Genes Identified for SDS Resistance

Careful Planning is Key to Managing this Soybean Disease

by LeAnn Strother and Karen Simon

Sudden death syndrome (SDS) can be disarming because plants suddenly turn yellow and die. However, scientists have discovered that while the plant may exhibit symptoms suddenly, the disease may actually be harbored in the plant for a long time, perhaps infecting the plant just days after germination.

"The best way to manage this disease is by planning," says Jason Bond, plant pathologist at Southern Illinois University. "You can't do much in August, but in October, you can plan for seed selection. Most cultural practices do little to control SDS; however, when soil is compacted, sub-soiling or chisel plowing can reduce it, though it won't eliminate it."

Bond's checkoff-funded research by the North Central Soybean Research Program (NCSRP) has shown early planting increases the chance of SDS.

"We hesitate to tell farmers to delay planting, but we encourage them to plant fields with history of SDS last," Bond says.

Rainfall also increases the chance of SDS. "Ironically, the conditions that drive high yield also contribute to greater SDS," Bond says.

X.B. Yang, Iowa State University plant pathologist, says management of SDS should start when harvesting corn fields. His group compared the survival of SDS fungus in different crop residues (corn and soybean) and found that corn kernels consistently had the highest SDS fungus population. This corresponded with observations that severe outbreaks of SDS can occur after a few years of continued corn production. Yang concludes that a high amount of harvest loss in corn increases the risk of SDS in the following soybean crop; minimizing harvest loss of corn may help reduce the risk of SDS.

Additional NCSRP-funded laboratory research reinforces what fields have shown. Leonor Leandro, Iowa State University plant pathologist, and her colleagues have learned that, although symptoms appear at flowering, soybean roots can become infected with the fungus that causes SDS shortly after germination. As roots mature, they are less susceptible to infections.

PHOTO COURTESY OF KAREN SIMON.

Iowa State University Researcher Leonor Leandro has found that SDS can appear on young seedlings, but shows up most frequently during the plant's reproductive stages.

"If the fungus remains only on the outside layer of the root, the toxin can't move up to the leaves," Leandro says. "The fungus must make its way into the center of the root. If infection is delayed, roots can resist having the fungus get to the center so leaves will stay healthy."

Leandro's research also shows that in warmer conditions young plants are susceptible to infection for only four days or less, while in cool temperatures roots are susceptible up to two weeks.

Farmers can apply this knowledge by planting SDS-infected fields last to reduce the chance of infection. If planting while soil temperatures remain

PHOTO COURTESY OF KAREN SIMON.

Researcher Gary Munkvold, Iowa State University plant pathologist, explains how he uses high-definition imagery to evaluate the impact of fungal pathogens, such as the one that causes SDS, on soybean root development.

Although symptoms appear at flowering, soybean roots can become infected shortly after germination. As roots mature, they are less susceptible to infection by the fungus that causes SDS.

The gray color of this soybean root is a good indicator of the presence of sudden death syndrome.

PHOTOS COURTESY OF LEANN STROTHER.

cool, they should try to avoid planting when it is wet.

Leandro's group is now focused on learning whether there's another susceptible time for infection, perhaps in the plant's reproductive phase.

Meanwhile, using lines with greater SDS resistance, plant breeders are now using genetic markers to breed resistance genes into high yielding varieties.

"Breeding for SDS resistance is difficult because it is controlled by many genes with each having a small effect on resistance," says Brian Diers, soybean breeder at the University of Illinois.

Another challenge is that many sources of SDS resistance genes are agronomically poor, making it difficult to breed resistance into high yielding varieties.

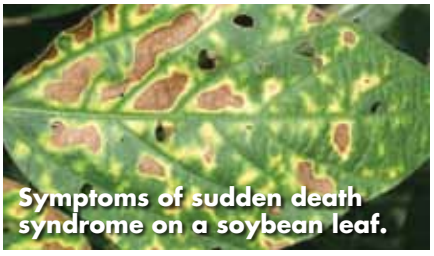
"We can't yet say we've solved the problem," Diers says. "However, we have found some genes that should increase SDS resistance and reduce grower losses."

