U.S. agricultural export-related employment in the short run, as projected 2009 employment falls by 13% (a loss of 45,000 jobs).

Effects on a global marketplace

The crisis will impact U.S. agriculture mostly through indirect international effects rather than through changes in the U.S. economy. The slowdown of growth in foreign economies will reduce import demand for agricultural commodities, resulting in lower U.S. agricultural exports and prices for agricultural commodities. Although the crisis originated in the United States, it has spread to the rest of the world and, especially, to large emerging markets, such as China, South Korea, and Mexico. The crisis is also strengthening the dollar against most other foreign currencies, as money throughout the world flows into the United States as a safe haven. In 2008, the net inflow of capital to the United States totaled about $650 billion. The stronger dollar reduces U.S. agricultural exports by making them more expensive in foreign markets than output by competitors. This analysis suggests that as a consequence of the slowing global economy and the appreciation of the dollar, U.S. agricultural exports could fall from $117 billion in 2008 to $96 billion in 2009.

Another feature of the crisis is that declining world economic activity has caused world energy prices to decline precipitously. This will not affect U.S. agricultural producers uniformly. The fall in energy prices has reduced the price and profitability of biofuels, and thereby lowered prices for feedstock crops, especially corn. On the other hand, all producers will benefit from lower input costs implied by reduced energy and fuel prices. This report projects that in 2009, the fuel and energy-related input costs faced by U.S. farmers could decline by 30%, returning costs to the levels of 2006. Livestock producers will be net beneficiaries of the energy price drop, as the decrease in crop prices will lower their feed costs.

While there is a great deal of uncertainty concerning the full magnitude of the U.S. and global recession, the effects of the crisis are expected to be less severe for U.S. agriculture than for many other sectors of the U.S. economy.\(^1\)

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\(^1\) Rural housing prices declined more than 8% in California, Nevada, Florida, and Rhode Island. They declined between 3 and 8% in Oregon, Maryland, New Hampshire, and Connecticut. On the other hand, rural housing prices increased in the Dakotas, Kansas, Oklahoma, Texas, West Virginia, and Delaware.
U.S. and world economies should stabilize in 2010 and then resume growth in 2011 near the relatively high rates of the early 2000s. The return to a growing world gross domestic product and consumer income, especially in emerging markets, will lead to a recovery in U.S. agricultural exports. Thus, this report’s reference analysis projects that by 2013, U.S. net farm income could rise to $83 billion, though agricultural exports are projected to be only $93 billion, largely unchanged from the projected 2009 value of $96 billion because of the higher value of the dollar. The return to growth will also expand demand for energy. This shift suggests that world energy and fuel prices could again increase. Economic growth would partially reverse the effects of the crisis and thereby help producers of corn and other biofuel feedstock crops. Effects on the livestock sector will be positive because of the economic growth but negative because of rising costs for feed and energy.

Long-term outlook

The main uncertainty for the long run concerns the value of the U.S. dollar compared with currencies of other major trading countries. One possibility is that the dollar will continue to strengthen substantially, especially against the Chinese yuan and currencies of other major emerging markets. Another is that the dollar will weaken, as it did doing during most of the 2000s before the 2008 crisis. In the first scenario, U.S. farmers will face a stronger dollar, which will reduce the price competitiveness of U.S. agricultural exports. In the appreciating dollar scenario, U.S. net farm income will decline by almost 7% to $83 billion and agricultural exports will drop by 27% to $85 billion by 2013. In the second scenario, the weaker dollar relative to the reference case will strengthen U.S. farmers’ competitiveness on world markets. With a weaker dollar, projected net farm income will increase by 19% to $106 billion in 2013 and to $118 billion in 2017, while agricultural exports will rise to $120 billion in 2013 and $134 billion in 2017. The weaker dollar, combined with the return to world growth, will create strong foreign demand for U.S. agricultural goods, which will help keep farm income high.


2 There is a lot of uncertainty about exactly how the current recession will play out. While the consensus forecast is for growth to resume by the end of 2009 or early 2010, the severity of recession in most countries has been consistently revised upward during the past year.

3 A special analysis was conducted to establish the reference scenario used in this report. This scenario was developed in January 2009, based on U.S. and global macroeconomic conditions at that time.
Canada East
New soybean inoculant technology

By Horst Bohner, soybean specialist, Ontario Ministry of Agriculture, Food, and Rural Affairs, Stratford, ON, Canada; horst.bohner@ontario.ca

Soybeans require a significant amount of nitrogen to produce a high-yielding crop. A 50 bu/acre crop requires 210 lb/acre of nitrogen. About 75% of that nitrogen comes from nitrogen fixation. Once the nitrogen-fixing bacteria are established in the soil, they will survive in the ground for many years. At present, about 60% of Ontario soybeans receive an annual application of inoculants. Research conducted with older inoculant formulations confirmed that yield gains were inconsistent and very small if the field had successfully grown soybeans in the past.

Advances in inoculant technology have provided “pre-inoculants,” products containing highly efficient strains of bacteria and “extenders” that prolong the viability of inoculants. Seed can be treated before it is delivered to the farm. Reduced inoculation procedures at planting time and excellent coverage are significant advantages to the grower compared with traditional drill box application. These high quality inoculants provide between 800,000 and 1,400,000 bacterial cells per seed, much higher concentrations than were previously available.

Researchers from Ohio State University found yield gains to be common in productive fields with a history of soybeans. The average yield response from 64 Ohio trials was 1.9 bu/acre from all inoculants tested. Some states such as Michigan, Indiana, and North Dakota have also found average gains ranging from 1.0 to 2.7 bu/acre in fields with a history of soybeans. Other regions have found much lower gains.

Trials were conducted at 16 locations in 2007 and 12 locations in 2008 as field-length strips, with two replications of each treatment testing two pre-inoculants compared with an untreated check. All fields had a history of soybeans. The two pre-inoculants chosen were Cell Tech SCI and HiStick Liquid with Extender. At each field site, soil samples were collected at planting time. A standard soil test analysis and presidedress nitrogen test (PSNT) was also conducted. Both nitrate and ammonium levels were assessed along with the usual soil test values.

In addition, sufficient topsoil was removed from each site to permit a bioassay of the nodulation potential of the existing Bradyrhizobium japonicum populations indigenous at that field test location in 2007. Field trials were weighed with a weigh wagon. Seed samples were collected, assessed for size and grade, and analyzed for oil and protein content by the University of Guelph, using near infrared reflectance.

Results and summary

Statistically significant yield differences were found between the untreated and inoculant treatments (Fig. 1). No statistical difference was found between the two inoculants. The average statistical yield gain of the inoculants compared with the untreated control was 1.0 bu/acre across the two years. At a selling price of $10/bu and a yield gain of 1.0 bu/acre, a return of $6.67/acre would be realized when using an inoculant (assuming a cost of $3.33/acre for the inoculant). Table 1 shows the average trial results.

No statistical differences were found in oil or protein content of the seed. PSNT could not be correlated to yield.

An average yield gain of 1.0 bu/acre resulted from the use of an inoculant on fields with a history of soybeans averaged across the two years. A numerical yield increase was shown in 75% of the trials. No statistical difference was found between the two inoculants.

Table 1. Yield response to inoculants.

<table>
<thead>
<tr>
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<th>2007 (16 trials)</th>
<th>2008 (12 trials)</th>
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<td>Average inoculant response, bu/acre</td>
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<td>1.1</td>
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<td>Percentage of sites with inoculant response ≥ 1.0 bu/acre, %</td>
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<td>67</td>
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Fig. 1. Yield response of 28 inoculant trials. Values followed by the same letter are not significantly different at the 5% confidence level.
Ontario CCA program update

By Tina Hanley, Ontario CCA program administrator, Elmira, ON, Canada

On February 6, 2009 the Ontario CCA program saw 56 people write the CCA exam in Woodstock and Kemptville. This is a nice increase over last year’s 49. Those who were successful in passing are starting to complete their forms and submit their credentials detailing education, work experience, and personal and professional references. Soon they will have the certification credentials they have worked so long and hard to achieve. Congratulations to all of you!

Once the jubilation of becoming certified has worn off (which we really hope it doesn’t), we expect to see the same type of enthusiasm at our 7th Annual Ontario CCA Conference and Annual Meeting being held January 13 and 14, 2010 at the Best Western Lamplighter Inn in London, Ontario.

We have taken your comments and recommendations from the feedback sheet to heart and are in the early stages of getting the speaker program lined up. If you have a suggestion for a guest speaker or a topic of interest, please contact me at 519-669-3350 or tina.tfio@sympatico.ca.

This is a great opportunity for CCAs to network with different businesses and their peers and to be brought up to speed with what’s happening within the Ontario CCA program. We extend an invitation to CCAs from outside Ontario to come join us. It has been a goal of the Ontario CCA board to encourage more networking amongst CCAs from different areas so that we can learn from each other.

Continuing education units have been applied for, and the conference is a good place to earn those required credits. In addition, there will be draws and trade show booth displays for viewing and gathering of information. Registration forms and more information will follow later this summer.

Canada West
Harapiak wins Prairie CCA Pioneer Award

By Eric Gregory, Prairie CCA program chair, Winnipeg, MB, Canada

At the last Manitoba Agronomists Conference, Dr. Don Flaten, professor of soil science at the University of Manitoba, and I were pleased to award John Harapiak with the Prairie CCA Pioneer Award. Mr. Harapiak recently retired and due to the scope and depth of his work and influence on the understanding of soil fertility and fertilizers in western Canada, the Prairie CCA board felt compelled to recognize his achievements.

Most of his career was spent with Western Co-operative Fertilizer where he completed and published a great deal of research on fertilizer placement and practices, much of which went on to influence what Western Canadian farmers practice today. Mr. Harapiak also spent much of his time providing extension services to growers and training industry agronomists. It was during this time that he recognized that a standard of agronomic knowledge was required among those consulting growers to that growers could be confident they were getting good information.

As a result, John was instrumental in bringing the CCA program to Canada in the mid-1990s and developing it for everyone’s benefit in the Prairie region. Since its inception, John has served the Prairie CCA board in many ways: as chair from 2000–2002, Canadian international CCA board representative from 2002–2004, and as an active participant in developing performance objectives for the Prairie program, just to mention a few. John has not only helped improve the Prairie program, but also the international program by ensuring that Great Plains agricultural systems are recognized in examinations.

