Team Advisors

HOME | ABOUT | MEDIA | RESOURCES | ROLES | HELP | FAQS

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Advisor Home My Info Logout

BACK TO HOME

Mission Folder: View Mission for 'Carbon Keepers'

State	Texas
Grade	6th
Mission Challenge	Environment
Method	Scientific Inquiry using Scientific Practices
Students	Briley Siemens (Barrelracer1) Felipe de Farias (1221Zn) Eliza Cole-Smith (wonderwoman)

Team Collaboration

(1) How was your team formed? Was your team assigned or did you choose to work with each other?

Our team was formed by multiple curious sixth graders asking questions about the role of soil in the mitigation of climate change. Our group mentor saw the diversity, potential, and hard working abilities in each one of us and introduced us. We met and discussed our shared interest in soil research as well as our love of working in the laboratory. We discussed a potential project relating to an issue in our hometown relating to farming and climate change. We were excited about it at the time and now it is something that we were able to turn into this project.

(2) Provide a detailed description of each team member's responsibilities and jobs during your work on the Mission Folder.

Our group brought many different skills together. We took a skill inventory before the roles were designated to learn more about ourselves and to use our talents and skills more wisely. (Please see the attachment)

Briley (Barrelracer1) managed and prioritized our group. Briley is also our explorer, researcher (for soil chemistry, agrinomicacy, and climate change) and one of the writers. Eliza (wonderwoman) shared some of the same jobs with Briley. Also, Eliza is our speaker and harmonizer, researcher in climate change and pollution in soil, works in the laboratory, artist and editor. Our other member, Felipe (1221Zn), also shares some of the responsibilities with Briley and Eliza. In addition, Felipe is our artist, technology guru, innovator, and researcher in carbon sequestration, organic matter, and climate change topics.

This is our team main roles and responsibilities description:

Briley's responsabilities description

Manager: Ensures that the team achieves its goals on time and moderates team discussion and keeps the group on task.

Thinker: Presents different explanations and solutions.

Prioritize: Place things in order of importance and do not get caught up in details.

Explorer: Seeks and explores new areas of inquiry.

Checker: Checks to make sure everybody understands the ideas and the group's conclusions.

Writer: Mission folder answers writer.

Eliza's responsabilities description:

1. Recorder: Takes notes of the discussions and decisions and keeps them on Google Docs.

2. Explorer: Seeks and explores new areas of inquiry.

3. Speaker: Acts as group spokesperson.

4. Timekeeper: Keeps the group alert of time for deadlines.

5. Harmonizer: Create a friendly and positive team atmosphere and try to reach agreement.

6. Editor: Mission folder editor.

Felipe's responsabilities description.

1. Innovator: Promotes imagination and provides new ideas.

2. Runner: Gets all the materials ready.

3. Safety Officer: Remind teammates about safety issues.

4. Artist: Draw and design team logo and presentation.

5. Computer Guru: Try to use the technology to help achieves the team goals and technical assistance.

6. Writer: Mission folder answers writer.

(3) Did your team face any problems working together? If so, how did you solve them? If not, why do you think you were able to work together so well?

Our problem was that each team member went to a different school and we live in two different communities. Because of this, we would need to meet outside of school times, which were primarily on the weekend. We would regularly meet and create tasks for the different team members to do. In addition, our advisor set up a Google Classroom where we can post work and communicate on a regular basis. We found this solution to be quite effective.

(4) What were some possible advantages to working together as a team on this project? How would working as individuals have made this project more difficult?

Working as a team provides so much more diversity of ideas, meshing together different ideas and traits, and real creativity. Without different skill sets, we would find that our ideas would become more expansive. Working with this team caused us to become closer and trust each other to get the job done.

If one of us had attempted this project alone, we are confident that we would not have expanded the project as intellectually or creatively. Not only this but the tasks would have taken longer and likely we would not have been able to accomplish as much because you would not have anyone to count on, the work would be slower because rather than having multiple hands and minds working on it you would be alone. Also, when working alone you don't learn to share roles and hold each other accountable when working on a project.

Uploaded Files:

- [**View**] **Selecting our Topic** (By: Barrelracer1, 02/23/2020, .pdf)
  This tells our story of how we chose Carbon Keepers for a topic this year. Selecting a topic for a long-term study can be one of the hardest parts of a project! We knew we were interested in plants and agriculture but narrowing it down was hard. We watched a fantastic TED Talk and emailed the professor who'd given it - and she wrote us back. We were hooked on carbon.
- [**View**] **Team Contract** (By: Barrelracer1, 02/23/2020, .pdf)
  One of the first tasks we did in August was to sit down as a team and come up with a Team Contract. It included expectations, goals, rules we set for ourselves, how to bond as a team, policies/procedures, and consequences. We all wrote it, read it aloud, agreed upon it, and signed it. This document kept us accountable as a team and on-track this year.
- [**View**] **Skills & Teamwork Inventory** (By: Barrelracer1, 02/23/2020, .pdf)
  Each team member filled out a skills and teamwork inventory in the beginning so we could learn each other's strengths and interests. This document was very useful as we got to know one another and formed a team.
- [**View**] **Action Plan for the Team** (By: Barrelracer1, 02/23/2020, .pdf)
  Designing a graphic organizer, we listed the community problem, the goal, each of the investigations we planned, and the community benefits that would result from this project. This document shows the big picture and it was used to keep us focused and on-task this year.
- [**View**] **Work Schedule** (By: Barrelracer1, 02/23/2020, .pdf)
  Our work schedule for the year is provided to show the dates we worked and what was accomplished throughout the year. It also shows what happened at each meeting and which team members worked on the various aspects of the project.
- [**View**] **Problem Statement Planning Session** (By: Barrelracer1, 02/23/2020, .pdf)
  This document shows the questions we asked ourselves as we selected the topic. It is the overall planning document for the project and includes safety, experiments, timing for the investigations, and community benefits.
- [**View**] **Roles and Responsibilities** (By: Barrelracer1, 02/23/2020, .pdf)
  According to our strengths, skills inventory, and growth mindset for the year, these are the primary roles and responsibilities we had on team Carbon Keepers.
- [**View**] **Timeline of the Project** (By: Barrelracer1, 02/23/2020, .pdf)
  This monthly timeline gives the major milestones of the project from September through February.
- [**View**] **Research Published in a Peer-reviewed Journal** (By: Barrelracer1, 02/24/2020, .pdf)
  One of our goals this year was to learn to conduct a scientific research project with enough data to be significant. Working with Dr. Weindorf, we reached out with these questions to learn how a Florida student worked on soil and was one of the youngest students to be published in a professional peer-reviewed journal - our goal.

Scientific Inquiry

Problem Statement

(1) What problem in your community will your team be investigating through scientific inquiry using scientific practices? Specifically, based on this problem, what question will you be trying to answer?

Imagine the wagon trains moving westward across the United States in the 1800s! They steered through beautiful tallgrass prairies and rich, fertile soil that would become the breadbasket of the world. Only 3% of North America's prairie remains and there is a drastically different landscape seen today. There is also a hidden danger that many do not see because with the changes from prairie to agriculture comes a massive loss of soil carbon that is greatly responsible for keeping the land rich and productive. Where did the carbon go? Into the atmosphere where it contributes greatly to climate change. The cultivated soils of the world have lost 70% of their original organic carbon, according to the Carbon Management and Sequestration Center. Without microbes and carbon-rich soil, it becomes dirt and productivity plummets. The community issue we are solving this year is the loss of carbon in the soil and the climate changes it causes when released into the atmosphere. What if the answer to problems in the atmosphere are actually found in the soil beneath our feet? Could agriculture be an answer to climate change?

The research question Carbon Keepers is asking:

How can we prevent carbon from being released into the atmosphere and increase the amount of carbon stored in the soil?

(2) Research your problem. You must learn more about the problem you are trying to solve and also what testing has already been done. Find AT LEAST 10 different resources and list them here. They should include books, periodicals (magazines, journals, etc.), websites, experts, and any other resources you can think of. Be specific when listing them, and do not list your search engine (Google, etc.) as a resource.

The research phase of this project is ongoing and sources of information include websites, professional journals, periodicals, newspapers, magazines, brochures, books, TED Talks, TED Ed lectures, National Public Radio, conferences, videos, online games, university seminars, community experts and personal interviews with experts in soil, biochemistry, chemistry, soil, plants, and climate change. Below is a list of those sources.

*** Please see our uploaded Bibliography in the MLA8 format.

Professional Journals:

1. Cardoso, J. A. and Gildemberg, A. “Soil Microbial Ecology and Its Role in Soil Carbon Sequestration in Sustainable Agroecosystems Under Climate Change.” Carbon and Nitrogen Cycling in Soil, 2019, pp. 249–291.

