Weathering Climate Change

Tracy Farmer Group Focusing on How Kentucky Agriculture Can Adapt

Global warming? Climate change?

"We've always had unpredictable changes in the weather," some say. "What we've seen in the past few years isn't anything that different."

Though there are still some nay-sayers on the topic of climate change, there is more and more evidence that change is real, and change is here. Perhaps the most compelling piece of evidence is the increase in the surface temperature of the planet, but there are other aspects of the climate system that are now providing us with an increasingly compelling case that something very different is happening to our climate.

"The recent Atlanta heat wave had been a one in one hundred year event, but is now a one-in-30-year event," says Alice Turkington, a University of Kentucky associate professor of geography. "Even more scary—this may become a yearly event in Atlanta."

She also points to the evidence in and around Greenland, a much faster ice melt than had been predicted. "We can easily see the decline in Arctic sea ice and can measure the warming not just of the surface of the oceans, but down to several hundred meters in depth." Turkington cites the award-winning Al Gore documentary, "An Inconvenient Truth," that in his presentation Gore discusses the possibility of the collapse of a major ice sheet in Greenland or in West Antarctica, either of which could raise global sea levels by approximately 20 feet. The result, Gore says, is that coastal areas would be flooded, producing 100 million refugees.

Dave Van Sanford, a UK professor of plant & soil sciences, agrees that climate change is real and is here and that there is an urgency in dealing with it.

"Global warming, increasing CO_2 concentrations, the hugely increasing variability and severity of major climatic events—rains, storms, droughts, and tornadoes—are clear indications of climate change," he says. "And the fact that the climate is changing dictates that we have to change way we do science."

Bringing UK Expertise to the Challenge

Turkington and Van Sanford are currently members of a cross-disciplinary group of researchers and teachers in UK's Tracy Farmer Institute for Sustainability & the Environment who are working to understand and respond to the effects of climate change. The Climate Change group, which includes 13 faculty members in 10 departments, five colleges, and one academic center, is led by Rebecca McCulley, an associate professor in plant & soil sciences whose specialty is grassland ecology.

"My main research focus right now is an ongoing forage climate change project," McCulley says. "The basic question we're trying to answer is, How will pastures in Kentucky respond to predicted changes in climate?" The answer to this question is obviously important for the state's $4 billion-a-year agricultural industry.

McCulley is monitoring several dozen plots of grasses—most are well-known KY species—to determine how they respond when subjected to an elevated temperature both day and night. The grasses she and her team planted include tall fescue, white and red clover, Kentucky bluegrass, crabgrass, and Bermuda, which, McCulley says, is actually more common south of the state.

Her "laboratory" for this work is located on prime farmland just north of Lexington at Spindletop Research Farm. Agronomic research conducted at Spindletop is focused on tobacco, grain crops, forages, and turf, McCulley explains.

Her various grass species are grown in conditions that simulate predicted increases for Kentucky in both heat and rainfall. Computer-controlled, infrared radiant heaters set at $+3^{o}C$ loom over each grass plot, which also gets elevated precipitation, based on predictions that Kentucky will be getting wetter. "A data water control station controls watering cycles, and all the plots are lined with 50-cm-deep aluminum sheeting to keep roots from talking with each other," McCulley explains, "and in order to keep water moving from one to the other."

To determine how the species change in reaction to the higher temperature and precipitation, her team clips the grasses three times a year and does chemical analysis on them.

McCulley emphasizes that other than the elevated temperature and greater water influx, her team does its best to keep these plots as natural as possible. “We treat this like a hayfield, kind of like a managed pasture, and hay it three times a year,” she says. “Keeping it natural is a way to invite indigenous animals—lots of mice and voles, for example.” She adds that part of this project is focused on forage quality, so her technicians set out a certain number of seeds in the plots and monitor how many disappear. McCulley’s research team includes two full-time technicians, two grad students and three undergrads. The three-year project was initially funded by the DoE’s National Institute for Climate Change Research for around $375,000.

McCulley says that in its first two years the project has generated lots of data, which she will be analyzing this summer. But there are some preliminary results. Total production has gone down with the increased heat, and for tall fescue and bluegrass the heat treatment is extending growth in the fall and spring, but the grasses’ decline in the fall is coming earlier and lasting longer.

“Within a few months we’ll be able to say which species do best with the plus 3 temperature and which don’t fare as well,” says McCulley. “This information may be very important for farmers down the road.”

Better Breeding of Barley and Wheat

In what could roughly be called a companion project, Dave Van Sanford, also utilizing the acreage at Spindletop Farm, is working to identify traits and methodologies that can be used for breeding wheat and barley in a way that acknowledges and accommodates the fact of climate change.