Perhaps most importantly, through his work and teaching, John exemplifies not only the high technical standards of the program, but the Code of Ethics, whereby the CCA works in the best interests of his/her client. It was with a strong passion for agriculture and this program that when new employees were hired, John’s question to them was not so much “Are you interested in challenging the CCA exam” but rather “So what date are you planning to write it anyway?” John initiated and today still develops one of the most successful promotional programs for Prairie CCAs—the CCA profile stories printed in Top Crop Manager magazine.

Congratulations John, we wish you the very best in your future endeavors!

What’s happening in your region?
cropsandsoils@agronomy.org

By Eric Gregory, Prairie CCA program chair, Winnipeg, MB, Canada

Harapiak wins Prairie CCA Pioneer Award

John Harapiak, left, receives the Prairie CCA Pioneer Award from Eric Gregory.
Cotton producers have a long history of developing technology to aid their crops, from the implementation of mechanized cotton pickers to methods of pest and weed eradication. As the industry evolves and confronts new challenges, technologies are being continuously integrated into the everyday on-farm practices of crop producers. New products to help manage irrigation, nitrogen fertilization, and harvesting lead the way as some of the most important new technologies helping producers today.

Measuring soil moisture

Managing the root zone for cotton crops is one of the greater challenges a producer faces. AquaSpy, a manufacturer and distributor of technology for the irrigation market, claims its soil moisture measuring products offer an effective way to judge current moisture levels available to the root zones.

“Most growers tend to irrigate the same throughout the whole season,” said Chet Townsend, vice president of AquaSpy, during the 2009 Beltwide Cotton Conference in San Antonio, TX in January. “What growers do in the early part of the season, they tend to overirrigate, irrigate too frequently, and that does not allow your root system to get down to the deeper depths. If you delay the onset of your next irrigation, you can force those roots to get deeper, and you can establish a much stronger plant that can tolerate stress later in the season.”

At the heart of AquaSpy’s products are its soil moisture probes, which are capable of penetrating at different soil depths with sensors throughout the length of the probe. Townsend said these sensors can accurately depict the water needs of the plants, whether they are at a proper level, are overwatered, or in need of irrigation. Most significant to the future of monitoring this data, however, are the probe’s capabilities of remotely transporting these figures. When used in conjunction with AquaSpy’s telemetry products, Townsend said the probe becomes the first step in logging unprecedented amounts of data for the user. Once the data is collected, it becomes instantly readable by downloading the materials to a PC, allowing producers quick access to these readings.

Utilizing this data can produce an irrigation template for cotton growers, helping them better understand their crop’s root system and how best to implement irrigation patterns.

“You can have an irrigation template where you can change the level to irrigate later in the season based on your depth of root system,” Townsend explained, “and you can drill down and look at much more detail, at every individual sensor, and you can actually determine when the roots get to different depths.”

Mapping nitrogen needs

In addition to water management, cotton producers must also keep a close eye on nitrogen levels. One company that understands this process is NTech Industries, which produces the GreenSeeker RT200. Using LED light sensors, this product calculates the Normalized Difference Vegetative Index (NDVI), a common measure of plant health and vigor. Red and near-infrared (NIR) light are used to calculate the NDVI, where a healthy plant would absorb more red light and reflect NIR.
Based on the NDVI, nitrogen rates are prescribed. The GreenSeeker RT200 allows the producer to identify the specific needs of different plants throughout the field and variably apply nitrogen as needed. This can help producers avoid spreading excessive amounts, thereby lowering their costs and increasing their profit potential. NTech says the RT200 is also recognized for its ease of use.

“The most basic offering is a single-sensor system that is either hand held or a machine mounted one that would just mount to an ATV or tractor,” said Jack Gerhardt of RedBall LLC, U.S. distributor of GreenSeeker products, who also spoke during the Beltwide Cotton Conference. “This system would allow you to get real-time vigor scores and GPS reference those scores so that you can create vigor maps, whether at the plot level or at the field level.”

Harvesting

The harvesting of cotton also requires innovative solutions to help growers maximize their yield and ease the burden of this time-consuming process. John Deere says the release of its 7760 cotton picker in 2007 was a major technological advancement for the cotton industry, providing nonstop harvesting with its on-board module builder. While this offers increased production, it also creates the challenge of accommodating one’s production process to this technology. Stover Equipment Company offers two new products directly targeted towards producers who use the John Deere 7760 cotton picker.

The first of these products, the Stover Module Mover, transports the modules to the cotton gin after harvesting and offers several advantages to its use, according to the company. With the Stover Module Mover, the modules can be picked up in the field without crossing the rows, avoiding soil compaction. Also, the company says a smaller tractor can be used, as the module is carried closer to the tractor, more efficiently distributing the weight so less weight is needed on the tractor.

The Stover Unwrapper GIS was developed as a way to remove the wrap from the modules produced by the John Deere 7760 cotton picker. This machine is fully electric with no hydraulics and is capable of processing the modules at over 80 bales per hour, the company claims. Perhaps most beneficial is the ease of use, as it only requires one person to operate. The Stover Unwrapper GIS was designed with the specifications of John Deere in mind, meeting all the requirements to help make the Deere 7760 picker the most efficient harvesting tool on the market, the company says.

The New Products section is a service to our readers. To simplify information, trade names may be used. No endorsement of these products is intended, nor is any criticism implied of similar products that are not mentioned.
Pioneer unveils new crop improvement technology

During a two-day conference at Pioneer’s George W. Carver Campus in Johnston, IA in February 2009, various researchers from Pioneer Hi-Bred International, a DuPont business, presented updates on their progress in seed and crop science research.

The company is utilizing technology to improve yield, disease resistance, and other traits in corn and soybeans as well as other crops, such as rice and canola. It unveiled a new family of traits and programs called Optimum Brand Innovations to provide growers more choices and help them be more productive. Pioneer says the Optimum GAT herbicide tolerance trait offers flexibility in weed control, and the Optimum AcreMax 1 insect protection system is a higher-yielding system for refuge management.

The insect protection system is expected to receive reduced refuge registration this year. Upon regulatory approval, Optimum AcreMax 1 would be the an “in-the-bag” refuge solution for growers, eliminating the need for farmers to plant a separate corn rootworm refuge. It would also make it easier for growers to meet the USEPA’s refuge management guidelines, according to the company. The insect protection system would be composed of a very high percentage of a hybrid with Hercules XTRA insect protection and a very low percentage of a hybrid with the Hercules I trait, which would serve as the reduced corn rootworm refuge. All seeds in the bag would have compatible herbicide tolerance and would be treated with an insecticidal seed treatment.

Optimum AcreMax 2, which delivers a single-bag refuge solution for both corn borer and corn rootworm resistance, is expected to receive regulatory approval in 2012.

The Optimum GAT herbicide tolerant trait was developed through proprietary DuPont gene-shuffling technology, and Pioneer claims it will enable broader spectrum weed control without compromising crop safety. It will be able to incorporate complementary ALS herbicides into a glyphosate program, including several new herbicides that DuPont Crop Protection has developed. The company plans to introduce commercial soybean varieties with the trait in 2011.

The company continues to pursue regulatory approvals in key export markets around the world for the herbicide-tolerant trait for both soybeans and corn. Pending regulatory approvals, the company is planning to introduce its proprietary trait in corn in 2010.

Standability stress research

During the February conference, Pioneer demonstrated its mobile wind machine, which tests the ability of higher-yielding experimental corn hybrids to withstand violent wind storms that cause significant standability issues and subsequent yield loss. Nicknamed Boreas—a name inspired by the Greek god of the cold north wind—the 20-ton device helps scientists improve the standability of corn hybrids by producing turbulent winds exceeding 100 mph.

“Pioneer researchers can’t always rely on Mother Nature to deliver the severe weather they need at the exact location of our research trials to test for the stresses our customers face,” explained Geoff Graham, Pioneer senior research director. “We created machines to bring the ‘storm of the decade’ to our research fields across the country each season to identify hybrids with the best standability in the most difficult growing conditions.”

Standability is one of the biggest challenges farmers face as more seeds are planted to each acre. Approximately 20 to 30% of the corn acres in North America can be impacted by root lodging, stalk lodging, or brittle snap each year. Root lodging occurs when environmental forces exceed the ability of the root system to support the plant, causing the entire corn stalk to lean or fall. Stalk lodging is the breakage of corn stalks below the ear. Brittle snap refers to breakage of corn stalks by violent winds, usually during periods of fast growth.

Plant breeders are challenged to develop higher-yielding plants with a stalk and root structure that can withstand violent storms when planted at higher populations. Prior to Boreas, researchers depended on natural storm events and mechanical “push” tests, which used a bar or other instrument to physically push the corn to simulate damage due to high winds. Boreas changes how plant researchers approach field research studies for standability traits by imitating the variety and intensity of winds that occur during violent storms.

“We are going to extraordinary measures to help our customers achieve industry-leading yields in the face of unpredictable and extreme growing conditions, including severe thunderstorms,” Graham said. “This is one of the ways we will more than double the annual rate of corn yield gain between now and 2018.”

Pioneer researchers began using Boreas five years ago but have kept the technology under wraps until patents were filed. Today, they are using multiple trait-specific, high-throughput machines to screen for root lodging, stalk lodg-
ing, and brittle snap. Testing is conducted across multiple environments and developmental stages throughout North America and compared with natural weather events to ensure the viability and predictability of the data.

FAST Corn technology

During the conference, Pioneer provided a tour of its research and greenhouse facility, which combines robotics and imaging and allows test plants to be grown at an accelerated rate, a technology the company calls FAST Corn (Functional Analysis System for Traits). The project is a combination of rapid-cycling germplasm research, transformation technology, automated greenhouse functions, and digital imaging procedures.

The 12,000 ft² facility expands the capacity of proprietary FAST Corn technology and introduces robotics to facilitate testing 24 hours a day and 365 days a year. It increases testing throughput eightfold over the original FAST Corn facility and process.

The new high-throughput approach allows the company’s research scientists to evaluate advanced plant genetics and critical new traits more quickly in more plants. With FAST Corn technology, researchers can grow corn to maturity and study new traits in a fraction of the time required for traditional corn.