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3. De Deyn, G. B. et al. Additional carbon sequestration benefits of grassland diversity restoration: soil C sequestration and diversity restoration. J. Appl. Ecol.48, 600–608 (2011).

4. Gestel, Natasja Van, et al. “Predicting Soil Carbon Loss with Warming.” Nature, 554, no. 7693 (2018).

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7. Lu, Meng, et al. “Responses of Ecosystem Carbon Cycle to Experimental Warming: a Meta-Analysis.” Ecology, vol. 94, no. 3, 1 Mar. 2013, pp. 726–738.

8. Ogura, Takehiko, et al. “Root System Depth in Arabidopsis Is Shaped by EXOCYST70A3 via the Dynamic Modulation of Auxin Transport.” Cell, vol. 178, no. 2 (2019)

9. Yadav, Gulab Singh, et al. “Conservation Tillage and Nutrient Management Effects on Productivity and Soil Carbon Sequestration under Double Cropping of Rice in North Eastern Region of India.” Ecological Indicators, vol. 105, Oct. 2019, pp. 303–315

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5. Schuh, Mari C. Soil Basics. Capstone, 2012.

6. Toensmeier, Eric. The Carbon Farming Solution: a Global Toolkit of Perennial Crops and Regenerative Agriculture Practices for Climate Change Mitigation and Food Security. Chelsea Green Publishing, 2016.

7. Warrick, Arthur W. Soil Physics Companion. CRC Press, 2019

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2. Gullickson, Gil. “Root For Roots (and Microbes, Too).” Successful Farming, Nov. 2019, pp. 46–48.
3. Mohr, Paula. “Strip Tillage Saves Cost, Helps Build Soil Health.” Farm Progress, 20 Sept. 2019, www.farmprogress.com/conservation/strip-tillage-saves-cost-helps-build-soil-health.\
4. Nugent, Ciara. “Take a Walk on the Rewilding Side.” TIME, 23 Sept. 2019, pp. 52–55.
5. Pollock, Dennis. “Mastering Soil Health Elevates Farm Productivity, Sustainability.” Farm Progress, 10 Dec. 2018, www.farmprogress.com/soil-health/mastering-soil-health-elevates-farm-productivity-sustainability
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TED Talks and TED-Ed:

7. “Carbon - Periodic Table of Videos.” TED, ed.ted.com/featured/7ovw67KW.
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Websites:
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2. “Climate Kids.” NASA, NASA, climatekids.nasa.gov/.
3. Climate-Woodlands. “Basic Soil Components.” Climate, Forests and Woodlands, 16 May 2019, climate-woodlands.extension.org/basic-soil-components/.
4. “Harnessing Plants Initiative.” Salk Institute for Biological Studies, www.salk.edu/harnessing-plants-initiative/.
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15. Roach, Steve, et al. “4 Ways Soil Gets Abused.” Regenerative, 15 Aug. 2014, regenerative.com/four-ways-soil-gets-abused/.
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17. Simpson, April. “Soil Health Can Combat Climate Change from the Ground Up.” Phys.org, Phys.org, 3 Sept. 2019, phys.org/news/2019-09-soil-health-combat-climate-ground.html.
18.“Soil Chemistry.” Soil Chemistry - an Overview | ScienceDirect Topics, www.sciencedirect.com/topics/earth-and-planetary-sciences/soil-chemistry.

Community Experts & Personal Interviews:

1. Weindorf, David - Associate Vice President in the Office of Research & Innovation (ORI), Professor, and BL Allen Endowed Chair of Pedology in the Department of Plant and Soil Science, Texas Tech University, Personal Interview, October 11, 2019.

2. van Gestel, Natasja– Assistant Professor Biological Sciences, Texas Tech University, Personal Interview, October 11, 2019.

Educational Game

1. “Smithsonian National Museum of Natural History.” Dig It! The Secrets of Soil, forces.si.edu/soils/.

Videos
1. “Nitrogen Cycle.” YouTube, YouTube, 2015, www.youtube.com/watch?v=HOpRT8BRGtk%2BNitrogen%2Bcycle.

2. Pastures, Dryland. “Isolating Rhizobia from Root Nodules.” YouTube, YouTube, 2014, www.youtube.com/watch?v=l2falR7qB3Q.

Conferences

1. We attended the No-Till Texas Soil Conference at the Overton Conference Center in Lubbock, Texas where we were featured by keynote speaker Dr. Natasja van Gestel because of our work to improve soil health in this region.

(3) What did you find out about your problem that you didn’t know before? What kinds of experiments have been done by other people before you? Be sure to put this in your OWN words, do not just copy And paste information. Also, be sure to cite your sources.

What we found out about our problem that we didn’t know before:

Source: “Smithsonian National Museum of Natural History.” Dig It! The Secrets of Soil, forces.si.edu/soils/.

1. Soil Composition has four main components: water, air, mineral matter, organic matter. Mineral matter makes up 45% of the soil, air and water both make up 25%, and organic matter makes up 5%. The organic matter in the soil is formed by the decaying of plants or animals. The percentage of organic matter varies greatly.

2. Soil is biologically active and unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants.

3. Healthier soil promotes climate solution, by taking in CO2 the plant then uses it to decrease climate change and to make photosynthesis. Soil pollution is toxic chemicals in

the soil harming the environment and its surroundings. If the concentration is high then it will have a risk to the environment and our health. Soil pollution has a number of cons and causes that happen everyday.

Source: Cardoso, J. A. and Gildemberg, A. “Soil Microbial Ecology and Its Role in Soil Carbon Sequestration in Sustainable Agroecosystems Under Climate Change.” Carbon and Nitrogen Cycling in Soil, 2019, pp. 249–291.

1.There are two types of soil pollution, man-made and natural occurring. Besides the rare chances when a natural accumulation of chemicals causes soil pollution, natural process might have an effect on the man caused toxic chemicals released into the soil, most of it increasing or decreasing the pollution in the soil. Soil pollution is toxic chemicals in the soil harming the environment and its surroundings. If the concentration is high then it will have a risk to the environment and our health.

2. Soil is very important to this earth and soil is wet or dry in different climates. The most important chemical property of soil is acidity. There is a limited range of plants that grow when pH is outside the normal limits of 6-8. Soils in dry climates are usually alkaline. The pH of the soil is important to the soil itself. Soils in a high rainfall area like the Amazon are usually acidic. Acidic soils are improved by adding lime to soil to raise the pH level.

Source: DeBano, Leonard F. “A Guide to Soil Quality Monitoring for Long Term Ecosystem Sustainability on Northern Region National Forests.” RMRS - Rocky Mountain Research Station, forest.moscowfsl.wsu.edu/smp/solo/documents/GTRs/INT_280/DeBano_INT-280.php.

In ecology, primary productivity is defined by the rate at which producers generate biomass. The biomass in an ecosystem is the total dry mass of all the living things per area.

Source: “Climate Kids.” NASA, NASA, climatekids.nasa.gov/.

The greenhouse effect is a natural phenomenon which prevents heat from escaping the ozone layer. Some greenhouse gases which trap in heat are listed: CO2, CH4, N2O, CHF3, CF3CH2F, CH3CHF2, CF4, C2F6, SF6. Emissions from these greenhouse gases have been going on for many years and in many different places causing climate change.

Source: “Save Our Soil.” Soil Association, www.soilassociation.org/news/2016/march/21/7-ways-to-save-our-soils/.

1. Soil pollution has a number of cons and causes that happen everyday. There are two types of soil pollution, man-made and natural occurring. Some types of man-made pollutants are on purpose from industrial treatment and some are accidental. Some examples of man-made pollutants are: spills in chemical use or storage/transportation,mining activities creating pollution because of the crushing raw materials, and the holding of waste in landfills the waste may leak into groundwater causing pollution.

2. Besides the rare chances when a natural accumulation of chemicals causes soil pollution, natural process might have an effect on the man caused toxic chemicals released into the soil, most of it increasing or decreasing the pollution in the soil. This might be caused by the complex soil environment. The natural processes lead to multiple soil pollution.

3. Land is changing and becoming non-arable due largely to global warming and agricultural fertilizers and pesticides. The population is growing and we need to feed our planet with agricultural food.

Source: Schuh, Mari C. Soil Basics. Capstone, 2012.

People are exposed to soil contaminants multiple ways. A few of the most common are listed: Ingesting soil, breathing dust, absorbing through skin, and eating food that was grown in contaminated soil.

Source: Simpson, April. “Soil Health Can Combat Climate Change from the Ground Up.” Phys.org, Phys.org, 3 Sept. 2019, phys.org/news/2019-09-soil-health-combat-climate-ground.html.

So this article was about how soil health affects the amount of carbon and water it holds. It was also about that healthier soil promotes the “climate solution.” On that note, the author continues to explain how soil health is important when discussing climate change. Because of the information we now know we can relate this to global warming, as the author continues, since that plants store CO2 (Carbon Dioxide) and produce Oxygen, if the soil health are better it would help the “climate solution” in which we need.