From this research, breeding lines with greatly improved resistance to SDS have been released for Maturity Groups I, II and III. Because this research is checkoff-funded, results are made available to both private and public breeders. Seed should be available to producers in three to seven years.

Identifying SDS

SDS is now one of the most important pathogens of soybean in the United States and Canada. It robs U.S. producers of an estimated 28 million bushels annually. Yield loss from SDS is the result of reduced pod and seed fill, or in severe cases, flower and pod abortion. It continues to move northward and is now not only found in Iowa and Illinois, but in Minnesota, South Dakota and Wisconsin as well.

Fields with high yield potential, including those with high fertility levels, tend to show more severe symptoms (interveinal chlorosis). Also, fields higher in soil moisture, such as poorly drained and no-till fields are more symptomatic. Symptoms are most likely to appear first in low-lying areas with excessive moisture and in areas of compaction.



Symptoms of sudden death syndrome on a soybean leaf.

Identifying SDS is the first step to managing it. Knowing which fields have SDS will allow soybean growers to implement proper management practices the next time soybeans are planted. Because the foliar symptoms of SDS are similar to brown stem rot, the two diseases are often misdiagnosed.

To accurately diagnose SDS, cut open the stem and tap root of the symptomatic plants. SDS infected roots will be gray or brownish in color, but the center of the stem will be white. In contrast, the center of the stems of brown stem rot infected plants will be chocolate brown.

Managing SDS

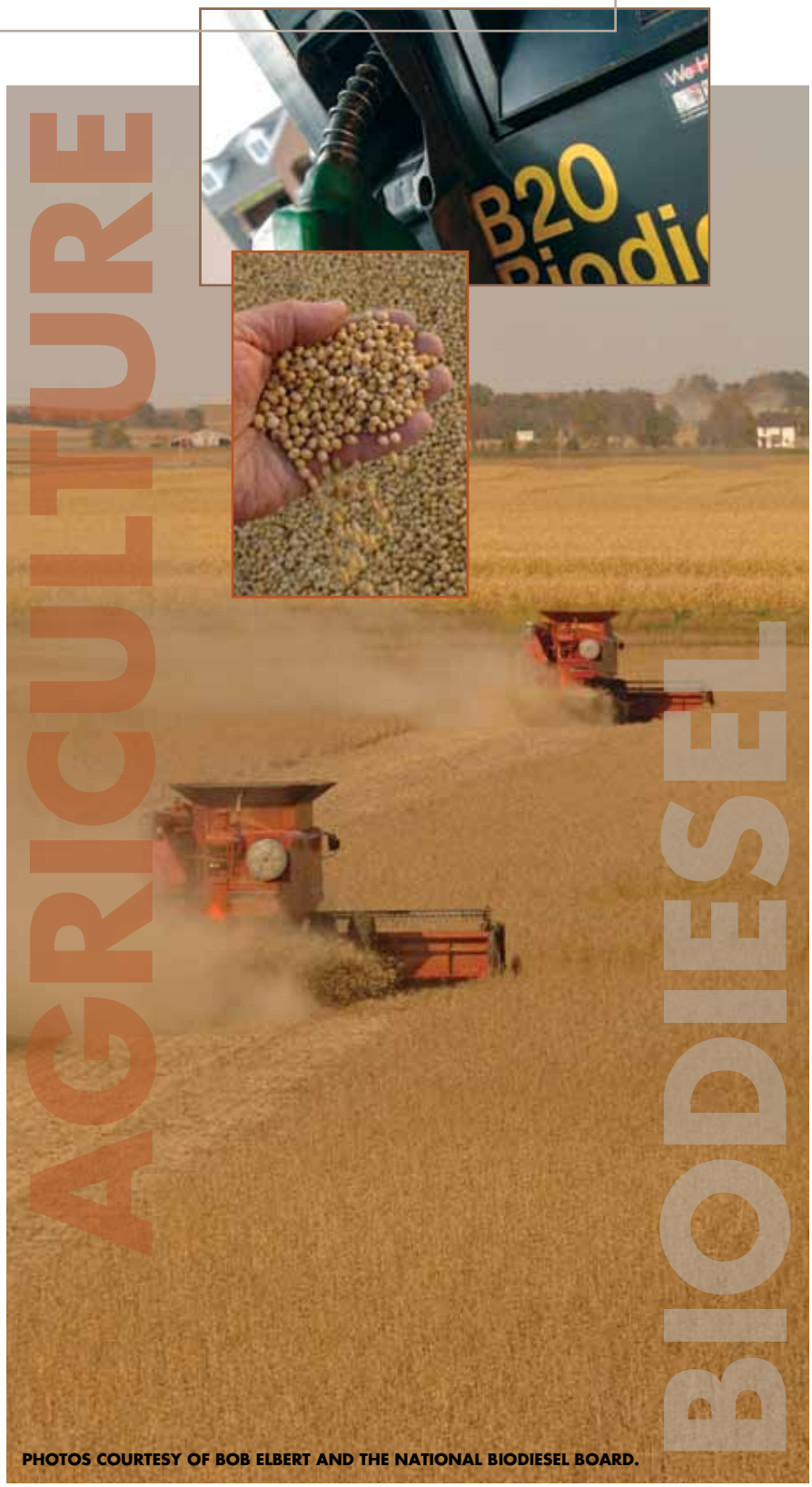
SDS is caused by a soil fungus that can survive in the soil for many years. Effective management of the fungus requires an integrated approach.