Utilizing the technology, Pioneer researchers can grow first-generation corn plants to maturity in approximately two months compared with more than 100 days in field conditions. And, if the first generation results are promising, a second generation can be planted in the greenhouse environment immediately, instead of waiting for the next year’s growing season as would happen in field testing. According to Robert Meeley, supervisor for Pioneer’s Genetic Discovery group based in Wilmington, DE, testing that could take two to three years in a field environment can now be completed in six to nine months.

An important element of the FAST Corn process is the use of a fully automated digital imaging system to precisely measure the growth of a corn plant throughout its life cycle. The imaging process quantifies growth and other visual data such as plant color. Advanced plant genetics and traits with beneficial properties can be quickly identified in the first or second generation and then advanced to a field-testing program.

Drought tolerance work

Pioneer is also working to improve corn yields under drought conditions through conventional breeding, molecular-enhanced breeding and selection, and transgenic approaches. Building on its 50-plus years of drought tolerance research, the company plans to introduce its first drought-tolerant corn hybrids developed with molecular-enhanced breeding as early as 2010, pending product performance in on-farm drought-stressed trials. These new hybrids, known as Drought I, contain native drought tolerance genes that have been identified through marker-assisted selection and advanced into genetics using the tools of the Accelerated Yield Technology (AYT) system.

Pioneer also plans to introduce transgenic drought-tolerant hybrids, labeled Drought II, within five to seven years. It claims that in 2008 research trials, Drought II hybrids
The business of soil science consulting

Given all the turmoil in the market these days, it seems odd to be talking about starting a new soil science consulting business. But CPSS Pierre Bordenave points out that the flip side of risk is the unique opportunity it presents.

“The nature of being in business is risk. In Chinese, the word crisis is composed of two characters. One represents danger, and the other represents opportunity,” said Bordenave, president and owner of the soil scientist consulting firm InterMountain Resources in Sandpoint, Idaho. He spoke during a presentation at Joint Annual Meeting of the American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, and the Geological Society of America last fall in Houston, Texas.

During his talk, “The Business of Soil Science Consulting,” he gave a realistic look at the business end of being a soils consultant. Bordenave regularly presents seminars to help soil scientists (or other professionals) skip many of the business mistakes that cost time and money and that he has learned in his years in the soil science consulting area.

“Being the best in your field has nothing to do with running a viable business,” Bordenave said. “Whether you think you can or think you can’t, you are right.”

The point is that someone could be an excellent soil scientist but a poor businessman. Bordenave stressed that to have success in business, an individual must have the drive to succeed. There are many great opportunities in soil science consulting. According to Bordenave, there is an estimated $1.3 billion of billable consulting in the practice. The types of work that pedologists do include site evaluation, site remediation, soil surveying, soil classification, land reclamation and waste disposal, soils research, environmental impact studies, and soil nutrient advising and management. These projects require soil conservationists, soil microbiologists, soil ecologists, soil chemists, soil scientists, land-use specialists, soil physicists, and natural resource managers.

Business structures

There are a number of things to consider when going into the consulting business, according to Bordenave. For example, there are various ways of structuring a business, such as “sole proprietor,” “limited liability partnerships,” “C corporations,” “S corporations,” and “a personal services corporation.”

A sole proprietor means one person owns the business (proprietor means owner). The law does not make a distinction between the things that belong to you and the things that belong to your business, which are called assets. There is also no difference between the money you owe people and the money your business owes people, which are called debts.

A partnership is a business that has between 2 and 20 partners. The partners own the business together. If two or more people want to start a partnership, they should sign a written agreement. Limited liability partnerships are partnerships where a partner’s liability for the debts of the business does not include acts of professional negligence or malpractice. There are two different types of corporations, the C corporation and the S corporation, and which is best often depends on the goals of the business. The C corporation is the standard corporation, and the S corporation is a standard corporation that has elected a special tax status with the Internal Revenue Service.

After considering what type of business structure they need, consultants should develop a complete business plan with financial projections. It is helpful at this stage to get professional advice with financial projections and business planning.

“It is very important that you get financing in place,” Bordenave advised, “but remember, banks are in the business of selling money, so shop around to get the best deal.”

According to Bordenave, soil science consultants should establish a line of credit up front and use that line sparingly and only if needed. A line of credit is a loan arrangement under which a bank extends credit up to a maximum amount (called overdraft limit) against which an individual or business can write checks or make withdrawals.

The most common form of business borrowing, an overdraft, is a type of revolving loan where deposits (credits) are available for re-borrowing, and interest is charged only on the daily overdraft (debit) balance. It is, however, also a demand loan; the facility can be cancelled (and entire outstanding-
“Never think long and hard before hiring a friend as an employee,” Bordenave said. “Such employee/employer relationships can become problematic.”

Subcontractors are individuals or companies hired by a general or prime contractor to perform a specific task as part of the overall project. Subcontractors get some part of the work or project done, but they do their work without your direction beyond getting an initial project task.

Professional associates or professional peers can be hired to bring their services to a project and are usually hired to ensure the client’s needs are fulfilled. In essence, because of the professional level fees, most associates are hired to ensure the work gets done for the client. For professional associates, the rule of thumb is that their fees should match your fees and the consultant should have a non-predatory agreement with them.

Contracts, fees, and billing

When it comes to contracts, Bordenave said every contract is only as good as the person you are doing business with. There is no contract, however well written and extensive, that cannot be challenged legally. So, he recommended using the “KISS” principle when writing contracts—Keep It Simple Stupid. Contracts should be a couple of pages at most.

Also, it is important to limit the scope of the project, and the client should have the understanding of these limits. He also outlined the difference between a “quote” and an “estimate” on a project. A quote is a hard number; to the best of the consultant’s ability, it is what a project will cost. An estimate is exactly that—an estimate of what the project will cost within some range.

It is important that the client realizes certain fees are not part of the project, such as application fees, and that the consultant will not and cannot guarantee the client will get a permit. 

[continued on page 25]
Applying the right inputs at the right time in the right amount is particularly important for sweet corn because its sales are all about eye appeal and taste. The way it looks determines whether it’s bought initially, and the way it eats determines the repeat business. CCAs can help growers hit that “sweet spot” and maximize the quality of the crop from variety selection to harvesting.

Few crops illicit the passion from consumers that sweet corn does. This passion drives sales, and it certainly can be a profitable business. The USDA says that specialty crops like sweet corn account for approximately half of the farmgate value of total plant agricultural production in the United States, with sweet corn generating around $860 million in 2007. The numbers will vary a lot, but an individual grower can gross $2,400 an acre, according to Matt Kleinhenz, Ohio State University extension vegetable specialist. Kleinhenz spoke during a special session on sweet corn at the 2008 Indiana CCA Conference in December.

Getting the most bang for the buck starts with selecting the right variety for the growing conditions. “What I have come to appreciate is that whatever we’re growing will thrive only when the conditions match up with the genetics,” Kleinhenz said. “What a sweet corn plant needs is being shaped by the breeder. They’re taking the basic genetic platform, and they’re retooling it to make it consistent with the conditions that prevail in the areas of the fields that you walk through and help manage.

At the same time, the growers are trying to modify the growing conditions to make them match up well with the genetics of the sweet corn.”

Success is achieved when the two meet in the middle—when the breeder has developed an excellent variety that performs well in the conditions where it will be grown and the grower has taken specific steps to ensure that those conditions prevail. Kleinhenz said CCAs can play an important role in helping farmers pick a variety that matches up well with the growing conditions.

Sweet genetics

Genetics determine the attributes of a variety, and within sweet corn there are three major platforms: sugary (su), sugary enhanced (se), and shrunken 2 (sh2), also know as supersweet. Su has been around for 1,550 years and forms the basis of North American sweet corn. It is noted for its creamy texture and rich, corny taste and is grown primarily for processing and specialized markets.

Se has higher sugar content and more tender kernels and is grown mostly for direct retail sales and local wholesale markets. Kleinhenz said that if properly cooled and refrigerated, it can hold sweetness for two weeks after harvest.

Unlike both su and se, which are naturally occurring mutations that were found in the genetic code of corn, sh2 was created in a breeding program. It’s sweeter than su or se, and it stays sweet for a long time because of its slow sugar-to-starch conversion, which facilitates lengthy shipping. However sh2’s kernels are typically not as tender as se corn. Supersweet types are grown for retail sales, local fresh markets, and wholesale shipping markets.

“The newest varieties combine all three of these platforms in ways that require very specific management on
Avoiding stress

Regardless of the variety, sweet corn is mature at roughly the milk stage (R3), and so that’s when it should be intercepted for market entry, Kleinhenz said. But stress during the vegetative stage can slow the crop down in its natural progression while stress during the reproductive stage can speed it up. This can result in peak sugar occurring outside the normal window of 18 to 21 days after anthesis, resulting in corn that is not as good as it could be and doesn’t sell well.

“Factors like soil temps being low, flooding, drought, lack of fertilizer, too much fertilizer—anything that can create stressful conditions that will disrupt that normal flow from vegetative to reproductive is especially important to the sweet corn grower.”

Right around anthesis, sweet corn’s water use peaks, requiring at least 0.25 inches a day for 18 or more days, Kleinhenz said. The water requirements could be greater on sandier soils.

“Irrigation application is one major step [farmers] can take to be more successful. Reports vary with respect to the actual direct impact of irrigation on crop quality and yield, but at minimum, low water stress will reduce tipfill and ear length.”

Reduced tipfill and ear length can cost processors millions of dollars, and for fresh market growers, it can be the difference between making the sale or not, Kleinhenz explained. As consumers, we’ve all done it—we’ve pulled down the husk, spotted blank kernels, and tossed the ear aside.

“There could have been nothing wrong with that corn with respect to how it eats, but you just tossed it aside because of a lack of tipfill, which could only be due to a lack of water at the right time. So what did you signal to the grower? Irrigate the corn! Every decision we make as a consumer about the quality of the product that we expect sends a clear signal back to the farm.”

Goldilocks principal

When it comes to fertility, Kleinhenz recommends following the Goldilocks principal: not too hot, not too cold—just right.