Source: http://www.fao.org/soils-portal/en/

Food and Agriculture OrganizatIon of the United Nations -Healthier soil takes in more carbon in the carbon cycle helping decrease climate change and global warming. For example, when Carbon Dioxide (CO2) emmits into the atmosphere it traps heat from escaping and causes global warming, so if plants have healthier soil then it could take part in a climate solution.

Source: https://www.soils.org/discover-soils/soil-basics

This website helped me understand that the surface mineral and organic layers have physical and chemical weathering. Soil is a limited natural resource and slowly renewable. We depend on it to grow food and cotton for our clothing. Soil supports filtered water from irrigation or rainfall. Soil is a mixture of minerals, dead and living organisms, air and also water. Protecting soil as an important natural resource to Earth is critical and we depend on soil a whole lot more than I realized. It doesn't just make our planet a better place, because there could be no life on Earth without soil.

Source: Climate-Woodlands. “Basic Soil Components.” Climate, Forests and Woodlands, 16 May 2019, climate-woodlands.extension.org/basic-soil-components/.

There are five components of soil, I learned that a soil is simply a porous material and that soil has a maximum limit of minerals in it and that the largest component of soil is the mineral portion,I also learned that the texture of soil is based on the percentage of sand.The most interesting part I think is probably about learning that water is the second basic component of the soil.The capacity of a soil to hold water is relying on soil the most.Gas or air is also a component of soil.

Source: “Soil Chemistry.” Soil Chemistry - an Overview | ScienceDirect Topics, www.sciencedirect.com/topics/earth-and-planetary-sciences/soil-chemistry.

I learned that soil chemistry focuses on chemical reactions in the soil and it is considered part of the natural chemical composition of a given soil. Soil chemical reactions affect plant growth and plant nutrition. Manipulation of soil chemistry begins with soil pH. A great cause of soil chemistry affecting plants and organic matter is acidity, which is a pH of 6 and below. Soil chemistry is also affected by herbicides and insecticides. Soil pH is usually more relative to native soils than bagged potting soil where it has been neutralized.

Source: Budhu, Muni. Soil Mechanics and Foundations. John Wiley & Sons, Inc., 2011.

The earth is a thin layer of soil composed of minerals, organic matter, and living organisms. It is known for its climatic history. Minerals are the components of soil. These minerals come from weathered rock called parent rock. Another component of soil is organic matter. Organic means it contains carbon which is the element found in living organisms. Organic matter can be decayed plants, animals, and bacteria, among other things. Soil is classified by the type of group it goes in according to its texture, carbon mass, water, and chemistry make-up, and other properties such as structure, depth, and color.

Source:Lu, Meng, et al. “Responses of Ecosystem Carbon Cycle to Experimental Warming: a Meta-Analysis.” Ecology, vol. 94, no. 3, 1 Mar. 2013, pp. 726–738.,

Soil is very important to this earth and soil is wet or dry in different climates. The most important chemical property of soil is acidity. There is a limited range of plants that grow when pH is outside the normal limits of 6-8. Soils in dry climates are usually alkaline. The pH of the soil is important to the soil itself. Soils in a high rainfall area like the Amazon are usually acidic. Acidic soils are improved by adding lime to soil to raise the pH level.

These are experiments that have been done by other people.

Source: Regenerative Organic Agriculture and Climate Change A Down-to-Earth Solution to Global Warming. 2014, rodaleinstitute.org/wp-content/uploads/rodale-white-paper.pdf.

Carbon cycle is an important cycle in our planet our planet earth. The carbon is moved through the atmosphere, biosphere, pedosphere, lithosphere, and oceans. Our sun functions as the source of fuel (light energy) for the cycle. This is a very important natural process, however, human activity has messed up the equilibrium of the carbon cycle. There is much more carbon being released and plants and the ocean cannot grab back it all. There is a possibility to bring back the lost balance in the carbon cycle to mitigate climate change and decrease drought and increase our agricultural productivity. This solution is being called Carbon Farming.

Source: Roach, Steve, et al. “4 Ways Soil Gets Abused.” Regenerative, 15 Aug. 2014, regenerative.com/four-ways-soil-gets-abused/.

Topsoil is an amazing resource but it has been abused to the point of virtual sterility. This means it does not hold the nutrients to grow healthy plants in many places. Soil can also be lost. If we speak of soil as a growing medium, we are talking about a layer from the Earth’s crust. The size of soil particles is important and determines what kind of soil is being discussed - sand, clay, loam, or silt. Sandy soils present problems to farmers but so do soils of mostly one component. Farmers have to watch what fertilizer they use or it could affect the plants or whatever they’re planting and use the fertilizer on. Soil sometimes gets washed away by wind or rain during erosion. There is an end for topsoil available to us and people must carefully conserve topsoil because of its importance.

Source: http://www.edu.pe.ca/agriculture/soil.pdf

Soil chemistry is a difficult topic for sixth grade students but on this site, I learned about soil chemistry. It helped me understand these facts and breaks them into a form where I can understand that soil depends on properties such as pH, salinity, and organic matter. These factors can determine the type of plant or crop which will best grow in the soil in a specific location.You have to conduct a soil test to determine soil quality. The pH of the soil can be changed by adding different chemicals. Each year, soil undergoes cycles in which people put materials in and then they take the materials out.

Source:Nationwide, SARE. “10 Ways Cover Crops Enhance Soil Health.” SARE, www.sare.org/Learning-Center/Topic-Rooms/Cover-Crops/Ecosystem-Services-from-Cover-Crops/10-Ways-Cover-Crops-Enhance-Soil-Health.

Many studies have been done with cover crops and this is a very important implementation to soil healthy and carbon mitigation. The Types of cover crops are legumes, brassicas, buckwheat, grasses (for example: rye, wheat, barley, oats, sorghum–sudan).

Leguminous crops, for example alfalfa, clovers, velvet bean, soybeans, beans, peas, vetch, and cowpeas peas, big flower vetch are generally good cover crops.
First, because of their ability to fix nitrogen from the air and add it back to the soil. Last, legumes provide an addi that is to attract good insects, to control erosion and to increase carbon mass. Inoculation is an important step for the cover crops seeds. They must be inoculated with the nitrogen fixing bacteria (rhizobial bacteria).

Experimental Design

(4) Based on the question you are trying to answer, and your research, what is your team’s hypothesis for this investigation? Be sure to include the independent and dependent variables and how they are related along with evidence of your research.

Investigation 1: The Effect of Pollutants in the Soil Productivity

Hypothesis 1: If a pollutant is added to the soil, its productivity will decrease.

Investigation 2: The Effect of wildfire and drought on the soil organic mass
Hypothesis 2: If soil is exposed to climate problems such as drought and wildfire, then the biomass will decrease.

Investigation 3: The Impact of Rhizobium Inoculation of Clover on Root Nodulation and Biomass
Hypothesis 3: If Trifolium is inoculated with rhizobium, then the roots will be longer, have more nodes, and the biomass would be significantly bigger.

Investigation 4: Soil Treatment to Increase Carbon Sequestration

Hypothesis 4:If fungus (mycorrhizae) is added to the soil, it will provide the greatest root stimulation, increasing the amount of organic matter and holding more carbon in the soil.

(5) Identify the independent and dependent variables in your investigation.

Investigation 1: The Effect of pollutant in the Soil Productivity

Independent Variable
Type of pollutants (Acetic Acid, Salt, and fertilizer)

Dependent Variable
Productivity after a week of treatment

Investigation 2: The Effect of wildfire and drought on the soil organic mass

Independent Variable
The condition of the land

Dependent Variables
Productivity (biomass)

Investigation 3: The Impact of Rhizobium Inoculation of Clover on Root Nodulation and Biomass

Independent Variable
The treatment on the plant of either rhizobium or no rhizobium.

Dependent Variables
Length of roots, the length of the green shoots, the biomass of the plants, and the number of nodes on the roots.

Investigation4: Soil Treatment to Increase Carbon Sequestration

Independent Variable
Type of soil additive (fungus, manure, and compost)

Dependent Variable
Amount of Carbon mass, the height of the plants, and the number of leaves

(6) What are the constants in your investigation?

Investigation 1: The Effect of pollutant in the Soil Productivity

The constants for this experiments:

The type of seeds
The same kind of soil
Plots size
the planting containers
The same temperature conditions
The same amount of light
The same length of time of the experiment

Investigation2: The Effect of wildfire and drought on the soil organic mass

The constants for this experiment:

The type of seeds
The same kind of soil
Plots size
The planting containers
The same temperature conditions
The same amount of light
The same length of time of the experiment

Investigation 3: The Impact of Rhizobium Inoculation of Clover on Root Nodulation and Biomass

The constants for this experiment:

The planting containers
The type of seeds
The same kind of soil
The same amount of water used
The same amount of light

The same temperature conditions
The day the measurements were taken.