If SDS causes defoliation in your fields, ask your seed dealer for information on varieties with partial resistance or tolerance to SDS. Managing soybean cyst nematode is also very important because the nematode can infect the soybean root with the fungus. Don't forget to choose varieties first for high yield potential based on multi-location data, then choose the agronomic package you need for each field.

Other management considerations include:

- Plant fields with a history of SDS last,
- Reduce harvest loss in corn,
- Make sure fields are well drained,
- Break up compaction zones.

CEMSA Data Do



PHOTOS COURTESY OF BOB ELBERT AND THE NATIONAL BIODIESEL BOARD.

by LeAnn Strother

The soybean and biodiesel industries are by nature closely tied. Soybeans are abundant and make a first-rate feedstock for fuel. Biodiesel adds approximately 25 cents per bushel to the price of whole soybeans, according to a recent report from the United Soybean Board (USB), while lowering the cost of protein meal for livestock feed.

Now a program developed by the Iowa Soybean Association (ISA) to help farmers improve efficiency in crop production provides important data that can benefit biodiesel and agriculture in the discussion about sustainability.

The issue came to the forefront in California, where that state's Low Carbon Fuel Standard (LCFS) calls for a reduction of at least 10 percent in the carbon intensity of transportation fuels by 2020. The California Air Resources Board (CARB) identified the goal of adopting and implementing a LCFS regulation by 2010.

What happens in California is significant because standards adopted across the country will be influenced by the California precedent.

Part of CARB's process involves calculating the greenhouse gas (GHG) emissions from biofuels' production and use. For biodiesel, GHG analysis includes the manufacture of fertilizer for crop production, the emissions used in farming, transportation, crushing and processing of soybean oil for biodiesel production, and distribution to consumer fuel tanks.

Realizing the far-reaching impact of a California decision, National Biodiesel Board (NBB) Director of State Governmental Affairs Shelby Neal and Director of Sustainability Don Scott worked with Don O'Connor, a recognized expert in GHG modeling, to engage in

es Double Duty

CARB's rulemaking process. As work proceeded, they realized data included in the models CARB was using were flawed. NBB's research identified data showing a 40 percent improvement over the CARB figures for soybean processing and a 50 percent improvement over CARB's figures for biodiesel production, but finding up-to-date data on soybean production was another matter.

"As certification frameworks are developed, there is a need for technical input from the experts who know farming best," Scott says. "Farmers need to continue to be engaged in these discussions and be armed with data that quantifies the rapid improvements in efficiency and yield technology that make food, feed and fuel production more sustainable."