“You want to hit that sweet spot. Not insufficient, not excessive….Where is the fertility optimal so that you or your client doesn’t spend money that is unnecessary, yet you’re spending the right amount? There is a sweet spot for every variety by soil by planting combination.”
spring is here and you are probably working long days to keep up. Certification activity slows down somewhat after a very busy winter educational season. Exam numbers for the February CCA exam were up about 10% over February 2008, and the spring soils exam numbers were about the same as last year’s, which were up about 40% over 2007.

We continue to finalize renewal and recertification numbers; so far, 95% of certification holders have renewed. There were more than 7,000 certified professionals who needed to fulfill their CEU requirements at the end of last year; 90% of them did so while the rest still need to update their records. History tells us that another 7 to 8% will update their records and come into compliance. There is still a strong interest among college students to become certified, and we continue to promote the value to farmers that working with a certified professional is a smart move.

The ICCA program will be running a new ad in Successful Farming magazine for 2009 (below). The message is predominantly the same but with a new look. The 2008 version had above average readership numbers compared with other ads in the magazine. We will not be running the ad as often as last year due to budgetary reasons but we will still reach the targeted audience. You want to use the ad in your local media; go to www.certifiedcropadviser.org/certified/promotional-activities or contact the office (certification@agronomy.org or 866-359-9161) for a copy.

USDA-NRCS Technical Service Provider program

The Technical Service Provider (TSP) program continues to recognize CCAs and CPAGs as qualified TSPs for the categories of nutrient management, pest management, and land treatment practices (tillage). CPSS’s are recognized as qualified TSPs for nutrient management, land treatment practices, and wetlands creation, enhancement, and restoration.

Howard Brown (chair of the ICCA board), Karl Glasener (director of science policy for the Societies), and I recently met with the new USDA-NRCS chief, Dave White, at his office in Washington, DC. White reaffirmed his commitment to continuing the TSP program and improving it. One area of discussion was to eliminate the practice of state NRCS offices inserting additional requirements beyond what is contained in the national Memorandum of Understanding (MOU), except where state law sets requirements. The 2008 farm bill did make some helpful adjustments to the TSP program that were pretty much in line with our recommendations. The rules to implement the changes were recently reviewed for comment and will be finalized later this year.

A significant change was to eliminate the “not-to-exceed” rate related to payment for services. The draft rule implements a process where there will be national guidelines and oversight, but the state NRCS office will set the payment rates for practices based on local (state) market conditions. The NRCS goal is to set rates that are “fair and reasonable,” and the new procedures allow flexibility with appropriate oversight for “consistency and quality control.” NRCS may also enter into contractual agreements with TSPs to perform specific technical assistance where payment can go directly to the TSP.

NRCS clarified in the draft rule that professional “licensing and state law requirements will be the only state level certification criteria allowed.” NRCS recognized that unique state level requirements beyond licensing and state law and implemented by state NRCS offices had hindered participation in the TSP program.

We consistently heard from certified professionals that the payment rates and unique state requirements were the two primary challenges with the TSP program. NRCS listened to our recommendations as evidenced by the draft rules. One other area that will be evaluated in the coming months is how someone becomes a TSP. The MOUs recognize the certification programs, and if certified, you are eligible to register as a TSP. CCAs, CPAGs, and CPSS’s working with NRCS staff created a process where a certified professional would first review and sign the performance standards for the practice, have their first plan for a client reviewed, and if satisfactory, would be registered as a TSP. If the certified professional felt the need for additional training, he/she could then opt to complete modules 1–7 before being registered. This process was successfully pilot-tested in eight states and emphasized the importance of knowing what NRCS expected and what type of training would be helpful to become proficient.

Training by NRCS will still be limited to training about NRCS policies,
regulations, procedures, processes, and business and technical tools unique to NRCS under the new rules. We’ll continue to work with NRCS to bring you the latest information about its programs that might better help you serve your clients.

Educational webinars
ASA in conjunction with Crops & Soils magazine began offering monthly, online educational seminars (webinars) in February. The next one will be on June 10 and is titled “Know Your Fertilizer Rights—the 4R Nutrient Stewardship Concept” by Dr. Tom Bruulsema from the International Plant Nutrition Institute (IPNI). It will carry 1 CEU in Nutrient Management and will run from 12 to 1 pm central time. To register for the webinar, go to www.agronomy.org/certifications/webinars.

Other upcoming webinar topics include cover crops on July 8 and climate change on August 12.

Climate change
The ASA–CSSA–SSSA science policy office conducted briefings in April for both the House and Senate staffs who work on greenhouse gas (GHG) mitigation. Both sessions were well attended, indicating interest is very high and the Societies are viewed as a trusted source of information. The focus was on agricultural lands, their importance, and the potential role of the people who work with them.

Agriculture and other working lands, properly managed, have the potential to provide low-cost, viable options for reducing greenhouse gas (GHG) emissions while providing additional carbon sinks. Agricultural land in the United States has the capacity to sequester about 650 million metric tons of carbon dioxide every year, offsetting up to 11% of the country’s GHG emissions annually (Lal et al., 2003). Of this amount, cropland accounts for about 41%, grazing lands 24%, and forest lands 36%.

Farmers, ranchers, and foresters, implementing best management practices such as cover crops, no-tillage, sustainable forestry, and nutrient management, could play an important role in sequestering carbon. They rely on CCAs, CPAgS, and CPSS/Cs for information, advice, and inputs and develop a close, trusted business relationship with their adviser, allowing the adviser to influence their business decisions and production practices.

CCAs, CPAgS, and CPSS/Cs understand the agronomic and soil science principles that are involved in growing crops and managing the soils. This same understanding is helpful when utilizing agricultural lands as part of GHG mitigation solutions (e.g., knowledge of the nitrogen cycle, plant utilization of carbon dioxide, or soil carbon storage). Agricultural lands and their ability to sequester carbon or mitigate GHGs are very practice dependent. The advisers working with the landowners already know the production practices being used on a particular farm and have the background knowledge that would be helpful.

A possible area of need is an assessment and verification system that involves certified assessors or verifiers who could truly evaluate agricultural lands for their GHG mitigation potential. A respected assessment followed by a verification process would help buyers and sellers of carbon have more faith in the system. ASA and SSSA certified professionals would make a logical group to work with based on their knowledge, experiences, and relationship with the landowners. They would probably need some specialized training in GHG mitigation, but that could be developed and offered through the continuing education process. It’s an ongoing discussion that could lead to a new business model for agricultural lands and those who serve it.

References
Newly certified

The following list includes newly certified individuals and those that have added additional certifications since the last issue of Crops & Soils. The list is alphabetized by state/province and by surname within each state/province.

Canada
Benson, Russell, Legal, AB (CCA-PP)
Gillespie, Scott, Taber, AB (CCA-PP)

United States
Rosel, Cheryl, Globe, AZ (APSS)
White, David, Flagstaff, AZ (APSS, APSC)
Blattler, Robert, Visalia, CA (CCA-CA)
Burkholder, Stephen, Davis, CA (CCA-CA)
Charest, Julian, Tulare, CA (CCA-CA)
DeSousa, Richard, Visalia, CA (CCA-CA)
Dutra, Justin, Stratford, CA (CCA-CA)
Fernandes, Jonathan, Tulare, CA (CCA-CA)
Gulley, Andrew, Five Points, CA (CCA-CA)
Kamstra, James, Modesto, CA (CCA-CA)
King, Mitchell, Hughson, CA (CCA-CA)
Kuehl, Eric, Brentwood, CA (CCA-CA)
Magana, Manuel, Oxnard, CA (CCA-CA)
Riddle, Charlie, Bakersfield, CA (CCA-CA)
Rose, Kathy, Woodland, CA (CPSS)
Schmida, Daniel, Freedom, CA (CCA-CA)
Shepperd, Michael, Bakersfield, CA (CCA-CA)
Skidgel-Clarke, Jennifer, Prunedale, CA (CCA-CA)
Stokes, Jerry, Los Banos, CA (CCA-CA)
Testerman, Eric, Orland, CA (CCA-CA)
Witty, James, Fairfield, CA (CPSS)
Howard, Paul, Bradenton, FL (CCA-FL)
Abrams, Andrew, Sigourney, IA (CCA-IA)
Brunsvold, Bradley, Algona, IA (CCA-IA)
Chesnut, Kyle, Boone, IA (CCA-IA)
Faghih, Amir, Ames, IA (CCA-IA)
Franzen, James, Denver, IA (CCA-IA)
Gipple, Seth, Morning Sun, IA (CCA-IA)
Kaskey, Michael, Aurelia, IA (CCA-IA)
Lawles, Kyle, Centerville, IA (CCA-IA)
Lloyd, James, Newton, IA (CCA-IA)
Luers, Will, Keota, IA (CCA-IA)
Peelen, Brett, Hospers, IA (CCA-IA)
Schaller, Vincent, Lamoni, IA (CCA-IA)
Schnell, Jason, Sully, IA (CCA-IA)
Schrum, Michael, Jefferson, IA (CCA-IA)
Swalwell, John, Macedonia, IA (CCA-IA)
Vohr, Eric, Cresco, IA (CCA-IA)
Duclos, Craig, Craigmont, ID (CCA-NW)
Adams, Mindy, Carlyle, IL (CCA-IL)
Graham, Edwin, Colfax, IL (CPAg)
Halcomb, Jerry, Deland, IL (CCA-IL)
Hoffman, Ryan, Bluff Springs, IL (CCA-IL)
Lambeth, James, Jerseyville, IL (CCA-IL)
Range, Jesse, Greenfield, IL (CCA-IL)
Wexell, Chad, Galva, IL (CCA-IL)