Investigation 4: Soil Treatment to Increase Carbon Sequestration

The constants for this experiment:

The planting containers
The type of seeds
The same number of seeds per cell
The same kind of soil
The same amount of water used
The same amount of light
The same temperature conditions
The day the measurements were taken.
Same electronic scale

(7) Will your investigation have a control group? If so, describe the control group. If not, why not?

Investigation1: The Effect of Pollutants on Soil Productivity
Control group: Spring water

Investigation 2: The Effect of wildfire and drought on the soil organic mass
Control group for the fire: Soil unburnt
Control group for the water: Normal amount of water

Investigation 3: The Impact of Rhizobium Inoculation of Clover on Root Nodulation and Biomass
Control group: The untreated Trifolium seeds

Investigation 4: Soil Treatment to Increase Carbon Sequestration
Control group: No addictive

Experimental Process

(8) List all of the materials you used in your experiment. Be sure to include all physical materials as well as any technology or website used to collect data (not websites you used in your research).

Investigation 1: The Effect of Pollutants on Soil Productivity

Potting soil
Rye grass seed
7 planting trays
7 planting tray domes
7 clear plastic cups
Plants labels
1 roll of string
Fertilizer
Salt
Electronic scale
Spring water
Weighing tray
Stirring rod
100 mL graduated cylinder
250 mL beaker
1 L graduated cylinder
1000 mL beaker
Salt Nacl, NaCl
Fertilizer
Vinegar
Pushpin
Scissors
Bottles

Investigation 2: The Effect of wildfire and drought on the soil organic mass

Rye seed
Soil
Gas flame
Fire extinguisher
Spring water
Vent hood
Beaker
Graduated cylinder
Computer
Spatule
Electronic scale

Container for the plant
Weighing dish
Paper tower
Tablespoon
Ruler

Investigation 3 material list: The Impact of Rhizobium Inoculation of Clover on Root Nodulation and Biomass

Piece of string
Metric Ruler
Beaker of water
Stereoscope 10x
Compound light microscope 100x
Soil
Trifolium Seeds
Trifolium Seeds treated with rhizobium bacteria
Water
Graduated Cylinder
Spoon
Planting trays
Clear covers for the planting trays
Plant identification markers
Sharpie

Investigation 4 material list: Soil Treatment to Increase Carbon Sequestration

Sandy Loam Soil from West Texas
Pots
Water
Heater
Lamp
Winter wheat seeds
Electronic scale
Scoopula
Scissors
Trays
Paper bag
Fungi
Horse manure
Plant labels
Pans
Compost
Crucibles
Spoons
Furnace
Weight dish

Technology Materials:
In all experiments we used Google Sheets and/or Excel to make graphs and calculations, a notebook and pen to take notes, and a digital camera to take pictures. The furnace in the university lab, the analytical scale, and the ovens for drying plant matter are also technology materials used this year.

(9) Explain your experimental process. Be sure to list all of the steps and ALL SAFETY PRECAUTIONS for your experiment. Remember to write it so someone else could follow the steps and recreate your experiment.

Risks and Safety (Please, see the complete safety resources in the attachment)

Lab Coats and safety goggles will be worn always throughout the experiment when in the laboratory.
Never work alone in the laboratory; use the buddy system.
Do not eat or drink in the laboratory.
Turn off heating apparatus and water faucets when not in use.
Do not touch the heating lamp.
Keep the laboratory floor dry and clear of all objects.
Follow all lab safety guidelines
Wash hands throughout the experiment.
Use protective gloves when collecting soil samples.
Wear shoes that cover the whole foot.
Always use a spatula or scoop to remove soil or chemical from a container.

Investigation 1: The Effect of pollutant in the Soil Productivity

Procedure for Treatment of Plants with High Salinity, Fertilizer, and Acid:

1. Plant grass seeds in potting soil. Divide the tray in 9 pots, 9 cm2 in size.
2. Water the samples with fresh water and let the grass grow.
3. After 4 weeks, in the lab, pour a mixture of salt water on the pots plants as described in Step 4.

4. Use table salt percent of 1%, 5% and 10% on part of nine samples of plants respectively during one week.
5. Repeat step 4 for fertilizer and acid pot tests as well.
6. After a week, remove the grass plants from the pots and measure the mass.
7. Wrap in paper and let air dry for 1 weeks.
8. Measure the dry mass, record in a table, and calculate the productivity in each sample.
9. Compare the primary productivity.

Investigation 2: The Effect of wildfire and drought on the soil organic mass

1. Procedure: Burning the soil
2. Get three planting containers and add soil.
3. Add ¼ tea spoon full of rye seed to the grass .
4. Add spring water to the grass everyday until the grass grows.
5. Cut the grass to 2 cm height.
6. Using a bunsen burner, under the hood, burn all the grass.
7. Let the burnt soil cool down until room temperature.

Procedure: Wildfire soil Experiment

1. Get a planting container with 24 cells.
2. In 12 of the cells add a control soil and the other 12 a burnt soil
3. Label the containers
4. Plant ¼ tea spoon full of rye grass seed in each cell
5. Water your grass everyday until the grass grows
6. Take the grass out of the cell into a weighing dish and let it dry for a week
7. After a week, weigh the grass and record it on a table.
8. Compare the total mass.

Procedure: Drought in soil experiment

1.Get nine planting containers.
2. Add ¼ tea spoon full of rye grass seed in each pot.
3. Add 10 mL of water to the grass everyday for two weeks.
4. Then stop watering 3 containers, keep watering 10 mL to three pots as control, and add 50 mL to the rest during two more weeks.
5. Take the grass out of the pots into a weighing dish and let all samples dry for a week
6. After a week, weigh the grass and record it on a table.
7. Compare the total mass.

Investigation 3: The Impact of Rhizobium Inoculation of Clover on Root Nodulation and Biomass

Procedures for planting the seeds

1. Gather supplies needed.
2. Place 20 mL of soil in each potting container.
3. To 18 containers, add ? teaspoon of clover seed to each one.
4. To 18 containers, add ? teaspoon of rhizobium-treated clover seeds to each one.
5. Add 5 mL of water to each container.
6. Place a clear lid over the containers and put in a sunny window for germination and growth.
7. Allow plants to grow for 21 days, adding water consistently as needed for moisture.

For measuring the biomass

1.Remove the Trifolium plants from the soil and gently wash in water.
2. Measure the length of the roots and the length of the shoots in centimeters.

For counting nodules on plant roots

1. Place one Trifolium seedling on the slide and onto the stage of the microscope.
2. Examine the end of the root for the presence of nodes.
3. Record the number of nodes on each root.
4. Repeat for each of the 12 clover plants.

For measuring the biomass

1. Remove the Trifolium plants from the soil and gently wash in water.
2. Measure the length of the roots and the length of the shoots in centimeters.
3. Place 6 samples of the untreated Trifolium plants and place on a scale to find mass. Do the same for treated Trifolium plants.

For Counting Nodules on Plant Roots

1. Place one Trifolium seedling on the slide and onto the stage of the microscope.
2. Examine the end of the root for the presence of nodes.
3. Record the number of nodes on each root.
4. Repeat for each of the 12 clover plants.

Investigation 4: Soil Treatment to Increase Carbon Sequestration

Procedure for Making Concentrations of Soil Additives in Soil Base

1. Collect various soil samples from five counties representing soil across west Texas.
2. Plant three grass seeds in each sample after treating with soil additives.
3. Add a 5%, 10%, 15%, and 20% concentration of each treatment (manure, compost, and fungi) in individual plant cups.
4. Replicate the experiment three times.

Procedure for Planting Seed in Cell Containers

1. Mark a planting bar at 3 centimeters depth, according to the instructions for the seed.
2. Dig the planting bar in the soil until you can see the 3cm line.
3. Drop three seeds in the hole.
4. Cover the seed with the soil.
5. Water the plants and place a plastic cover over the cell containers to hold in moisture and create a Greenhouse Effect.

Lab Procedure for Preparing the Plants and Soil for Drying

1. Remove one plant from the container cell using a scoopula.
2. Separate the roots from the soil carefully, collecting the soil in a separate container.
3. Wash the roots using DI water to remove remaining soil.
4. Cut the roots from the green shoots, thus separating the plant growth above ground from the plant growth below ground.
5. Put shoots in a lunch-size paper bag and use a Sharpie permanent marker to label the bag with the corresponding number on the data table in Excel and on our hard copy that was used during experimentation.
6. Put the roots in a small cup and label with the corresponding number.
7. To continue with the soil, weigh a small aluminium pan using a digital analytical balance providing a measurement to the ten thousandth place marker. Record the mass of the pan on the data sheet.
8. Add the soil sample to the pan and reweigh, recording the mass on the data sheet. Use a marker to put the corresponding number on the pan.
9. This procedure will result in the shoots in bags, the roots in cups, and the soil in pans all having the same number sample written on the data table to assure the right data is matched with the correct condition after drying.
10. Continue following this protocol for all 260 samples of plants and soil.
11. Put roots and soil on a drying rack to be placed in drying ovens to remove all moisture.