Many lifecycle studies use USDA data for fuel use and fertilizer application rates dating as far back as 1985. NBB and ISA staff, who collaborate routinely, considered whether ISA could provide more up-to-date, accurate data.

"USDA's numbers didn't reflect modern gains in efficiency, attaining higher yields through biotechnology and using fewer, better managed inputs," ISA Director of Market Development Grant Kimberley says. "We suspected more relevant data might be available through ISA's CEMSA project."

CEMSA (Certified Environmental Management Systems for Agriculture) involves farm planning that combines resource conservation and farm management into a comprehensive, environmental management system. In 2007, ISA added a planning module with an Energy Efficiency Calculator (created by independent Iowa crop advisers at MGT Envirotec) to help farmers scientifically assess, document and identify paths for improving their energy use efficiency related to crop production.

An added benefit is that CEMSA has made ISA a repository of robust data regarding production practices, outcomes and environmental impacts.

In a project funded by the soybean checkoff, ISA Environmental Programs State Technical Assistance Coordinator Heath Ellison, who manages the CEMSA program, and contractor Doug Johnson of Environmental Intelligence worked with NBB to analyze aggregate data from Iowa soybean producers who participate in CEMSA. The questions they considered: How much fuel is used to grow soybeans? How much fuel is used to transport soybeans from field to farmstead bin and/or co-op? What are the nutrient inputs per bushel?

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> **Ron Heck**
> **Perry soybean farmer,**
> **ISA director,**
> **ISA Environmental**
> **Programs advisory board chair**
> **and NBB director**

Using Iowa's data, NBB could put real numbers on what it takes to grow, handle and manage a soybean crop. As a result, they were able to demonstrate a 37 percent improvement in fuel efficiency over the data CARB is using to score soybean production. In fact, the new data for soybean production could alone improve biodiesel's carbon overall score by 9 or 10 percentage points compared to petroleum.

"When we met with CARB to discuss this new data, they were intrigued because it shows agriculture to be significantly more efficient than even the most recent, albeit outdated, USDA data does," Neal said. "CARB staff, however, were concerned that the sample size was too small so they chose not to include the Iowa data in their modeling."

However, while California is nearing the end of its LCFS process for 2010, there remain opportunities for CARB to accept better data and improve their overall GHG scoring for biodiesel. The same is true for EPA and other states that are also looking for the best available data for lifecycle analysis. An opportunity exists to improve biodiesel's GHG score with accurate data on modern and efficient crop production, and CEMSA provides a framework for doing so.

"If we can expand the scope of the program to include other leading soy-producing states to further show that these numbers represent current practices, we have a good shot at getting the new data included in the CARB modeling, thus improving biodiesel's chances of being a fuel of choice under the LCFS policy," Neal said.

"The bottom line is, not only can we talk about being energy efficient; with CEMSA data, we can document and prove it," says Ron Heck, a soybean farmer from Perry and ISA director who chairs the ISA Environmental Programs advisory board and has also been an NBB director. "We gather relevant and timely data that not only helps farmers become more efficient, but also allows farmers to have a larger voice when attacked by faulty assumptions of those who are not familiar with agriculture."

As ISA Environmental Programs Director Roger Wolf says, "The most exciting thing about this project is it impacts both the supply and demand side of the soybean industry with an eye on the environment."