Newly certified

Downing, Bradley, Greentown, IN (CCA-IN)
Hedrick, James, Brinthurst, IN (CCA-IN)
McCullough, Shane, Brazil, IN (CCA-IN)
McKenzie Matthew Goodland, KS (CCA-KS)
Pachta, Ella, Belleville, KS (CCA-KS)
Siefkes, Robert, Hudson, KS (CCA-KS)
Harrison, Michael, Westminster, MD (CCA-CB)
Fullmer, Irene, Grant, MI (CCA-MI)
Martus, Jeffrey, Richville, MI (CCA-MI)
Tanton, Travis, Deckerville, MI (CCA-MI)
Walker, Amanda, Paris, MO (CCA-MO)
Beck, Dale, Rolette, ND (CCA-ND)
Bertholf, Neil, Mountain, ND (CCA-ND)
Larson, Michael, Harwood, ND (CCA-ND)
Lyons, Ryan, Lisbon, ND (CCA-ND)
Nelson, Marvin, Rolla, ND (CCA-ND)
Oberlander, Cory, West Fargo, ND (CCA-ND)
Scheresky, Darrell, Washburn, ND (CCA-ND)
Vingleen, Joshua, Casselton, ND (CCA-ND)
Beckman, Matthew, Tilden, NE (CCA-NE)
Hansen, Christopher, McCook, NE (CCA-NE)
Voet, Lindsey, York, NE (CCA-NE)
Youngers, Nicholas, Perry, NY (CCA-NR)
Brautigam, Paul, Saint Marys, OH (CCA-OH)
Dunn, Christopher, Bucyrus, OH (CCA-OH)
Kerr, James, Cadiz, OH (CPSS)
Michael, Daniel, Lebanon, OH (CPSS)
Schlechty, Kyle, Ansonia, OH (CCA-OH)
Siegel, Cindi, Alvordton, OH (CCA-OH)
Hogervorst, Eric, Watford, ON (CCA-ON)
Murphy, Gregory, Guelph, ON (CCA-ON)
Robson, Chris, Ilderton, ON (CCA-ON)
Scott, Blair, Formosa, ON (CCA-ON)
Drohan, Patrick, University Park, PA (APSS, APSC)
Leitheiser, Adam, Olive, SD (CCA-SD)
Cook, Damon, Kosse, TX (CCA-TX)
Mattke, Casey, Khme, TX (CCA-TX)
Cline, Lester, Harrisonburg, VA (CCA-CB)
Craig, Brent, Martinsville, VA (CCA-CB)
Seaford, Kevin, Richmond, VA (CPSS)
McWilliams, Colnin, Seattle, WA (CPSS)
Rod, Kenton, Richland, WA (CPSS)
Watts, Timothy, Rosalia, WA (CCA-NW)
Berkevich, Robert, Lake Mills, WI (CCA-WI)
Hinz, Matthew, Almond, WI (CCA-WI)
Hofp, Justin, Howards Grove, WI (CCA-WI)
Kirk, Kevin, Merrill, WI (CCA-WI)
Stull, Kyle, Oconomowoc, WI (CCA-WI)
In terms of setting his fees, Bordenave said that a low professional fee generally reduces the legit aspect and respect for the whole profession. “The best clients are looking for the best, not the cheapest,” he said.

Soil science consultants should bill on a consistent and timely manner. Don’t allow an invoice to go beyond its due date. Even if the consultant does not have a full-time accountant or bookkeeper, one should be hired on a part-time basis to ensure that billing is done consistently and to follow up with any past due invoices.

Bordenave gives a number of interesting guidelines on scheduling and time management, which is critical to success in consulting. The most important lesson in time management is learning how to say no.

“Schedule the day, prioritize the week, plan out the month, and set goals for the year,” Bordenave said. Basically, consultants need to set long-term goals, such as what they want to accomplish in five years. Bordenave recommended writing these down because if it is not documented, it does not exist. The consultant’s goals should match up with the time and energy it takes to open and successfully build the business.

Also, the consultant should avoid the numerous time wasters that we all face such as telephones, socializing, disorganization, inability to say no, obsessively checking and responding to email, unannounced visitors, and excessive meetings.

“If you had to leave for two months, what are the three things you would get done by the end of the week?” Bordenave asked.

If your consulting business has no clients, then you have no consulting business. Part of the consultant’s job is marketing services to people who may not even be aware that they need those services. Bordenave said the difference between advertising and marketing is that advertising is a random search for clients while marketing is a targeted way to reach clients.

### NAPT working for you

**Pay attention to the units**

*By Keith Reid, soil fertility specialist, Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA), Stratford, ON, Canada, and chair of the NAPT Oversight Committee*

It is easy to assume that every soil test is the same, but that would lead to improper interpretation of soil test results and poor advice to your clients. Every soil test report should list the units that are being reported, and every CCA should have some understanding of what these units mean.

### Different units that really aren’t

A variety of different units are used to report concentration of nutrients on soil test reports, but most of them are actually the same. The common factor is that the mass of extracted nutrient is reported per million masses of soil, or in parts per million (ppm). This may also be reported as milligrams per kilogram (mg/kg), or sometimes mg kg⁻¹, which means the same thing) or grams per megagram (g/Mg). In all these cases, the large number is one million times the small number, so the concentrations reported are directly comparable.

Since many soil tests are scooped rather than weighed, the purists will report the soil test value as milligrams per liter of soil (mg/L). What you need to remember is that a dried and ground soil, as scooped, will have a bulk density that is not far off of 1 kg/L, so treating these numbers as part per million will not introduce a significant error into your interpretations.

### Parts per million or pounds per acre?

Most soil tests report the concentration of nutrient in the soil, but a number of states have traditionally reported the nutrient concentration as pounds of available nutrient per acre. The underlying assumption is that most of the available nutrients are in the topsoil and that each acre-furrow slice weighs about 2 million lb. This means that the nutrients reported in pounds per acre are double those reported in parts per million since the report is actually in units of “parts per 2 million.” For those in the metric system, the conversion factor is still 2 since the calculated weight of a hectare-furrow slice is very close to 2 million kg.

The picture gets a little more complex when soil nitrate is measured since this is generally a deeper sample than for P or K. The multiplier to convert from parts per million to pounds per acre would increase to 4 for a 1-ft (30-cm) sample and 8 for a 2-ft (60-cm) sample.

### Element or oxide?

A further complication is the chemical species that is actually reported, particularly by labs that analyze both feeds and plant tissue. The standard in most feed analyses is to report nitrate (NO₃⁻) and sulfate (SO₄²⁻). In contrast, most soil and plant tissue analyses report the elemental equivalent, so it is nitrate N and sulfate S. Since one includes the weight of the oxygen, and the other does not, the numbers reported will be widely different. Knowing for sure which is being reported will avoid confusion.
Soil Science Step-by-Step Field Analysis
Sally Logsdon, Dave Clay, Demie Moore, Teferi Tsegaye, editors

Natural resource manager, agronomist, land use consultant, educator, environmental consultant…. The lines are blurred, the questions are complicated, and soil science is required knowledge. Soil Science: Step-by-Step Field Analysis provides the knowledge for conducting specific activities related to improved natural resource management. Readers will learn both new procedures and tips for improved performance in the field, with a focus on usefulness for real-life applications.

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• installing wells and piezometers, monitoring water table information
• surveying using simple or sophisticated equipment
• cleaning yield monitor data
• evaluation of overall soil quality
• identification of water repellency
• measuring soil density and water content, infiltration, temperature, and rainfall rate

2008, 255 pages
Water-resistant softcover, coil binding, 8 1/2 by 11”
Soil Science Society of America
ISBN: 978-0-89118-849-0

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Measuring Nutrient Removal, Calculating Nutrient Budgets

**Nutrient removal** is the quantity of nutrients removed in plant material harvested from the field. All plant material contains quantities of the following elements: nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), and zinc (Zn). The first six elements, N, P, K, Ca, Mg, and S, are taken up in greater quantities by plants and are termed **macronutrients**. They are present in concentrations of percent (%). The remaining nutrients are present in smaller concentrations, parts per million (ppm), and are therefore referred to as **micronutrients**. Directly measuring nutrient removal requires measuring how much biomass is removed from the field as well as the concentrations of nutrients in that biomass.

Nutrient removal is commonly estimated from measured yields and published nutrient concentrations. For instance, the P removal rate of corn grain has been estimated by multiplying 0.37 lb P$_2$O$_5$ bu$^{-1}$ by the yield in bushels per acre. However, there are inaccuracies involved with using average concentrations. For grains, much of this uncertainty comes from the use of a volumetric measurement (bushel) rather than a mass measurement. For forages, nutrient removal coefficients usually do not specify how much moisture is assumed to exist.

Nutrient removal estimates are most often used to calculate **partial nutrient budgets**, where total applications are compared with total removals. Such budgets are partial because losses from erosion, runoff, and leaching are not considered, nor are additions from atmospheric deposition, sediment deposition, or collection of runoff from other areas. Partial nutrient budgets have implications for soil test levels of immobile nutrients. Positive budgets result when application rates exceed those of removal, and under such conditions, soil test levels are expected to rise. Negative budgets result when application rates are less than removal.

**Summary**

Nutrient removal is the quantity of nutrient removed from a specified area. Commonly, farmers and advisers use published removal rates (on a yield unit basis) to estimate such quantities. However, measurements may be taken on the farm to improve evaluations and provide opportunities to further examine and evaluate nutrient management practices. The measurements that are essential to calculating nutrient removal are:
- harvest area
- weight of moist plant material
- moisture content of harvested plant portions
- nutrient concentration.

Guidance is provided for using these measurements to calculate dry matter yield and nutrient removal. In addition, nutrient budgets are discussed, along with their evaluation using soil test data. In the last section, two examples are provided. The first considers a farming operation that produces forage for internal use. The second guides the reader through measurements and calculations used on a grain farm.

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The four fertilizer rights: Selecting the right source

By Robert Mikkelsen, International Plant Nutrition Institute, Merced, CA; Greg Schwab, University of Kentucky, Lexington; and Gyles Randall, University of Minnesota, Waseca

The Four Fertilizer Rights (4R) concept was developed to connect the ideas of selecting the right source, right rate, right time, and right place for nutrient stewardship. The first article in this series (see March–April 2009 Crops & Soils, page 13) discussed the use of these “rights” for getting the best value from applied fertilizers, as defined by different stakeholders. This current article highlights the importance of selecting the right source of fertilizer for achieving your individual goals that will meet specific economic, environmental, and social objectives. Although the focus is on selecting the right source, none of these decisions can be made without consideration of the other “rights” to achieve the best results.

The idea of selecting the most appropriate nutrient source seems simple in concept, but many factors need to be considered when making this choice. Plant nutrition requirements, soil conditions, fertilizer delivery issues, environmental risks, product price, and economic constraints are all important considerations when selecting the most appropriate fertilizer source. Some decisions may be based on the availability of various materials within reasonable distance. The accessibility of fertilizer application equipment may also narrow the options. It is tempting to rely on tradition and experience when making these decisions, but a thoughtful review of these factors helps farmers gain the maximum benefit from these valuable resources and the significant economic investment they represent.