Procedure for Labeling the Samples for Drying
1.In order to be sure the correct soil additive, in the correct concentration, and in the exact type of soil remains clear throughout the data collection process, a labeling system for everything must first be established.
Devise a system of initials for the soil additives:
Ma = Manure
Cp = Compost
Fun = Fungi
Co = Control
Devise a system of initials for the type of soil used:
Devise a system of numbers for the concentration of the soil additives put in the soil:
5% = 5% additive + 95% soil
10% = 10% additive + 90% soil
15% = 15% additive + 85% soil
20% = 20% additive + 80% soil
Devise a way to label the three different samples of each to insure a repeated and replicated experiment whose results could be trusted:
Rep 1 = Replicate #1
Rep 2 = Replicate #2
Rep 3 = Replicate #3

For the complete labeling system, put the initials together in a code that looks like this:
Ma5%S5Rep1 = Manure 5% is in Soil #5 and this sample is replicate #1
Cp15%S3Rep3 = Compost 15% was added to Soil #3 and this is replicate #3

To simplify labeling of the paper bag, small cup, and aluminum pan, number each sample on the data sheet next to the codes using numerals 1-260. Instead of writing the entire code on every sample, just write the number 12, or 134, or whatever sample corresponds with the code recorded on the data sheet.

Procedure for Determining Moisture Lost

1. Set the furnace to 105 degrees Celsius
2. Put the pan with soil in the furnace and apply this heat for 24 hours.
3. Remove the pan from the oven and reweigh the pans with soil. Record on the data sheet.
4. Subtract the resulting mass (dehydrated) from the initial weight of the soil to obtain the weight of the soil without moisture.
5. Record the amount of moisture in the soil on the data sheet.

Data Collection and Analysis

(10) Present the data you collected from your experiment. Be sure to include all of the data you collected from your observations and measurements. Use of graphs and charts is HIGHLY encouraged. Explain how your data supports or refutes your hypothesis.

Investigation 1: The Effect of Pollutants on the Soil Productivity

Productivity was tested during this investigation. We did productivity because it is one way to express the volume of organic matter produced in a plot size. Decreasing productivity means losing organic matter. The average productivity for the control samples was 10.21 g/cm2. week.

This investigation was divided into three experiments. The first experiment, we tested 1%, 5%, and 10% fertilizer solutions as a pollutant. Our results show that the average samples productivity decreased by 28.63%, 12.05%, and 30.36% respectively.

The second experiment, we tested 1%, 5%, and 10% NaCl solutions. Our results show that the average samples productivity decreased by 0.69 %, 7.15 %, and 10.38 % respectively.

The third experiment, we tested 1%, 5%, and 10% acetic acid solutions. Our results show that the average samples productivity decreased by 29.09%, 39.78%, and 43.98% respectively.

Please see our lab report data and graphs in the attachment.

Investigation 2: The Effect of wildfire and drought on the soil organic mass

Our experiment that investigated the effect of fire on soil total mass, the burned soil had a better result than the soil that was not burned. It was 22.7 g in total (average, 1.89 g) and the unburned was 19.2 g (average 1.6 g) so that means that the burned soil kept more carbon.

The burnt soil kept 16.43 % more carbon mass than the control.

The experiment in the excess (flood) and absence (drought) of water the sample results show that productivity was lost by 70.81% and 67.97% respectively.

Investigation 3: The Impact of Rhizobium Inoculation of Clover on Root Nodulation and Biomass

Length of Roots - An average of 2.97 cm treated and 3.03 cm untreated - not a significant difference in root length. The lengths of the roots were basically the same. The Rhizobium Bacteria did not show a difference between the root length.

Length of Shoots - An average of 2.36 cm for treated and 1.67 cm for untreated - a significant difference was shown for the length of shoot. The above ground shoots were taller for the treated seeds. The tray of treated seeds clearly looked taller and healthier than the untreated.

Biomass of Plants - An overall average of 4.8 grams for treated seeds and 0.8 grams for untreated seeds. This was a significant increase in biomass for the treated seeds. There was a 400% difference between the treated and untreated seeds.

Number of Nodes on Roots - The treated seeds had an average node count of 2.5, and the untreated seeds averaged 3.17 nodes per root.

Investigation 4: Soil Treatment to Increase Carbon Sequestration

In this investigation we planted 3 seeds in each cell and we tested 20 samples for each addictive: horse manure, fungus, and compost. Growing measurements were taken during 2 weeks and the soil carbon matter was analysed after the 14 day.

Our results showed that the average of the samples productivity increased by 2.56% in the presence of fungi. Compost and horse manure had an opposite effect in productivity, they decreased 49.9% and 27.52% respectively.

Then we tested different concentrations of the fungi to see its effect in the carbon mass.
We tested 5%, 10%, 15% and 20% fungi concentration on soil. Our results show that the average of all samples productivity increased by 59.4%, 47.0%, 38.6 % and 12.9 % respectively. Fungi had an increadible effect in all concentrations.

(11) What are your potential sources of error? Remember, this doesn't mean "Did everything work?", all tests have potential sources of error, so make sure you understand what that means. Explain how these sources of error could have affected your results.

When scientists talk about "potential sources of error," they are not talking about mistakes made during testing such as forgetting to water a plant or spilling a beaker of water. Those mistakes would be corrected at the time and the experiment should be redone to make it right. Instead, sources of error means sources of uncertainty in measurements that are made. All experiments have sources of error in the scientific sense. There are two types of sources of error:

1) Systematic - These errors will always exist and cannot be corrected by repeating measurements. They are caused by instruments that could be old or ones with problems. In our experiments, systematic errors included the use of thermometers that were difficult to read, and errors in misreading a ruler when more than one person was measuring throughout the experiment (3 people measured). This could cause our data to be either higher or lower than what was actually recorded in the data table. In the same way, using 10-year-old digital scales in the high school lab were not as accurate as the scales used in the university lab and this could have affected data by giving us numbers either too large or too small. Possible changes in calibration while using the scientific analytical balance at Texas Tech is also a source of systematic errors.

2) Random - These errors are made by problems reading instruments when there is no line and they can be corrected by making multiple measurements. In our experiments, random sources of error occurred when we used an analytical scale that fluctuated as air flow changed a number from 2.35678 g to 2.35682 g, for example. By repeating the measurements on multiple plants, we were able to minimize the effect random errors had on our data. Another random error experienced was when counting the number of seeds that germinated under different soil treatments. Some of the seeds were different sizes even though they were the same species and this could affect the number of viable seeds. By planting multiple seeds and having any samples, we minimized the effect of the seeds that never germinated. Using different types of beakers and graduated cylinders in the initial experiments with fire, drought, acidity, fertilizer, and salinity also would be considered a random error, therefore many measurements were made to decrease the effects on the data.

Drawing Conclusions

(12) What conclusions can you draw based on the data you gathered during your experiment(s)? Be sure to include data and how it relates to the experiment(s) and the original question. Your conclusion should be related to your original problem and your experiment, include the data you collected, and discuss if your hypothesis was supported or refuted by your experiment.

Investigation 1: The Effect of Pollutants on the Soil Productivity

Our initial problem for investigation 1 was that changes in pH (acidity), fertilizers, and salinity are commonly encountered in agriculture but what are these pollutants doing to the soil productivity - an excellent measure of soil health?
The hypothesis was supported, indeed the pollutants negatively affected the productivity of the soil. Overall productivity was lost when pollutant was added.
After conducting 27 tests on salinity, acidity, and nitrogen (fertilizer) pollutants, it was clear each of these common pollutants have a negative effect on productivity. This knowledge is vital in moving forward with the project and looking at soil additives that will boost productivity and improve soil health.

Investigation 2: The Effect of wildfire and drought on the soil organic mass

Climate change is bringing unprecedented drought to our area and with drought, comes wildfire across the prairie. In this experiment we studied if this affects the soil and plant total biomass.
Our hypothesis was not correct for the burnt grass. Its total carbon mass was more than the control. In this case fire helped! However, the amount of water on soil affected tremendously. The productivity decreased in a drought condition and flood condition.

Drought in soil causes organic matter to not stick to the minerals and water absorption to decrease as well.

Fire had a positive impact on organic matter and encouraged plant growth.
The burnt soil kept 16.43 % more carbon mass than the control.