Conquering Climate Change

Soybean Industry Seeks Answers to Anticipated Shifts

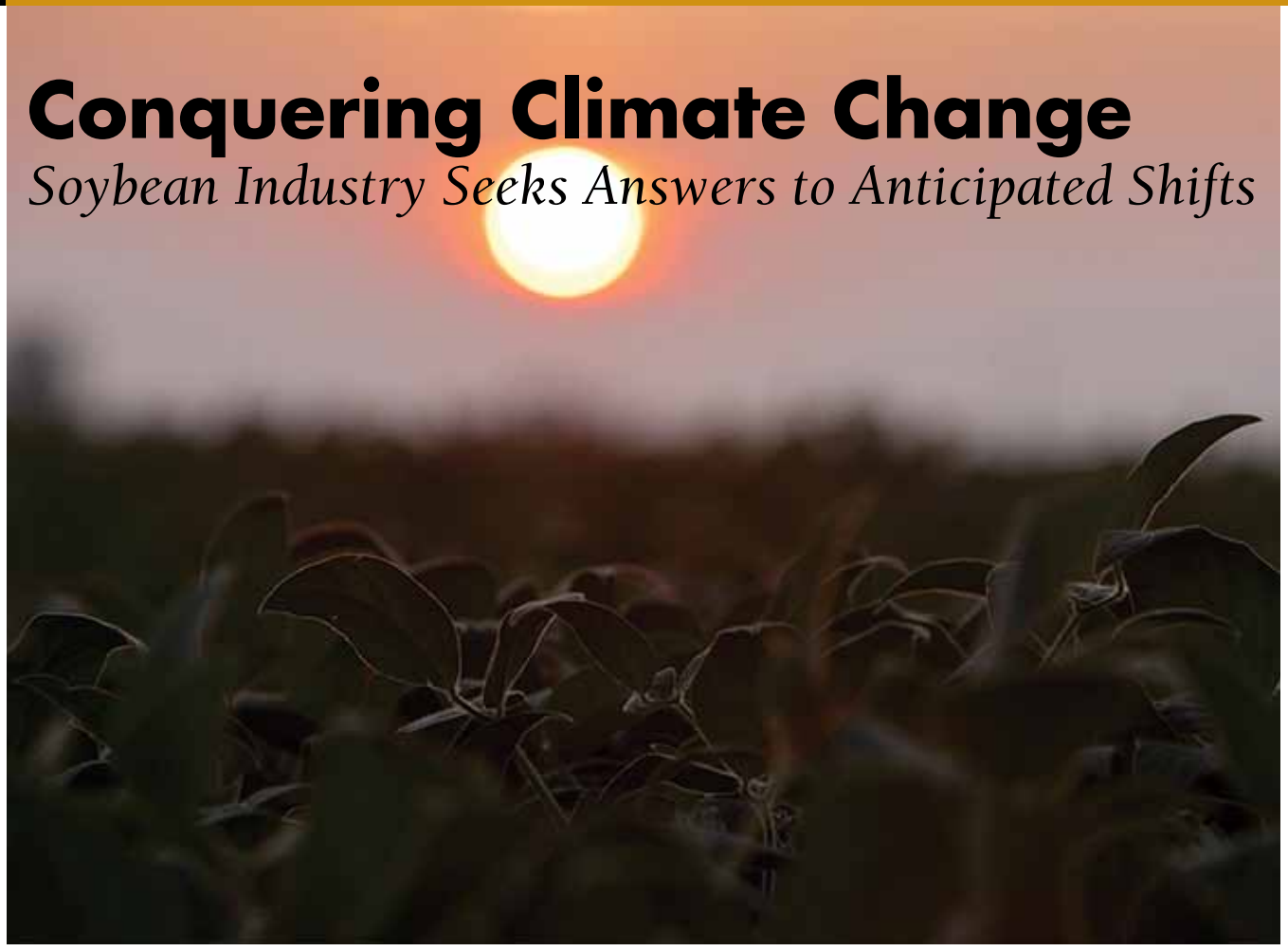


PHOTO COURTESY OF THE UNITED SOYBEAN BOARD/SOYBEAN CHECKOFF.

Climate change has become a familiar term. And while scientists do not fully understand yet how climate change may affect agriculture in the Midwest this century, they do agree that changes are likely. A number of efforts are underway involving several different disciplines to help soybean farmers adapt to those anticipated atmospheric changes.

"There is some uncertainty about the impact climate change will have on specific areas. Scientists feel pretty confident about temperature changes but less certain about rainfall patterns. The scientific community does anticipate that weather will become more volatile," says Don Hofstrand, co-director, Agricultural Marketing Resource Center. "Soybean varieties will need to be developed that can flourish under various conditions."

