The Science of Farming

by Joyce Parker

Dr. Gregg Sanford stands next to a plot of switchgrass and describes biofuel crop farming experiments to a group of students. Dr. Sanford is part of a team of agronomists attempting to figure out how to produce the biofuel ethanol from plant material such as corn stalks and cobs, grass, or wood. He studies how to produce the plant material, also know as biomass, in efficient and sustainable way.

In the middle of Wisconsin's lush farmland, there is an experiment going on. It started in 2008. Two hundred quarter-acre plots are neatly laid out, separated by grassy lanes. Poplar saplings grow in one plot. Corn in another. A third one contains a mix of prairie grasses. A patch of miscanthus grass, taller than a person, stands between a plot of switchgrass and a patch of "weeds." What is going on here?

The answer? An agronomy experiment. Dr. Gregg Sanford, an agronomist working with the Great Lakes Bioenergy Research Center, is in charge of the experiment. Agronomy is the study of crop production and incorporates ideas from biology, chemistry, economics, ecology, and earth science. But is agronomy similar to other sciences?

Dr. Sanford points out that, like all scientists, agronomists ask questions, formulate hypotheses, and test those hypotheses based on evidence. What kinds of questions do agronomists ask? At the Great Lakes Bioenergy Research Center, agronomists are attempting to figure out how to produce the biofuel ethanol from plant material such as corn stalks and cobs, grass, or wood. Dr. Sanford and his colleagues study how to produce the plant material, also know as biomass, in efficient and sustainable ways.

What kinds of questions do agronomists ask? Some of the questions they are trying to answer in this experiment are: *How much biomass can we expect different crops to produce? How much does it cost to grow biomass crops? How much energy (mostly in the form of fuel for farm machinery) does it take to grow the crops? Does it help biomass yields to grow a mixture of plants? Can the perennial crops (crops that survive the winter and grow again in the spring), such as grass and poplar trees produce as much biomass as corn? How do different crops affect their environment?*

These questions can't be answered with experiments in the lab. It is too difficult to realistically reproduce variations in soil, weather, and surrounding environment, so agronomists do experiments on farms. But this means that they

can't control or test all of the variables. It may be unusually cold one year and dry the next. They can't test every different kind of soil. In fact, this experiment is looking at only two basic soil types—the rich, silty soil of Wisconsin and the loamy soil of mid-Michigan, where a similar experiment is ongoing. And unusual weather has affected the results. The winter of 2008 was so cold in Wisconsin that it killed the newly planted miscanthus grass. The summer of 2012 was so dry that crop yields were down across the entire US.

Top: Students explore a plot of 10-foot tall miscanthus grass. Bottom: An aerial view of the GLBRC cropping trials showing the replicated plots of various bioenergy crops on the experimental farm.

Agronomists control what variables they can and track those that they can't. They can control the crops they plant, as well as how they plant, tend, and harvest them. When comparing a crop grown in different places or soils or under different conditions, they make sure the seeds are genetically identical. They sew the crops in the same way using similar machines. They follow the same procedures for fertilizing them and treating them for pests, and they harvest them at the same time of year again using similar machines.

So what about variables like soil and weather that can't be controlled? Agronomists measure these carefully and then look for patterns. For example, high crop yields might be associated with years with lots of rain in June. Or perhaps the corner of the field where there is slightly more carbon in the soil produces more corn than the rest of the field. Years with very high temperatures in August might yield less switchgrass than other years with normal temperatures. The key to identifying patterns in the midst of short-term weather variations and local soil effects is having lots of replicates—plots in as many different places and as many years of data as possible. This way, researchers can separate random differences from real patterns.

Dr. Sanford's experiment includes seven crops that are potential sources for ethanol production in the Midwest: corn grown three different ways, miscanthus grass, switchgrass, two different types of prairie, poplar trees, and "old fields," where nothing specific is planted (whatever seeds land there are allowed to grow).

And the results? One of the most imporant findings is that the type of soil and weather make a big difference. In the rich soil of Wisconsin, where the winters are harsh, corn gives the biggest yields. But in Michigan, where the soil is less rich but the winters are milder, miscanthus, the 10-foot-high grass, and poplar trees produce almost as much biomass as Wisconsin corn. In addition, miscanthus has the added benefit of enriching the soil rather than depleting it. The grass's extensive root system helps hold soil and nutrients in place, preventing them from being washed away by rain. What's certain is that the field experiments that Dr. Sanford and his team of agronomists are carrying out provide critical information that cannot be obtained from lab experiments.