The experiment in the excess (flood) and absence (drought) of water the sample results show that productivity was lost by 70.81% and 67.97% respectively.

Investigation 3: The Impact of Rhizobium Inoculation of Clover on Root Nodulation and Biomass

In this experiment we studied what effect rhizobium bacteria has on biomass and nodulation of Trifolium.
The hypothesis was both refuted and supported due to the four tests. The number of nodes was less in the treated seeds and the length of roots was basically the same for treated and untreated.

The hypothesis was supported because the aboveground shoot length was higher for the treated seeds and the biomass was significantly higher for the treated seeds - almost 400% higher. The treated seeds had an average node count of 2.5, and the untreated seeds averaged 3.17 nodes per root. In conclusion, treated seeds with rhizobium bacteria are more effective in increasing biomass and promoting plant growth.

Investigation 4: Soil Treatment to Increase Carbon Sequestration

Using our own region soil, we studied which soil treatment would provide the greatest root stimulation, increasing the amount of organic matter and holding carbon in the soil. Manure, compost, and mycorrhizae fungi were studied.

Our hypothesis was proven correct and thus supported. The mycorrhizae did indeed provide the greatest root stimulation, increasing the amount of organic matter and holding more carbon in the soil. Our results showed that the average of the samples productivity increased by 2.56% in the presence of fungi.

Since productivity is a measure of the decrease in emissions, when local farmers start adopting these methods soil will hold more carbon. Carbon being sequestered in the soil and kept from being released into the atmosphere as greenhouse gases will benefit our planet.

In conclusion, agriculture is affecting climate change. According to U.S. Environmental Protection Agency, agriculture and forestry were responsible for 9.0 percent of United States greenhouse gas emissions in 2017, and globally 13.5 % of these gases are directly related to agriculture, with 17% due to land-use change. This sector holds a large mitigation potential -- mainly through reduced deforestation, soil management and increased productivity.

Agriculture is both part of the problem but also the best hope for a solution!

Uploaded Files:

- [View] **Project Safety Rules** (By: Barrelracer1, 02/23/2020, .pdf)
  Safety was stressed throughout our eCYBERMISSION project. This document shows the major safety rules agreed upon by the team and the resources online that were used to ensure each step of the procedures were done safely from start to finish.
- [View] **Lessons Learned in a University Laboratory** (By: Barrelracer1, 02/23/2020, .pdf)
  One of the most awesome parts of this project was getting to meet Dr. Weindorf and Dr. van-Gestal and work in their laboratory at Texas Tech University. Not very many students in 6th grade have that experience and are able to use high-quality scientific equipment. These are the lessons we learned working weekly in a college lab.
- [View] **Bibliography in MLA8 Format** (By: Barrelracer1, 02/23/2020, .pdf)
  The team's bibliography changes daily as we add more and more resources. It seems the more contacts we make, the more sources of information appear and the bibliography becomes a living document. This is current as of February 20th.
- [View] **Future Research** (By: Barrelracer1, 02/23/2020, .pdf)
  The team has many ideas for future research and these are some of the ideas we have for further scientific study.
- [View] **** Pollutants Investigation** (By: Barrelracer1, 02/24/2020, .pdf)

*** VERY IMPORTANT UPLOAD This is the complete I. The Effects of Pollutants on Soil Productivity lab report. It contains photos, problem, hypothesis, variables, procedures, data tables, graphs, data analysis, and conclusions.*

- [View] **** Wildfire & Drought Investigation** (By: Barrelracer1, 02/24/2020, .pdf)

  **** VERY IMPORTANT UPLOAD This is the lab report including problem, hypothesis, variables, procedures, data tables, graphs, conclusions, and photos. In this preliminary investigation, we looked at the effect of climate changes on plant biomass and soil's ability to hold carbon in drought and after wildfires.*
- [View] **** Rhizobium Investigation** (By: Barrelracer1, 02/24/2020, .pdf)

  **** VERY IMPORTANT UPLOAD This is the complete lab report for one of our preliminary investigations titled "The Impact of Rhizobium Inoculation of Clover on Root Nodulation and Biomass" It contains photos, problem, hypothesis, variables, procedure, data tables, graphs, and conclusions.*
- [View] **Hypotheses - Evidence from Research** (By: Barrelracer1, 02/24/2020, .pdf)

  Based on research, there was evidence for investigations that needed to be conducted. This table shows the investigation, along with the evidence for doing these tests.
- [View] **Data Tables for Soil Productivity - Carbon Tests** (By: Barrelracer1, 02/25/2020, .pdf)

  Data tables are provided to show the final results of the soil productivity tests using many concentrations of treatments and soil types - and over 200 samples.
- [View] **Data Tables for Rhizobium Inoculation - Carbon Tests** (By: 1221Zn, 02/26/2020, .pdf)

  Data tables are provided to show the final results of the Data Tables for Rhizobium Inoculation.
- [View] **Data Tables for fire and drought/flood - Carbon Tests** (By: 1221Zn, 02/26/2020, .pdf)

  Data tables are provided to show the final results of the Data Tables for fire and drought/flood - productivity Tests
- [View] **Data Tables for Soil Treatment to Increase Carbon Sequestration Tests** (By: 1221Zn, 02/26/2020, .pdf)

  Data tables are provided to show the final results of the soil carbon mass tests using many concentrations of treatments and South Plains soil type - and over 200 samples.
- [View] **** Soil Treatment Investigation** (By: 1221Zn, 02/26/2020, .pdf)

  **** Very Important Upload Investigation document - contains photos, problem, hypothesis, materials, procedures, data tables, charts, explanations, data analysis, and conclusions.*

Community Benefit

(1) Explain how investigating the problem your team chose will help the community. Be sure to include the impacts your research will have on individuals, businesses, organizations, and the environment in your community (if any). Make it very clear why solving this problem would help your community.

Our team is divided into two different communities. In both of these communities, farming is one of the primary industries. Not only that, but we are surrounded by farming, and our community is made up of farmers and families who are directly impacted by farming. In fact, the families of two of our team members are connected to farming, either in our past or currently. Put simply, farming is a very important issue for us as a team and our communities. Because of our connection to farming, we know the difficulties farmers face and we are also very aware of the climate issues that not only affect our farming communities but every single person and community. When our town is built on farming it is important for the soil health to have a positive effect on climate change for the health of our community's environment.

In doing our research, we realized there are a large number of farmers who are not utilizing best practices to increase and maintain carbon stores. Our team wants to educate local farmers about ways carbon sequestration can increase soil and crop health in our communities. Increased carbon stores promote healthier crops that benefit both producers and consumers. Carbon stores also improve water retention and reduce the need for fertilizer. Because of the water retention and reduced need of fertilizer, this method of farming will be more cost effective in the long term. We hope our research will produce innovative ways to increase carbon stores that are not currently being widely used in our area, share these outcomes with local farmers and encourage carbon farming in West Texas.

We also want our research to have a multi-generational impact. We are sharing our research with school age children, first year farmers/ranchers, and farming/ranching operations that have been in business for decades. We believe our message can influence older farmers/ranchers to take a look at a new approach, provide producers who are just starting out with best practices they can apply, and our generation by educating them about the importance of increasing carbon in the soil and keeping it out of the atmosphere.

Many people believe farming is one of the main contributors to climate change. According to the Intergovernmental Panel on Climate Change (IPCC), agriculture is responsible for over 25% of total greenhouse gas emissions. These emissions are due to the use of machinery as well as farming practices that release carbon into the atmosphere. One of our main goals is to educate the public on the fact that agriculture is actually a major part of the solution.

Beyond West Texas, agriculture is the foundation supporting human life. Every person on Earth benefits from agriculture on a daily basis.

IMPACT ON:
*Team Members:
- We have realized during our research that we are interested in pursuing careers in agriculture and soil science.
- We are more informed and enthusiastic about climate change.

*Individuals:
We have motivated others to use additives such as compost and natural fertilizer in home gardens and landscaping.
We are encouraging community members to shop at local farmers markets
We have inspired others to make compost bins at home.
We have engaged others in the conversation of climate change to further these important conversations.
We are educating the public through our social media pages on Facebook and Twitter.
We created a webpage to share our message.

*Businesses:
Our work is encouraging businesses to focus on carrying products that are organic and naturally based.
We have educated businesses that increasing the amount of carbon stores will enrich the prairies for ranchers.

We have demonstrated that healthier soil produces healthier products. Our outcomes will in turn create more nutritious vegetation, and increase crop production.
We are promoting companies who provide soil and crop fertility management and regenerative agricultural practices.
We are discussing our research with farming and ranching operations with the hope they will utilize our findings, and implement regenerative agricultural practices.