Futuristic Research

Researchers at the University of Illinois and USDA/ARS SoyFACE (Soybean Free Air Concentration Enrichment) facility are exploring a variety of climate change factors and their impact on soybeans. Researchers at the facility are able to grow soybeans under actual field conditions in the type of atmosphere predicted for mid-century.

"One of our current treatments is to look at impacts of combined temperature and carbon dioxide interactions," says Don Ort, SoyFACE coordinator. "For the study, we have increased the canopy temperature by 3.5°C, with and without elevating the carbon dioxide levels. Higher temperatures may shorten the growing season and lower yields, while we anticipate elevated carbon dioxide will partially mitigate the negative impacts."

Ort explains the temperature treatment is being applied year round, so the soil will remain heated even when the crop is not in the ground. He anticipates a higher temperature will accelerate carbon cycling, work against carbon sequestration and possibly boost nitrous oxide emissions. Warmer soil may also affect moisture content and seed germination.

"Warmer temperatures may also keep microbial activity going longer. We anticipate a change in 'who' we will find in the soil," says Ort. "We want to know both whether our hypotheses are true, and if true, to what extent we see these changes."

In other work, Ort and colleagues are looking at the effects of surface level ozone on soybeans. "Ozone is a very dynamic atmospheric pollutant and affects soybean cultivars differently," he says. "We have identified cultivars that show considerable tolerance and those that are highly sensitive. We cross the most sensitive and most tolerant to produce recombinant inbred lines. By planting and analyzing the progeny, we hope to be able to decipher the genetic basis of tolerance and isolate the DNA of sensitivity and tolerance."

Seed Company Efforts

Ort says several seed companies have been watching SoyFACE research with interest. Private research is also underway to help soybean farmers be in tune with climate change.

"Recent years seem to be more variable than in the past, creating a need for varieties that can perform well across a wide range of conditions that fluctuate year to year," says John Soper, PhD and senior research director, soybean product development, Pioneer Hi-Bred. "We are responding by ensuring that our varieties contain defensive trait genes required for a wide range of disease, pest and environmental stresses. We are using Accelerated Yield Technology (AYT) to build in top-end yield potential."

Monsanto research focuses on such relevant areas as stress tolerance, insect- and disease-resistance and a broad portfolio of germplasm for developing well-tailored varieties for a broad range of environments. Calvin Treat, director of global soybean breeding, says the current pace of change may allow for gradual shifts in maturity groups and proper placement of varieties for the best chances to succeed. Better scientific understanding and approaches for improving soybeans are advancing rapidly. Treat says that will translate into new variety development to ensure successful soybean crops for decades to come.

"Farmers will need to maintain flexibility," Hofstrand says. "Farmers may not know the challenges that confront them until the change is upon them, especially with weather volatility. In addition, any climate change legislation will impact farmers. A number of opportunities may be available to sell carbon offsets that supplement farmer income."

Soil Solutions

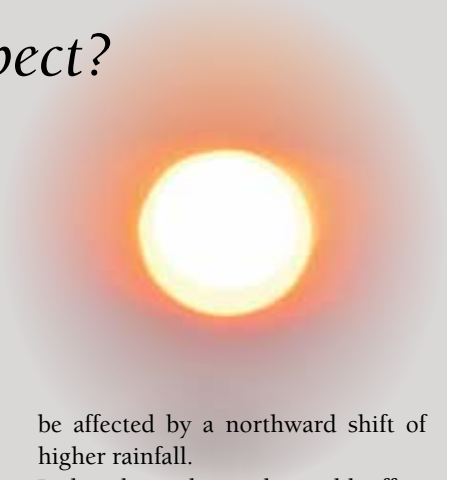
Jerry Hatfield, director of the National Laboratory for Agriculture and the Environment in Ames, Iowa, agrees. He says carbon sequestration is already a strategy some farmers are implementing through no-till practices. Carbon sequestration can help reduce runoff and leaching. Better soils produce more crops with better use of soil water and nitrogen.

