Name____________________

DATA Nugget

Growing energy: comparing biofuel crop biomass
Featured scientist: Gregg Sanford from University of Wisconsin-Madison
Written with Marina Kerekes

Research Background:

Most of us use **fossil fuels** every day to power our cars, heat and cool our homes, and make many of the products we buy. Fossil fuels like coal, oil, and natural gas come from plants and animals that lived and died hundreds of millions of years ago - this is why they're called "fossil" fuels! These ancient energy sources have many uses, but they also have a major problem. When we use them, fossil fuels release carbon dioxide into the atmosphere. As a greenhouse gas, carbon dioxide traps heat and warms the planet. To avoid the serious problems that come with a warmer climate, we need to transition away from fossil fuels and think of new, cleaner ways to power our world.

Biofuels are one of these alternatives. Biofuels are made out of the leaves and stems (called **biomass**) of plants that are alive and growing today. When harvested, the biomass can be converted into fuel. Plants take in carbon dioxide from the atmosphere to grow. It's part of the process of photosynthesis. In that way, biofuels can create a balance between the carbon dioxide taken in by plants and what is released when burning fuels.

At the Great Lakes Bioenergy Research Center scientists and engineers work together to study how to grow plants that take in as much carbon as possible while also producing useful biofuels. Gregg is one of these scientists and he wants to find out how much biomass can be harvested from different plants like corn, grasses, trees, and even weeds. Usually, the bigger and faster a plant grows, the more biomass they make. When more biomass is grown, more biofuels can be produced. Gregg is interested in learning how to produce the most biomass while not harming the environment.

The experimental bioenergy crop farm has multiple plots of each crop planted in a grid.

Name____________________

Switchgrass harvest: Researchers harvest the crops in the fall. Then they dry, weigh, and compare the biomass.

While biofuels may sound like a great solution, Gregg is concerned with how growing them may affect the environment. Biofuels plants come with tradeoffs. Some, like corn, are great at quickly growing to huge heights - but to do this, they often need a lot of fertilizer and pesticides. These can harm the environment, cost farmers money, and may even release more of the greenhouse gasses we are trying to reduce. Other plants might not grow so fast or so big, but also don't require as many chemicals to grow, and can benefit the environment in other ways, such as by providing a habitat to animals. Many of those plants are **perennials**, meaning that they can grow back year after year without replanting (unlike corn). Common biofuel perennials like switchgrass, Miscanthus grass, prairie grasses, and poplar trees require fewer fertilizers and pesticides to grow, and less fossil fuel-powered equipment to grow and harvest them. Because of this, perennials might be a smart alternative to corn as a source of biofuels.

Believing in the power of perennials, Gregg thought that it might even be possible to get the same amount of biomass from perennials as is normally harvested from corn, but without using all of the extra chemicals and using less energy. To investigate his ideas, Gregg worked together with a team to design a very big experiment. The team grew many plots of biofuel plants on farms in Wisconsin and Michigan, knowing that the soils at the site in Wisconsin were more nutrient rich and better for the plants they were studying than the Michigan site. At each farm, they grew plots of corn, as well as five types of perennial plots: switchgrass, *Miscanthus* grass, a mix of prairie plant species, young poplar trees, and weeds. For five years, the scientists harvested, dried, and weighed the biomass from each plot every fall. Then, they did the math to find the average amount of biomass produced every year by each plot type at the Wisconsin and Michigan sites.

Scientific Questions: Are any perennial crops a good alternative to corn for biofuel production, and if so, why? How does the location of biomass production affect the outcome?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation or a description of a pattern, which can then be tested with experimentation or other types of studies.

Name____________________

Scientific Data:

Use the data below to answer the scientific questions:

Crop	**Type**	**Wisconsin: Average biomass (Mg ha^{-1} yr^{-1})**	**standard error**	**Michigan: Average biomass (Mg ha^{-1} yr $^{-1}$)***	**standard error****
corn	annual	16.1	0.6	12.3	0.9
prairie	perennial	3.7	0.3	2.8	0.2
switchgrass	perennial	6.9	0.3	6.0	0.6
miscanthus grass	perennial	12.0	1.2	15.6	1.3
poplar trees	perennial	4.6	0.9	12.5	0.3
weed field	perennial	2.8	0.3	2.6	0.2

** Biomass is measured as the amount of dried biomass harvested from a certain area. In this study the units are "Megagrams of dried biomass per a hectare in one year (Mg ha^{-1} yr^{-1})."*
*** Standard error (SE) tells us how confident we are in our estimate of the mean, and depends on the number of replicates in an experiment and the amount of variation in the data. A large SE means we are not very confident, while a small SE means we are more confident.*

What data will you graph to answer the question?

Independent variable(s): ______________________________________

Dependent variable(s): ______________________________________

Draw your graph below: Identify any changes, trends, or differences you see in your graph. Draw arrows pointing out what you see, and write one sentence describing what you see next to each arrow.

Name____________________

Interpret the data:

Make a claim that answers each of the scientific questions.

What evidence was used to write your claims? Reference specific parts of the table or graph.

Explain your reasoning and why the evidence supports your claims. Connect the data back to what you learned about the tradeoff between annual and perennial crops.

Name____________________

Did the data support Gregg's hypothesis? Use evidence to explain why or why not. If you feel the data was inconclusive, explain why.

Your next step as a scientist: Science is an ongoing process. What new question(s) should be investigated to build on Gregg's research? What future data should be collected to answer your question(s)?