*Organizations:
-We attended the No-Till Texas Soil Health Symposium where our work was featured by Dr. Natasja van Gestel. We were able to make contact with local farmers and agriculturalists from other countries.
Lubbock Master Gardeners Association
Natural Resources Conservation Services: Lubbock, Texas
Natural Resources Conservation Services: Morton, Texas
Farm Service Agency
Muleshoe National Wildlife Refuge
Cochran County Agricultural Stabilization and Conservation Services (ASCS)
We collaborated with
Scientists at Texas Tech University
Farmers in Cochran County
Farmers in Hockley County

*Environment
Our research proved we can create a healthier soil through the use of additives. The amount of carbon matter stored in the soil can be increased, and we can reduce the amount of greenhouse gasses emitted.

Future Plans
*We will be presenting at Texas Tech University's Geoscience Department alongside graduate students in May 2020.
*We will be exhibiting pop-up presentations at local museums.
*We will create an educational powerpoint to be shared with 5th grade students during their Earth Science Unit.
*We are publishing our comic strip, Dr. Soil, and distributing it to area famers and students. (See attachment)
*We will continue attending local meetings and conferences offered through our County Extension Agencies, NRCS, ASCS, FSA, and Texas Tech University to share our research and expand our network.

Uploaded Files:

- [View] **Carbon Keepers Logo** (By: Barrelracer1, 02/23/2020, .pdf)
  The team logo was developed and designed by Felipe with input from the team. It demonstrates exactly what we wanted to convey to others about the importance of carbon in the soil. A description of the logo's elements and what they mean is given here with the graphic. The logo was used on shirts, brochures, business cards, surveys, posters, and other educational materials we distributed.
- [View] **Flyers and Posters** (By: Barrelracer1, 02/23/2020, .pdf)
  Carbon Keepers had an important message to share with the public! We designed flyers and posters to educate others by including a simple message, a website URL, a QR code to scan with their phones, a flow chart from our community to the world, and a link to the Global Goals - of which one is focused on CARBON!
- [View] **Presentation Practice & Notes** (By: Barrelracer1, 02/23/2020, .pdf)
  We had notes to use for our public presentations and also used video chatting in groups to practice speaking. Since one team member lives 50 miles from the other two, technology was a big help! This document shows a photo of us using the video feature and includes abbreviated notes.
- [View] **Community Contacts and References** (By: Barrelracer1, 02/23/2020, .pdf)
  The major supporters and mentors of the project are listed in this document with their contact information and the contributions they made to our work this year.
- [View] **Social Media Outreach** (By: Barrelracer1, 02/23/2020, .pdf)
  Carbon Keepers started a Facebook page and a Twitter account in order to get the message of soil's solution for climate change to the general public. There were great benefits to our team as we followed many important groups on Twitter. These are listed in this document as well.
- [View] **Original Comic Strip** (By: Barrelracer1, 02/23/2020, .pdf)
  An original comic strip was created by team member Felipe and stars Dr. Soil, a hero of climate change solutions. The comic will be used to educate farmers, ranchers, and others about the critical role soil plays in holding onto carbon. This is the original sketch which led to a revised version on the website.
- [View] **Website & Quick Response Code** (By: Barrelracer1, 02/23/2020, .pdf)
  The team created an educational website and QR code for the educational and community involvement initiative.
- [View] **Global Contacts for the Team** (By: Barrelracer1, 02/24/2020, .pdf)
  Our team has contacts and partnerships in 10 countries, taking Carbon Keepers to a global level. We wanted the impact to extend past our local community to the state, national, and international level. The contacts we've made this year and people with whom we're working are listed, along with their contact information and expertise.
- [View] **Farmers' Survey Results** (By: Barrelracer1, 02/24/2020, .pdf)
  A survey was created by the team and the results are included in this document with tables, graphs, and interpretation.
- [View] **Connections - A Web Graphic Organizer** (By: Barrelracer1, 02/24/2020, .pdf)
  Connections were made between the Earth, soil, atmosphere, bacteria, fungi, plants, and carbon. This represents the interconnected elements and was used when describing our project to children and youth.
- [View] **No-till Texas Soil Health Symposium** (By: Barrelracer1, 02/24/2020, .pdf)
  The team attended the soil health symposium in February where we were able to network with other farmers and scientists interested in carbon and the soil. We were recognized and videoed by the conference as young citizen scientists and world changers.

- [View] **Media Attention** (By: Barrelracer1, 02/24/2020, .pdf)
  The team received media attention from radio stations, television, and newspapers. Many soil health groups featured the work on their pages as well. This helped spread awareness of carbon in the soil.
- [View] **Carbon Footprint Calculator for Farms** (By: 1221Zn, 02/26/2020, .pdf)
  A unique carbon footprint calculator was used by the team. It allowed us to share with farmers and land managers a way to input the treatments used on their land and the amount of carbon that results in the soil or in the atmosphere. This is an example of data input from the farm of our team member.
- [View] **** Project Summary Presentation** (By: 1221Zn, 02/26/2020, .pdf)
  **** VERY IMPORTANT UPLOAD This presentation was used to show a summary of the project. It includes the community issue, investigations, partnerships, teamwork, and a photo gallery for media attention.*
- [View] **Global Connections Map** (By: 1221Zn, 02/26/2020, .pdf)
  This map shows all our global connections to the present. We hope to get more connections in the future.

Mission Verification

(1) Does your Mission Folder project involve vertebrate testing, defined as animals with backbones and spinal columns (which include humans)? If yes, team must complete and attach an IRB approval form.

Yes

(2) Did your team use a survey for any part of your project? If yes, team must complete and attach a survey approval form.

Yes

(3) You will need to include an abstract of 250 words or less. As part of the abstract you will need to describe your project and explain how you used STEM (Science, Technology, Engineering and Mathematics) to improve your community

The United Nations' Global Goals include urgent action against climate change as one way to change the world for the better by 2030. Taking this to heart, Carbon Keepers, learned that soil carbon sequestration is a process in which CO2 is removed from the atmosphere and stored in soil as organic matter. According to the Environmental Protection Agency, 746 billion tons of CO2 are captured annually, but much more is released, contributing to climate change. We learned that soil can help mitigate this problem, but to what degree?

Alongside local and federal community partners, and with university mentors, we wondered how soil treatment would affect carbon sequestration. Initial investigations measured the effects of drought, salinity, acidity, wildfire, and fertilizer on carbon. Further research led us to use soil treatments such as manure, mycorrhizae fungi, and compost.

Grass was planted in soil from five regions, adding four different concentrations of the three treatments, for over 200 samples and five repetitions. After four weeks, the plants and roots were separated, washed, dried, and weighed. Carbon organic matter greatly increased using mycorrihizae, which means the amount of CO2 in the atmosphere would be reduced.

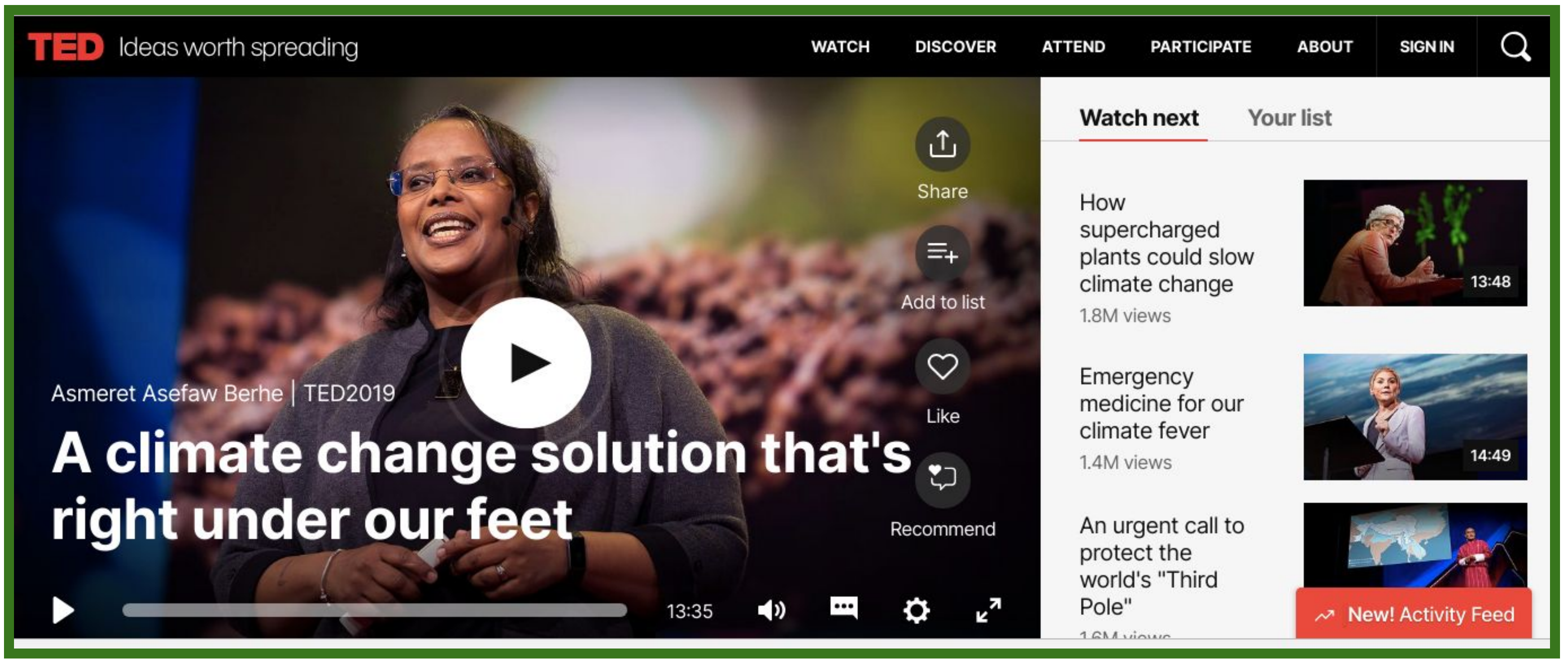
Community outreach included flyers, newspapers, posters, social media, a website, and meetings. The work was featured in a state soil conference, and received global interest from ten countries. Education and outreach will be key for those with the greatest potential to impact climate change - farmers and ranchers. Together, we can reduce CO2 by 18 billion tons.