"The problem is that as we have cultivated land, we have removed soil carbon. This decreases the water-holding capacity and nutrient availability, so soil is more dependent on having nutrient and water inputs at the right times for maximum production," he says.

"Continued soil degradation will reduce the potential productivity capacity. The variation in crop production will rise with variable weather during the growing season."

Hatfield says fields with conventional tillage have greater variation than fields with long-term no-till. "Success will come from those willing to evaluate cropping systems and take a long-term view of building a more resilient system to the increasing climate variation," he says. "Our soil system is a critical part of resource management. Degraded soils will not be as productive nor provide the resilience to climate variation that farmers need."

What Can We Expect?



Gene Takle, Iowa State University atmospheric science and agricultural meteorology professor, says farmers can expect to see an impact from a number of climate changes:

- The frost-free period may be longer, but the growing season required may be shortened. Nighttime temperatures rose more than daytime temperatures over the last 30 years, and summer daytime maximum temperatures dropped.
- Pests over-wintering may be more of a problem due to fewer extreme cold events.
- More freeze-thaw cycles are likely, but that might be better for breaking down hard-pan soils and allowing more winter recharge of soil moisture.
- Higher day-to-day and year-to-year variability in temperatures could damage crops or delay spring planting and crop growth.
- Precipitation is difficult for models to simulate. A complicating issue is location close to regions of high precipitation gradients. Annual precipitation is much less in western Iowa than eastern Iowa and less in northern Iowa than southern Iowa. In Illinois, there is less in the north than the south, but east-west differences are small. If precipitation patterns shift eastward, Iowa would be more affected than Illinois, but both would be affected by a northward shift of higher rainfall.
- Reduced wind speeds could affect pollination and pest and pathogen dispersion.
- Increased precipitation likely would be accompanied by more cloudiness and less solar radiation, particularly in spring, and would slow early-season crop growth.
- Higher temperatures promote generation of tropospheric ozone from automobile exhaust. Ozone may account for up to 30 percent yield loss over the next century.
- Higher temperatures and more soil moisture could lead to faster plant breakdown to form carbon dioxide out of soil carbon, increasing the loss of soil carbon.
- Since many weeds respond more quickly to elevated carbon dioxide than crops, herbicides may become less effective on weeds.
- Crops grown under high carbon dioxide environments would tend to conserve water better and increase their water-use efficiency.

U.S. Soybean Exports Do It Again

2009-2010 Marketing Year Could Be Different

Even though fall harvest has been off to a slow start in many parts of the country, the 2008-2009 marketing year for U.S. soy exports showed no signs of slowing down the continuing trend of year-after-year growth. With more than 1.56 billion bushels of U.S. soy exported, soy remains the leading U.S. agriculture export valued at $15 billion. Soybean checkoff-funded international marketing efforts assist U.S. soybean farmers and the U.S. soy industry in reaching these record-breaking exports.

Of the 2008-2009 soybean crop, the U.S. exported 55 percent, including 1.24 billion bushels of whole soybeans. The U.S. exported nearly 320 million bushels of U.S. soybean meal, and exports of U.S. soybean oil totaled nearly 900,000 metric tons.

"The checkoff funds programs that help increase the demand and preference for U.S. soybeans around the world," says Jim Call, soybean farmer from Madison, Minn., and United Soybean Board (USB) International Marketing chair. "And, despite the worldwide economic situation, U.S. sales of soy internationally have increased."

For the marketing year, China remained the top importer of U.S. soybeans with a total of 686 million bushels or 23 percent of total U.S. soybeans. The United States' southern neighbor, Mexico, imported the most U.S. soybean meal at 56 million bushels and the second-highest amount of U.S. soybeans with 113 million bushels and U.S. soybean oil with 110,600 metric tons. Total Mexico imports of U.S. soy equaled over $1.6 billion. India imported the most U.S. soybean oil, totaling 172,600 metric tons. U.S. soybean exports to Japan dropped slightly at 88 million bushels. The European Union remained a strong market as the Netherlands imported 32 million bushels and Germany imported 25 million bushels.

PHOTO COURTESY OF BOB ELBERT.