Selecting the right fertilizer source begins with determining which nutrients are actually required for optimal plant growth. This decision should be made with the help of diagnostic tests such as soil analysis and tissue testing. These tests need to be made in advance of the fertilizer application decisions. If this information is not available, nutrient applications can be made based on nutrient removal rates in the harvested crops or personal experience such as knowledge of past cropping and fertilizer practices on a given field. However, guessing the appropriate nutrient requirement can lead to numerous problems associated with under- or over-fertilization or can lead to overlooking specific nutrients until shortages become severe. Commit to getting the necessary diagnostic information for each field before fertilizer decisions need to be made.

It is common to focus on a single nutrient that is in short supply to the exclusion of the other nutrients. For example, a lack of adequate nitrogen (N) is easy to detect by observing stunted growth and chlorotic leaves. However, the maximum value from applied N will not be obtained if secondary deficiencies of nutrients such as phosphorus (P) or potassium (K) are not also corrected (Fig. 1). Although we often focus on individual nutrients, they must function together to support healthy plant growth.

Forms of fertilizer

Selecting the right source of fertilizer frequently begins with choosing the form of nutrients to apply.

Fluid fertilizers. Due to their versatility for mixing many nutrients into a homogenous material that can be applied uniformly in the field, fluid fertilizers are popular. For example, fluids are effective and give placement flexibility when applied as starter fertilizers or dribbled as a topdress application, and they also perform well when applied with irrigation water. They are easy to handle and are excellent carriers for a variety of micronutrients, herbicides, and pesticides.

Fertilizer suspensions. Suspension-type fertilizers are also appropriate in some situations for the same reasons as clear fluid fertilizers. They can be made from less soluble materials, and higher nutrient concentrations can be achieved than...
with clear fluids. Larger quantities of micronutrients can be incorporated into suspensions as well as powdered herbicides and insecticides that are not suitable for clear fertilizers.

**Compound fertilizers.** In many circumstances, compound fertilizers, containing various ratios of N-P-K and other nutrients, are a good choice. Compound fertilizers may be easier to transport and apply than individual nutrients. They are convenient for a basal application of several nutrients, followed later in the growing season with additional N or whatever nutrient is needed. Compound fertilizers are useful for obtaining a uniform application of nutrients since all of the nutrients are contained in each pellet and they are not susceptible to particle segregation, which occurs with some blends made from individual fertilizer materials. Unique chemistry can be incorporated into individual complex granules, such as addition of small amounts of elemental sulfur (S) to enhance nutrient availability by promoting acidification surrounding the particle. The nutrient composition of compound fertilizers should be selected to match the needs of the individual fields.

**Bulk blends.** Two or more granular fertilizers can be mixed together to make bulk blends to meet the specific needs of a customer. Each field can receive the specific amount of each nutrient recommended. Bulk blends are popular since they can be made from lower-cost components with relatively inexpensive equipment. The blended materials must have chemical and physical properties that are compatible. One potential problem that can occur with bulk blends is separation of the mix during transportation and handling. Fertilizer blending specialists are aware of this concern and match uniform particle sizes of different nutrients as much as possible.

**The salt index.** If the fertilizer will be placed in close proximity to the seed, the “salt index” is also a factor to consider. The salt index is an indication of the osmotic contribution that the fertilizer will make when dissolved in the soil solution. It does not predict the actual damage to a seedling but allows comparisons to be made among fertilizer sources. Fertilizers with a higher nutrient content often have a lower salt index per unit nutrient since a smaller amount of actual material is added to the soil. Fluid fertilizers may have a lower salt index than granular fertilizers since they are more uniformly distributed over a greater soil volume.

Selecting the right source of fertilizer requires understanding the soil, climate, crop growing conditions, and the farmer’s goals in order to make the best decisions. An overview of the properties of a few example fertilizer materials will illustrate some of the considerations to make when selecting the right source.

**Soil application**

**Nitrogen**

There are many excellent fertilizer sources of N. Selection of specific fertilizer sources is made with a view to factors such as price, available application equipment, and the nutritional needs of the crop. Because of potential impacts on water and air quality, which can vary greatly with N source, weather, soil, and cropping system, increasing emphasis needs to be given to potential losses when using this valuable nutrient.

**Anhydrous ammonia.** Widely used for direct application, anhydrous ammonia contains the highest N content of all fertilizer sources, but many safety features must be considered when transporting and applying anhydrous ammonia, and strict safety procedures must be followed during handling. Soil moisture content should not be too dry or too wet when anhydrous ammonia is applied in order to avoid volatile losses due to poor sealing. It is the product of choice for fall application for corn in the Midwestern U.S. Addition of a nitrification inhibitor may be beneficial where the potential for loss through leaching or denitrification is elevated (e.g., in sandy or poorly drained soils receiving substantial rainfall). Anhydrous ammonia can also be added through irrigation water but may be susceptible to ammonia volatilization loss when using this technique.

**Urea.** A relatively high nutrient concentration and lower production costs make urea the most common N fertilizer used worldwide. Urea normally hydrolyzes to ammonium within a few days when the urease enzyme is present. Urease is abundant in most soils, plants, and residues. If urea is left on the soil surface without incorporation by tillage or downward movement with water, it may be susceptible to considerable volatile ammonia loss. Once urea moves beneath the soil surface, the loss of ammonia is mostly eliminated. Chemical additives have been used to temporarily inhibit the urease enzyme and reduce ammonia loss from surface-applied urea. The use of additives should be considered when urea cannot be incorporated, especially when soil pH is high, or when plentiful crop residues remain on the surface. Nitrification inhibitors can also be used with urea where the potential for nitrate leaching or denitrification is elevated. Solutions of urea are effective for foliar application since damage to plant tissue is less than with many other N sources.

**Nitrogen solutions.** Solutions containing a mixture of approximately half of the N from urea and half from ammonium nitrate are widely used. The behavior of this liquid, urea ammonium nitrate (UAN), as a N fertilizer is similar to each of the individual components. UAN is desirable because of its ease in handling, complete solubility, and mixing compatibility with many other fluid fertilizers and chemicals. Nitrogen solutions are particularly well suited for sidedress, fertigation, and weed and feed applications.

**Controlled-release fertilizers.** In some production systems, use of controlled-release fertilizers (CRFs) can provide significant benefits in yield, labor savings, environmental impacts, and management flexibility when the particular fertilizer material is properly matched with crop demand and growing conditions. The mechanism for controlling the release of nutrients varies considerably for different...
products. Many controlled-release products have a polymer shell surrounding the soluble fertilizer (most often urea). The coating will respond to moisture and elevated temperature to gradually allow the nutrient to diffuse through the polymer shell over a length of time. The recommended timing of application is provided with the product label. The release of N from other CRF materials is controlled by biological activity or by slowly dissolving in water.

A number of other N-containing fertilizers can also be excellent choices, depending on the crop need and other factors. These sources might include materials such as ammonium sulfate, ammonium thiosulfate, and numerous nitrate-based materials. Each can be the right source under various conditions.

**Organic sources of N.** For many cropping conditions, organic sources of N can be beneficial. When animal manures are used as a N source, it is important to know the nutrient content of the material, expected volatile loss of ammonia (depending on application timing and placement), and nutrient release rate. Manures having a high ratio of ammonium to carbon release N relatively quickly. When manure contains more organic N or bedding material, it will release N more slowly. These slower N-releasing manures generally provide more second-year N availability, which should be considered when using them. Some cover crops (especially legumes) and crop residues are also potential N sources that can provide a valuable source of plant nutrients.

**Phosphorus**

Plant-available P concentrations in soil are generally quite low due to the high reactivity of P with various mineral components. The soil chemistry involving P fertilizers is complex and involves both rapid surface adsorption reactions and extended solid-phase transformations. In most soils, selection of a particular P fertilizer does not greatly affect the short or long-term plant availability.

The most commonly used dry P fertilizers are monoammonium phosphate (MAP) and diammonium phosphate (DAP). While MAP and DAP are N sources, their primary value is as a P source. Ammonium polyphosphate (APP) is the most commonly used liquid source of P.

A major difference between MAP and DAP is the pH directly surrounding the granule following dissolution. A saturated solution of MAP has a pH of <4 while DAP has a pH of 8. Therefore, a band application of DAP in high-pH soils can result in the release of ammonia, which may harm germinating seeds. The potential for ammonia loss from surface application of DAP is greater than for MAP, especially on alkaline soils. There is no significant agronomic difference in the P fertilizer value of these materials.

**Liquid APP.** Approximately half of the P in liquid APP is orthophosphate, and the remaining half is made up of polyphosphate compounds. The polyphosphate molecules rapidly convert to orthophosphate and become available for plant uptake. This slight delay in P availability occurring during polyphosphate hydrolysis has no detrimental effect on plant growth. In some soil conditions when P is added in a granular form, its initial plant availability may be limited by slow water movement into the granule, resulting in decreased plant availability compared with liquid P fertilizers. However, for most practical purposes, differences in P availability between liquid and dry sources are not significant.

**Animal manures.** Animal manures can be an excellent source of P for plants. When manure is used primarily as a N source, the amount of P applied is often 3 to 5 times more than many plants require, which can result in excessive P accumulation following multi-year applications. An alternative is to apply manure to provide adequate P and then supplement that with additional N fertilizer to meet crop requirements. Management of animal manure should include a plan to avoid surface runoff of nutrients. In many manures and composts, >75% of the total P is present in the orthophosphate form, which will behave similarly to fertilizer P. The fraction of organically bound P requires microbial degradation before it is available for plant uptake, much of it occurring within a year.

**Potassium**

There are many excellent fertilizer sources of K. Since the behavior of K from these materials is identical in the soil, a major consideration is the accompanying anion that is present in the fertilizer material.

