Growing Energy: Comparing Biofuel Crop Biomass

Featured scientist: Gregg Sanford from University of Wisconsin-Madison

Research Background:

Most of us use **fossil fuels** every day. Fossil fuels power our cars, heat and cool our homes, and are used to produce most of the things we buy. These energy sources are called “fossil” fuels because they are made from plants that grew hundreds of millions of years ago! After these plants died, their tissues were slowly converted into coal, oil, and natural gas. An important fact about fossil fuels is that they are limited and non-renewable. It takes a long time for dead plants to be converted into fossil fuels. Once we run out of the supply we have on Earth today, we are out! We need to think of new ways to power our world, now that we use more energy than ever.

Biofuels are a potential replacement for fossil fuels. Biofuels, like fossil fuels, are made from the tissues of plants. The big difference is they are made from plants that are alive and growing today. Biofuels are **renewable**, meaning we can produce them as quickly as we use them up. At the Great Lakes Bioenergy Research Center sites in Wisconsin and Michigan, scientists and engineers are attempting to figure out which plants make the best biofuels. Plants that grow bigger and faster make more tissues that can be used to produce more biofuel.

Gregg is a scientist who wants to find out how much plant tissue, called **biomass**, can be harvested from different crops like corn, grasses, weeds, and trees. Gregg is interested in maximizing how much biomass we can produce while also not harming the environment. Each plant species comes with a tradeoff - some may be good at growing big, but need lots of inputs like fertilizer and pesticide. Corn is an annual, meaning it only lives for one year. Corn is one of the best crops for producing a lot of biomass. However, farmers must add a lot of chemical fertilizers and pesticides

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

to their fields to plant corn every year. These chemicals harm the environment and cost farmers money. Other plants harvested for biofuels, like switchgrass, prairie species, poplar trees, and *Miscanthus* grass are perennials. Perennials grow back year after year without replanting. Perennials require much less chemical fertilizers and pesticides to grow. If perennials can produce high levels of biomass with low levels of soil nutrients, perhaps a perennial crop could replace corn as the best biofuel crop.

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

To test this hypothesis, scientists worked together to design a very large experiment. Gregg and his team grew multiple plots of six different biofuel crops on experimental farms in Wisconsin and Michigan. The soils at the Wisconsin site are more fertile and have more nutrients than the soils at the Michigan site. At each farm, they grew plots of corn to be compared to the growth of plants in five types of perennial plots. The types of perennial plots they planted were: switchgrass, *Miscanthus* grass, poplar saplings (trees), a mix of prairie species, and weedy fields. Every fall the scientists harvested, dried, and then weighed the biomass from each plot. They continued taking measurements for five years and then calculated the average biomass production in a year for each plot type at each site.

Scientific Questions: Are any of the perennial plot types a good alternative to corn for biofuel production? Does the outcome depend on location (MI or WI)?

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

Scientific Data:

Use the data below to answer the scientific question:

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

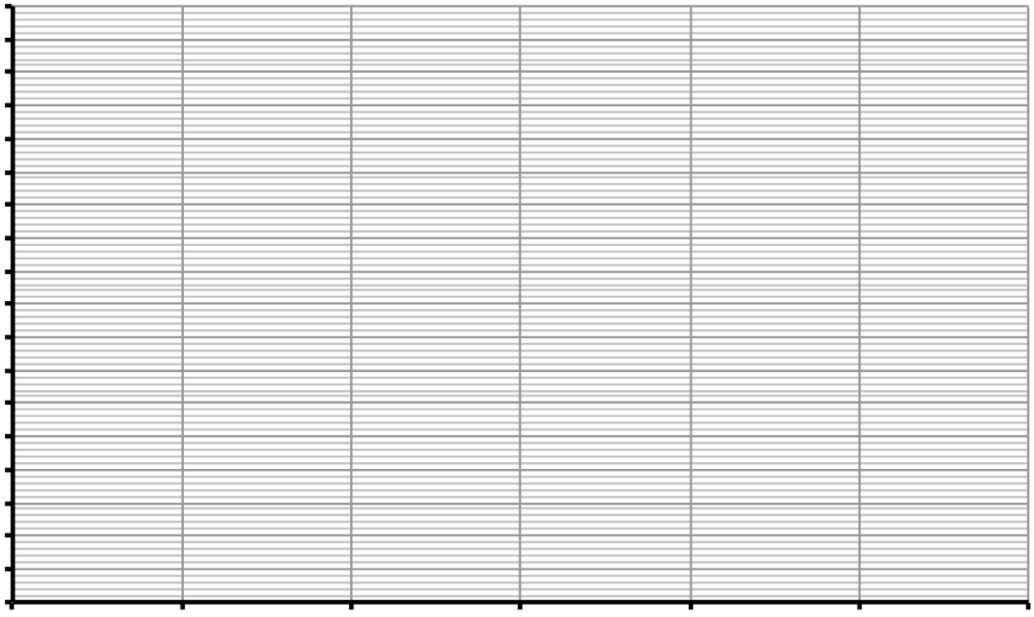
** Biomass is measured as the amount of dried biomass harvested from a certain area. In this study the units are "Megagrams of dried biomass per a hectare (Mg DM ha-1)."*
*** Standard error (SE) tells us how confident we are in our estimate of the mean, and depends on the number of replicates in an experiment 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.



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 different sites and their soil nutrient levels.

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 questions do you think should be investigated? What future data should be collected to answer them?