To maintain and increase U.S. soybean exports, the soybean checkoff supports a number of international marketing efforts, including hosting trade teams from around the world who visit the U.S. to see farms, soybeans in various growth stages, animal-feeding trials and other uses for U.S. soybeans. USB farmer-leaders also participate in trade missions to foreign countries to meet with farmers, processors, agricultural associations and government officials to discuss the quality and benefits of U.S. soybeans.

"Other countries know that when they buy U.S. soy, they are going to get a consistent product," Call says. "U.S. soybean farmers produce a high-quality product."

The slow harvest poses some concerns for the 2009-2010 marketing year. With the U.S. harvest moved back, this crop will be coming on the market later than usual. This could upset the opportunity for U.S. soy in the w inter months. Part of the increase in 2008/09 exports resulted from a drought in Argentina that left a gap for soybeans on the international market that the United States continues to fill.

"The U.S. soybean farmer cannot rely on some of these outside market forces to continue to drive our export growth," Call says. "For this reason, we are looking at ways to optimize our investments in the markets that represent the greatest growth opportunities, and we're going at this by looking at the model in which we approach the entire international marketplace. U.S. soybean farmers take very seriously our role of helping to feed the world, and optimizing our international marketing efforts will allow us to continue helping with global food supply issues even with the population growth we're facing."

A YEAR WE WON'T FORGET

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It is really difficult to imagine that after the flood in 2008 the next growing season would be as challenging as it was. Some would even say it was more challenging and I know for sure I will not forget it. The only good news from 2009 is that yields were fantastic. USDA is predicting that our average corn yield in Iowa is 188 bu/acre and our average soybean yield is 52 bu/acre.

It all started with a long and cold winter. Field work was finished in the fall and the snow did not disappear until late March. However, as soon as the snow disappeared we went into the field with one of the firmest seedbeds I have experienced here in Iowa. In fact, it was nearly perfect.

The first corn was planted in central Iowa around April 10. It was cold but because of the perfect seedbed it was difficult not to be out there planting. Looking at the data today many have wished they were planting that early since the yield results were unreal from these early plantings.

Soybean planting first started during the last couple of days of April. Soil was still cool, around 50°F, but it was not a problem with current technologies. The pace of soybean planting was slow and we were running behind the five year average until late May.

We did not see a lot of severe weather with tornadoes in the state but we had a lot of hail. Large areas in northeast and central Iowa were severely hit by hail. I have heard estimates that close to 1 million acres in Iowa alone were hit by hail with several hundred thousand areas complete destroyed.

PHOTO COURTESY OF BOB ELBERT.

The summer then stayed cool and with frequent rainfall throughout the growing season. Because of that, our two major diseases that thrive in cool and wet conditions, white mold and sudden death syndrome (SDS), became a huge problem in many parts of the state. In August, soybean aphids showed up in massive numbers like they did in 2007 and 2008. We thought the pest would only be a problem every other year but based on the new trend it looks like it's an insect we will have to deal with every year. This fall, the migration of aphids back to buckthorn (wither host) was excessive so the chances that 2010 will be a large aphid year are pretty good.

Harvest pace was slow as well. Because of a cool summer, harvest was delayed between 10 to 14 days on average. Then, in addition to this, the month of October was wet which delayed harvest even more. Today, when I am writing this column on November 1 we still have 40% of our soybeans and 75% of our corn left in the fields. We have been forced to dry soybean or aerate them this year for the first time in decades. All corn needs to be dried as well and I would guess the average moisture content this year was around 22%.

So what can we learn from 2009? Well, first of all we cannot control Mother Nature but beside that I think that our choice of varieties that we are planting can still be improved. I am still wondering why we plant susceptible or moderate susceptible varieties do diseases like white mold and SDS in areas that have a history of these two diseases. December will be a good month to go through all the data from yield testing trials so these two diseases do not cause as much yield loss our farms as they did in 2009. As always, please do not hesitate to contact me if you have any specific question related to managing these two diseases or any other soybean management issues. Merry Christmas!