**Potassium chloride.** Because it is often the least expensive and the most abundant K mineral in commercial deposits, potassium chloride is the most widely used source of K. Potassium sulfate is also an excellent nutrient source where S is also desirable or where chloride application should be minimized. It is less soluble than potassium chloride and not used widely for making fluid fertilizers. The use of potassium-magnesium sulfate provides a valuable soluble source of three essential plant nutrients. Other sources of K, such as potassium thiosulfate and potassium nitrate, are used effectively in more specialized conditions. Potassium present in plant residues, manure, and compost remains soluble and readily available for plant uptake, similar to K fertilizer.

**Fertigation**

Application of nutrients with irrigation water is commonly done to save labor, increase the flexibility of timing nutrient application, and improve nutrient efficiency. Fertilizer sources intended for fertigation are prepared so that precipitation and clogging of the irrigation system are avoided. There are many excellent fertilizers that are compatible with any type of irrigation system. Particular attention needs to be given when adding P-containing fertilizers to any irrigation water that contains abundant calcium or magnesium in order to avoid plugging. Remember that nutrient distribution through fertigation is no better than the uniformity of the water delivery system.
Foliar application

For some crops, foliar nutrition may be the most economical and reliable method for providing certain nutrients, especially micronutrients. There can be large differences in the effectiveness of various fertilizer sources in actually penetrating into leaves and providing the desired nutritional benefit. In specialized cropping conditions, foliar nutrition may be useful in supplementing soil nutrient supplies during critical growth stages as part of an overall nutrition plan, but this practice is not beneficial for most agronomic crops. Local recommendations should be followed for selecting the most effective foliar nutrient source on specialty crops.

Many factors are involved in combining the 4R concept of selecting the right source–rate–time–place combination to meet the specific economic, environmental, and social goals. There is clearly no one “perfect” source of nutrients for all situations. As technology and economic conditions change, a periodic re-evaluation is required for getting the most value from plant nutrients. This article, which discusses the most common plant nutrient and fertilizer sources, points to the need for continued conversations between the Certified Crop Adviser and his/her clients when evaluating plant nutrition and potential fertilizer sources.

May–June 2009
Self-Study Quiz

The four fertilizer rights: Selecting the right source (no. SS 03900)

1. Selecting the right source of fertilizer should be based on
   □ a. economic considerations.
   □ b. individual goals with multiple objectives.
   □ c. availability of application equipment.
   □ d. potential for the greatest yield.

2. Soil analysis and tissue testing are important when selecting the right nutrient source by
   □ a. suggesting specific forms of fertilizer that should be used.
   □ b. guiding selection of the most affordable nutrients.
   □ c. helping to choose between dry and fluid nutrient sources.
   □ d. identifying the specific nutrients that may be limiting crop growth.

3. The source of fertilizer nutrients that are used
   □ a. never makes a difference to the farmer.
   □ b. is determined by price.
   □ c. requires integration of many factors.
   □ d. has a minimal environmental impact.

4. Compound fertilizers can be useful for
   □ a. targeting specific nutrient needs in the field.
   □ b. stopping nitrogen leaching losses
   □ c. providing a simultaneous application of several nutrients.
   □ d. minimizing off-field nutrient losses.

5. The potential for soluble fertilizers to damage young seedlings is estimated by
   □ a. pressure bomb.
   □ b. salt index.
   □ c. the ratio of carbon to nitrogen.
   □ d. soil biological activity.

6. Urea continues to gain popularity as a nitrogen fertilizer because
   □ a. the white granules reflect solar radiation.
   □ b. it is readily identified in a bulk blend with other nutrients.
   □ c. it can be quickly converted to a volatile form for plant uptake.
   □ d. it is the highest nitrogen-containing solid fertilizer commonly available.

This quiz is worth 1 CEU in Nutrient Management. A score of 70% or higher will earn CEU credit. The International CCA program has approved self-study CEUs for 20 of the 40 CEUs required in the two-year cycle. An electronic version of this test is also available at www.certifiedcropadviser.org. Click on “Self-Study Quizzes to Earn CEUs.”

Directions

1. After carefully reading the article, answer each question by clearly marking an “X” in the box next to the best answer.
2. Complete the self-study quiz registration form and evaluation form on the back of this page.
3. Clip out this page, place in envelope with a $20 check made payable to the American Society of Agronomy (or provide your credit card information on the form), and mail to: ASA c/o CCA Self-Study Quiz, 677 S. Segoe Road, Madison, WI 53711. You can also complete the quiz and pay online at www.certifiedcropadviser.org ($15 charge).

Quiz continues next page
7. Controlled-release fertilizers
- a. are too costly for agronomic crops.
- b. always result in greater yield and quality.
- c. provide an additional option for nutrient management.
- d. allow nutrients to be applied at any time of the year.

8. An important difference between monoammonium phosphate (MAP) and diammonium phosphate (DAP) is
- a. DAP provides phosphorus in a more plant-available form.
- b. the nitrogen in DAP will be used more readily by the plant.
- c. the soil pH around a MAP granule will be lower.
- d. only MAP will convert to polyphosphate.

9. Most potassium fertilizer sources
- a. contain potassium in different chemical forms.
- b. differ primarily in the accompanying anions.
- c. should be selected based only on price.
- d. are more effective than manure as a potassium nutrient source.

10. A good use for a urease inhibitor would be when
- a. anhydrous ammonia is used.
- b. urea is incorporated into the soil.
- c. urea is broadcast on the soil surface.
- d. UAN is applied with center-pivot irrigation water.
Producers of upland cotton are interested in alternative row spacings and planting patterns to improve productivity. One alternative to solid planting is a skip-row pattern, in which entire rows are not planted adjacent to planted rows. A full 2 × 1 pattern refers to two planted rows adjacent to a skipped row of the same width. Skipping rows reduces the seed planted per acre, so planting costs are reduced. Another system involves planting in ultra-narrow rows (UNRs) roughly 15 inches wide, with no post-plant cultivation, and harvesting with a finger-stripper harvester. Although more seed is typically planted in UNRs, higher planting costs may be offset by lower equipment ownership and other cost savings relative to conventional wide-row cotton.

The growth habit of cotton allows the plant to partially compensate for potential yield lost to skip-row planting, such that yield reduction is less than proportional to the reduction in planted area. In Alabama, for instance, cotton yields increased in skip-row patterns by 29 to 62% on a planted-area basis but decreased 12 to 46% on a field-area basis, depending on number and frequency of skipped rows. The least yield loss relative to solid cotton occurred in the 2 × 1 skip-row pattern spaced at 40 inches, which yielded 88% as much as solid planting. Several Mississippi Delta studies showed that cotton in a full 2 × 1 skip-row pattern yielded from 68 to 92% of solid planting. Across locations in Australia, researchers found that yield differences between solid and 2 × 1 skip-row cotton appeared as yields increased greater than 324 lb lint/acre. In another study, maturation of plants in skip-row plots has been shown to be generally later than solid planting.

One study found that yield compensation was accompanied by delayed maturity, which can lead to losses of yield and fiber quality in short-season environments. Yield compensation in dryland skip-row cotton may be partly due to soil water conservation. In a Texas dryland environment, researchers postulated that soil water stored beneath adjacent skipped rows tends to distribute the seasonal water supply more favorably for crop development. They found that yield response to skip rows differed by year. With relatively normal rainfall, yields per field area were similar in solid and 2 × 1 skip rows but lower in 2 × 2 skip rows. In a relatively dry year, however, yields (on land-area basis) were lower but similar in all three planting patterns. Seasonal water extraction was similar for the planted rows of all patterns and for the fallowed row of the 2 × 1 pattern, indicating that cotton could extract as much water from the skipped row as from planted rows. This attribute of skip-row production is a major reason for its adoption in dryland regions, and it could also be valuable for nonirrigated cotton grown in subhumid regions, especially in dry years.

Effect of planting patterns on yield of upland cotton

Photo courtesy of Todd Baughman. See http://peanut.tamu.edu/todd.htm.
Most skip-row research has been conducted in row spacings of at least 30 inches or more, but few published studies have evaluated possible interactions between row spacing and planting pattern in cotton. One study reported that plants in 30-inch rows produced more lint yield on a land-area basis than those in roughly 40-inch rows in Mississippi Delta soils. Plant size was larger in the full 2 × 1 skip-row planting pattern compared with solid planting, but solid planting produced higher lint yield on a land-area basis. The study did not indicate whether responses to row spacing and pattern were independent or interactive.

Similar studies have evaluated several row spacings and patterns in other cotton-growing climates but did not specifically address interactions between row spacing and pattern. Even so, inferences can be drawn from their data. In all six location-years of yield data that they reported, similar yields were obtained from 15-inch rows planted in a solid and 2 × 1 skip-row pattern. In 30- and 38-inch rows, however, similar yields were obtained from solid and 2 × 1 skip rows in three cases, and in three other cases, higher yields from solid plantings were obtained. These results suggest the possibility that skip-row effects on yield may not be equivalent at all row spacings.

UNR cotton is typically planted in solid rows spaced less than 15 inches, with dense plant populations. High seeding rates were recommended in the 1990s mainly to facilitate harvesting with a finger-type stripper. Many comparisons of UNR and wide-row cotton involved fairly large differences in plant density and inconsistent effects on yield. In Texas, researchers evaluated earliness of maturity by successive hand harvests in four row spacings, with plant density treatments varying within the UNR spacings. The researchers found maturity differences on a heavy clay soil with some row spacing plans. On a lighter silty clay loam soil, however, yields and earliness were unaffected by row spacing and density treatments. Considered together, these studies suggest that earliness and yield potential in UNR are associated with early boll set, which in turn depends on adequate light penetration to lower leaves in the canopy.

Earlier canopy closure and photosynthetically active radiation interception in UNR cotton is generally considered beneficial for weed suppression. Several studies of weed competition in soybean found that planting in narrow rows can result in greater season-long weed control than wide-row soybean due to faster canopy closure providing greater shading and weed suppression. It has been reported that reducing soybean row spacing by roughly one-third reduced redroot pigweed biomass by 20% and increased soybean yield by 18%.

To determine how best to optimize planting patterns, researchers from the University of Tennessee varied planting densities within rows, planted at various distances between rows, and studied the effect of irrigation and nonirrigation on yields. The field studies were replicated for three years in adjacent irrigated and nonirrigated fields in Milan, TN. Cotton was grown in approximately 10-, 30-, and 40-inch rows, each planted in a solid and 2 × 1 skip-row pattern.
Table 1. Plant population, final plant height, canopy interception of photosynthetically active radiation (PAR), and pigweed suppression in nonirrigated and irrigated cotton as influenced by row spacing and configuration, 2003–2005.