“I’m part of a huge project that began in February of this year,” Van Sanford says. “We’re talking $25 million over five years, with 50 scientists from all over the U.S.” The National Institute of Food and Agricultural Sciences, part of the USDA, is funding this project, titled Improving Barley and Wheat and Germplasm for Changing Environments.

“The major challenges we’re all facing are that the population of the world is increasing—it’s expected to be 9 billion by 2060—but the amount of aerable land is not increasing,” Van Sanford says, pointedly. “The fact that the climate is changing dictates that we have to change the way we do science, plant breeding, to make it more efficient.

We have to anticipate stresses that are likely to occur as a result of climate change and devise ways of breeding plants to tolerate those stresses." He adds that wheat is the "crop of choice" in this project because it is a major staple crop throughout the world, in developed and in developing countries.

In this project, which will also be conducted in breeding plots at the West Kentucky Research and Education Center in Princeton, Kentucky, Van Sanford will be focusing on nitrogen efficiency. Nitrogen use is of great interest to Kentucky growers because this crop stimulant is not only expensive, but can also be dangerous if it runs off fields and into the local water supply.

To assess effective nitrogen use, Van Sanford will be taking a hi-tech, two-pronged approach. First, he will be using something called Canopy Spectral Reflectance, which utilizes a device that measures the way light is reflected from the canopy, or top leaves, of wheat. Based on the reading from this device, Van Sanford can tell how much concentration of nitrogen is in the wheat. He will concurrently use DNA sequencing of many different breeding lines and wheat varieties.

"Both of these are new technologies that, especially when combined, should give us more accurate readings of nitrogen content than were possible 10, 20, 30 years ago. The idea is, we will be able to identify genes that govern "maximum use" traits," Van Sanford says.

"With climate change it's important to stress that we don't know what to expect. Warming in general is going on, but we can't predict the degree of warming for a given location," he adds. "If we assume there are increased levels of CO_2, with increased plant growth, there will be a greater need for nitrogen, which makes it crucial to identify these genes that enable plants to make the most efficient use of nitrogen."

Climate Change a Hot Topic in the Classroom

Some of the most popular science courses in the past few years at UK deal with climate change. The Department of Geography offers a 200-level course, Weather and Climate, as well as a 300-level course, titled Global Environmental Change, both taught by Alice Turkington.

"Students get pretty fired up in these classes about how climate works and how it changes," says Turkington, "in part because they realize they have a vested interest in climate change. Many of them want to know what they can do at a local level; they want to be caretakers of the environment."

One theme she returns to in teaching this class is the fact that climate change is an extremely complicated issue.

"Some students, early on, believe that climate change is a simple and straightforward issue—burning coal equals global warming," Turkington says. "Probably the most difficult thing for the students is to understand the subtleties of how the climate is naturally variable and how it's changing because of the greenhouse gas effects."

The students' ability to think about climate change logically and rationally is a continual goal, she says.

"Too often, students tend to believe someone's opinion just because it appeared in print. We spend a lot of time assessing the validity of arguments they hear and read. It's important to sharpen their ability to critically evaluate what they read," she says.

In the Department of Plant and Soil Sciences, Van Sanford teaches a course titled Transdisciplinary Research in Plant & Soil Sciences, a graduate course which focuses on different aspects of climate change, such as biofuels and the global food crisis.

"Maybe the most challenging thing in teaching this course is to be able to link cause and effect," Van Sanford says. "With higher levels of CO_2, what is the impact on crop growth today? What will the impact be in 10 years? This spawns a lot of good discussion." He adds that even in other courses he's taught for many years, plant breeding, for example, he spends more and more time each year discussing climate change.

George Wagner, another member of the Climate Change group and also a professor in plant & soil sciences, says his starting point in teaching climate change is to refute those who say it isn't real, that climate change is a fiction.

"On the topic of climate change, there is an industry of denial—pundits, profiteers, uninformed politicians—particularly in the United States, so I see my main task as trying to stimulate discussion of and raise awareness about climate change," he says.

Wagner recently led a seminar at UK that focused on why so many Americans are misinformed about climate change, a topic he is passionate about.

“The sad news is that only 70 percent of Americans say they trust scientists, only around 80 percent believe world temperatures are increasing, less than half of Americans polled believe weather patterns are changing, and only a third believe climate change is real. So I presented data which shows that 98 percent of scientists with expertise on climate change agree that it is real, and that all major scientific—academic and government—organizations agree with this consensus. So I try to defeat this doubt element which, sadly, even exists among some non-expert scientists, and to stimulate some hopeful discussion of the subject.”

■*Jeff Worley*

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