<table>
<thead>
<tr>
<th>Row width</th>
<th>Row configuration</th>
<th>Plant population</th>
<th>Plant height</th>
<th>PAR interception 41–48 DAP†</th>
<th>83–88 DAP</th>
<th>Pigweed rating‡</th>
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<td>inches</td>
<td>no./ft row</td>
<td>no./yd²</td>
<td>inches</td>
<td>% scale§</td>
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<td>19.3a</td>
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<td>71a</td>
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<td>7.1c</td>
<td>37a</td>
<td>35c</td>
<td>77c</td>
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<td>69e</td>
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</tbody>
</table>

† DAP, days after planting.
‡ Least square means of original ratings at 92 DAP in 2004 and 84 DAP in 2005; P values and letters from arcsine transformed ratings.
§ Rating scale from 0 (no suppression) to 100 (complete suppression of weeds).
¶ Letters separate means within groups at P = 0.05 by independent pairwise t tests in Proc Mixed (pdiff option).
# Probability of obtaining a greater F value if null hypothesis is true.
Following University of Tennessee Agricultural Extension Service guidelines, cotton growth was regulated by multiple applications of mepiquat chloride to all plots, and insect pests were controlled using methods recommended for *Bacillus thuringiensis* (Bt) cotton. All spray applications after planting were made with a self-propelled, high-clearance sprayer.

Light interception by the cotton canopy was measured in each plot of the irrigated and nonirrigated tests with a pair of quantum PAR (photosynthetically active radiation) sensors. These data were collected within two hours of solar noon at 48 and 88 days after planting (DAP) in 2003, 43 and 88 DAP in 2004, and 41 and 83 DAP in 2005. A point sensor (model LI-190, LI-Cor, Lincoln, NE) was situated above the canopy of each plot, while a LI-191 line sensor was placed under the canopy.

Seedcotton from each plot was weighed at harvest, and a subsample was collected for ginning at the West Tennessee Research and Education Center. Lint yield was defined as the mass of lint harvested per unit ground area, calculated from seedcotton weight, gin turnout, and plot area harvested.

Multiyear data from irrigated and nonirrigated tests were analyzed separately by the General Linear Model (GLM) and Mixed procedures of SAS, version 9.2. The GLM procedure was run with fixed effects only to determine the relative magnitude of main effects of treatments and year × treatment interactions. Year × treatment interactions were considered non-negligible in cases where $P(F) < 0.05$ and $F$ values were higher than those of corresponding main effects. In these cases, the Mixed procedure was applied to individual-year data with replications as random effects. Otherwise, the Mixed procedure was applied to multiyear data with years and replications as random effects. Least square means were separated by independent pairwise $t$ tests, using the pdiff option at the 0.05 level of significance.

For all but one response variable, the main effects of treatment were more significant than effects of the corresponding year × treatment interaction, so their treatment effects were analyzed across years. The one exception occurred in the nonirrigated study, where the year × row spacing interaction for lint yield was more significant than main effects of row spacing. Most of this interaction was produced when 2005 yield data were combined with the 2003 and 2004 data, so 2005 yields were analyzed separately. There was no significant year × row spacing interaction for lint yield in 2003 and 2004, so yield data were analyzed across those two years.

Both row spacing and configuration affected final plant height, with reductions in height related to plant density. Cotton planted in 2 × 1 skip rows averaged 6 to 7 cm taller than in solid plantings, consistent with the lower plant densities in skip-row patterns. Canopy interception of PAR was also directly related to density during squaring (41–48 DAP) in both irrigated and nonirrigated fields. The skip-row pattern intercepted significantly less radiation than solid plantings early in the season. By cutout (83–88 DAP), however, row spacing and pattern had an interactive effect on canopy PAR interception.

There were no significant differences between solid and 2 × 1 skip rows in narrow rows while skip row continued to intercept less radiation than solid plantings in the other row widths. With PAR interception less than 90%, the narrow skip-row planting had essentially closed canopy by cutout in both irrigated and nonirrigated crops. Canopy of the wider solid planting also reached 90% interception by cutout.

### Suppression of large weeds

Suppression of pigweed growth by the cotton crop was affected interactively by row spacing and pattern (Table 1, previous page). As expected, weed suppression was generally related to canopy PAR interception. Under nonirrigated conditions, weed suppression was maintained in solid plantings of all row widths but was reduced in skip rows where PAR interception was less than 75%. Under irrigated conditions, however, pigweed suppression was reduced in plots with greater than 90% PAR interception, possibly due to additional flushes of pigweed emergence induced by irrigation events. Cotton growers who adopt skip-row cotton production systems can manage late weeds either by adapting their directed sprayers to the row configuration or by planting transgenic varieties that tolerate late-season applications of glyphosate.

Results suggest that early canopy closure is conducive to early maturity of the crop, provided that plant density is not excessive for the particular environment. A delay of maturity increases the risk of encountering inclement weather as harvest is delayed. Irrigated cotton may support a higher plant population with less compensatory adjustment of boll load than nonirrigated cotton. The capacity to produce high yields at a high plant density depends considerably on adequate moisture supply for boll development.

Cotton grown in narrower rows and solid plantings tended to close canopy earlier and more completely, suppress weed growth, and mature earlier than wider rows and a 2 × 1 skip-row pattern in this study. Incomplete canopy closure in wide 2 × 1 skip-row spacings resulted in less weed suppression, indicating a need for additional weed control in this configuration. However, weed growth in skipped rows tended to diminish with row spacing, suggesting an opportunity to gain some advantages of skip-row cotton without creating large weed problems in the field. Possible advantages of narrow skip-row planting may include lower planting costs, soil moisture conservation, and establishment of tram-lines for field equipment traffic, but these possibilities need further research. Later maturity with a 2 × 1 skip-row pattern tended to diminish with narrower row spacing. Time to crop readiness for harvest-aid application was seven to nine days later in the 40-inch skip rows than in the 10-inch skip rows, which is an important difference in short-season environments where risk of inclement weather tends to increase in late season.

In nonirrigated conditions, row spacing and configuration for optimal lint yield depended on growing conditions of a particular year. Under irrigation, however, cotton grown in...
solid-planted 30-inch rows consistently yielded more than cotton in either 10- or 40-inch solid or skip rows. With or without irrigation, however, lint yields were 13 to 15% lower in the 40-inch skip rows than in the 40-inch solid planting while yields did not differ between solid and skip rows in narrower row widths. This finding suggests that some cost savings with skip rows may be gained without yield sacrifice in rows spaced 30 inches or less, a finding that merits economic analysis.


May–June 2009
Self-Study Quiz
Effect of planting patterns on yield of upland cotton (no. SS 03901)

1. Under irrigation, solid planted 30-inch rows consistently yielded
   □ a. more than either 10- or 40-inch solid or skip-row cotton.
   □ b. less than 10-inch rows but more than 40-inch rows.
   □ c. less than skip-row cotton.
   □ d. more than skip-row cotton, but less than 10-inch rows.

2. The growth habit of cotton
   □ a. results in delayed maturity in solid planting.
   □ b. allows the plant to partially compensate for potential yield lost to skip-row planting.
   □ c. results in earlier maturity in skip-row planting.
   □ d. allows the plant to partially compensate for potential yield lost to solid-row planting.

3. What is considered a major reason for adoption of skip-row production in dryland regions?
   □ a. Cotton can extract more water from planted rows than from skipped rows.
   □ b. Skip-row production reduces irrigation costs.
   □ c. Skip-row production increases water use efficiency.
   □ d. Cotton can extract as much water from skipped rows as from planted rows.

4. Skip-row cotton matured later than solid planting, but this effect also diminished with
   □ a. wider rows.
   □ b. narrower rows.
   □ c. later planting.
   □ d. earlier planting.

5. Both row spacing and configuration affected final plant height, with reductions in height related to plant density. Cotton planted in 2 x 1 skip rows
   □ a. averaged 6 to 7 cm taller than in solid plantings.
   □ b. averaged 6 to 7 cm shorter than in solid plantings.
   □ c. were about the same height as solid plantings.
   □ d. were more than 8 cm taller than in solid plantings.

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8. Weed growth in skipped rows tended to diminish with row spacing, suggesting an opportunity to gain some advantages of skip-row cotton.
   a. despite creating large weed problems in the field. Possible advantages of narrow skip-row planting may include lower planting costs, soil moisture conservation, and establishment of tram-lines for field equipment traffic.
   b. without creating large weed problems in the field. Possible advantages of narrow skip-row planting may include lower planting costs, soil moisture conservation, and establishment of tram-lines for field equipment traffic.
   c. without changing weed exposure in the field, but reducing planting costs.
   d. without changing weed exposure in the field, but increasing planting costs.

9. Cotton growers who adopt skip-row cotton production systems can manage late weeds either by adapting their directed sprayers to the row configuration or
   a. by irrigating.
   b. by planting transgenic varieties that tolerate late-season applications of glyphosate.
   c. by planting later.
   d. by planting transgenic varieties that tolerate early-season applications of glyphosate.

10. With or without irrigation, lint yields were 13 to 15% lower in the widest skip-rows than in the widest solid planting
    a. and were higher in skip rows with the narrow row widths.
    b. while yields did not differ between solid and skip rows in narrower row widths.
    c. while yields were lower in narrow solid plantings.
    d. while yields were lower in narrow skip rows than in the narrowest solid plantings.

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**SELF-STUDY QUIZ REGISTRATION FORM**

Name: __________________________
Address: __________________________
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CCA certification no.: __________________

☐ $20 check payable to the American Society of Agronomy enclosed.

☐ Please charge my credit card (see below)

Credit card no.: __________________ Name on card: __________________

Type of card: ☐ Mastercard ☐ Visa ☐ Discover ☐ Am. Express Expiration date: __________________

Signature as it appears on the Code of Ethics: __________________

_I certify that I alone completed this CEU quiz and recognize that an ethics violation may revoke my CCA status._

This quiz issued May 2009 expires May 2012

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Information presented will be useful in my daily crop-advising activities: 1 2 3 4 5
Information was organized and logical: 1 2 3 4 5
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