Uploaded Files:

- [View] **Survey Approval Form** (By: Barrelracer1, 02/23/2020, .jpg)
  Our team surveyed farmers about their experiences with soil treatments and additives that hold carbon in soil. This is the survey approval form with administrative approval for conducting this survey.
- [View] **IRB Approval Form** (By: Barrelracer1, 02/23/2020, .jpg)
  IRB Approval Form - our team conducted a survey for farmers and since humans are vertebrates, an IRB form is uploaded to show the signatures of the committee who approved this study.

Selecting our Topic

Our team was researching the topic for our community problem. We wanted to do something with plants and agriculture. Many topics were written in our brainstorming folder, for example vertical farming, fertilizer contamination, water problems in agriculture, pollination and bees, salinity in soil, cotton farming, and biofuels. Then we got to a new TED talk where soil was presented as a resource to fight climate change. Keeping more carbon in the soil means less in Earth's atmosphere. We liked it!



I contacted the speaker of this talk, and she answered me! Then we started researching studies that had already been done on this topic, and designing a new and innovative study of our own!

167 of 176

Felipe de Farias Sun, Oct 6, 2019, 3:55 PM

Dear Dr. Berhe, I am a 6th grader and I am working with 3 friends on a project related to the effects of soil in climat…

Asmeret Berhe <aaberhe@ucmerced.edu> Sun, Oct 6, 2019, 10:43 PM

to me

Hi Felipe,

Thank you for your message and kind words. I am very glad to hear that you found my TEDtalk useful. Unfortunately meeting in the coming days is a bit complicated as I am on a work trip in Australia.

When is your competition? Is there a specific date before which you need to do the interview? Perhaps you can tell me more about your project on email?

Cheers,
Asmeret

Asmeret Asefaw Berhe
Professor, Soil Biogeochemistry
Ted and Jan Falasco Endowed Chair in Earth Sciences

Department of Life and Environmental Sciences

Team Contract

Team Name: Carbon Keepers **Date:** 9/29/2019

GOALS: What are our team goals for this project?
We want to help fight climate change. We are going to find a way to figure out how soil can contribute to lower the carbon dioxide in the atmosphere. We will share our findings with our community, especially the farmers.
TEAMWORK EXPECTATIONS: What do we expect of one another?
• We will communicate using google classroom at least twice a week. • We will try to get together weekly for meetings. • We will share all the material before we upload them to the mission folder. • We will use our time together very well. • We will research individulay and share the results with the team. • We will teach each other what we have learned and we will learn all the material. • We will be responsible for our good work. • We will share the material cost.
POLICIES & PROCEDURES: What rules can we agree on to help us meet our goals and

expectations?
1. Be responsible for your tasks 2. Complete work on time and correctly 3. Listen to each other 4. Give and get respect 5. Make an equal contribution to the final folder. 6. Let project manager know about absence 7. Make your best effort 8. Ask for assistance when you don't know what to do 9. Learn a lot during the mission 10. Make friends 11. Have fun
CONSEQUENCES: How will we address non-performance in regard to these goals, expectations, policies and procedures?
We will contact our mentor Mrs. Wilbanks regarding any problem or concern. She will address the consequences.

We share these goals and expectations, and agree to these policies, procedures, and consequences.

Briley Siemens	Briley Siemens
Name	**Signature**
Eliza Cole-Smith	Eliza Cole-Smith
Name	**Signature**
Felipe de Farias	Felipe de Farias
Name	**Signature**

Adapted from Barkley, E.F., Cross, K.P., & Major, C.H. Collaborative Learning Techniques. San Francisco: Jossey-Bass. 2005

Carbon Keepers Skill Inventory

1. Name Eliza Cole-Smith	Email: Elizacs@gmail.com

In each of the following areas, please place an X next to all the skills or experiences that you believe you have.

Communication Skills	
Write, Summarize, and edit	
Negotiate, sell, and promote	X
Communicate verbally	X
Listen	
Facilitate Discussion	X
Ask Questions	X
Interview	X
Hold Conversation	X
Use Languages	

Organization Skills	
Solve Problems	X
Manage Time	
Give Directions	

School Information Skills	
Use Math Skills	X
Organize Information	X
Keep Records	
Use Logic	X
Computer Skills (PowerPoint, Graphs, ideas, Webpage)	

Hands-On Ability Skills	
Build and Construct	X
Invent	X
Repair and Restore	X

Research & Exploration	
Analyze Ideas	X

Carbon Keepers Skill Inventory

Analyze Data	
Research	
Formulate Hypothesis	X
Read Information	

Business Skills	
Public Speaking	X
Leadership	X
Technical Writing	
Ability to Interact with the Public	X
Ability to Work Independently	X
Ability to Work in Teams	X
Project Management	
Accommodating Different Viewpoints	X
Ability to Motivate Others	
Ability to Give and Receive Constructive Feedback	

Social Skills	
Care and Encourage	X
Calm people down	X
Help people complete a task	X
Inform or explain to groups	
Know how to get along with different personalities	

Artistic Skills	
Drawing, illustrating, sketching	X
Use photography	X
Design	X

Please list any other relevant skills and outside school activity.

I enjoy writing, lab work, and getting dirty!
Science is my favorite subject. I love planting and playing with my dogs.
I play trumpet at school. Also, I love drawing and coloring.
I can start a conversation with new friends easily.
I play a lot of games too!

Carbon Keepers Skill Inventory

Name Felipe de Farias	Email: fdefarias1221@gmail.com

In each of the following areas, please place an X next to all the skills or experiences that you believe you have.

Communication Skills	
Write, Summarize, and edit	X
Negotiate, sell, and promote	
Communicate verbally	X
Listen	X
Facilitate Discussion	
Ask Questions	X
Interview	X
Hold Conversation	
Use Languages	X

Organization Skills	
Solve Problems	X
Manage Time	
Give Directions	X

School Information Skills	
Use Math Skills	X
Organize Information	X
Keep Records	X
Use Logic	X
Computer Skills (PowerPoint, Graphs, ideas, Webpage)	X

Hands-On Ability Skills	
Build and Construct	X
Invent	X
Repair and Restore	X

Carbon Keepers Skill Inventory

Research & Exploration	
Analyze Ideas	X
Analyze Data	X
Research	X
Formulate Hypothesis	X
Read Information	X

Business Skills	
Public Speaking	X
Leadership	X
Technical Writing	X
Ability to Interact with the Public	
Ability to Work Independently	X
Ability to Work in Teams	X
Project Management	
Accommodating Different Viewpoints	X
Ability to Motivate Others	
Ability to Give and Receive Constructive Feedback	X

Social Skills	
Care and Encourage	X
Calm people down	X
Help people complete a task	X
Inform or explain to groups	X
Know how to get along with different personalities	X

Artistic Skills	
Drawing, illustrating, sketching	X
Use photography	X
Design	X

Please list any other relevant skills and outside school activity.

Swim on Mondays, Wednesdays, and Fridays.
Play violin at school or at home.
Play chess at chess club on Thursdays and at tournaments.
Science UIL at school.
Learn to do robotics for my free time and at the school robotics club.
Participate in sword drill at church every Wednesday night after swim lesson.

Carbon Keepers Skill Inventory

Read books all the time.
Study Technology (computer language, video and webpage making) at school.
Draw or Sketch in my free time.
Write cartoon for fun.
Play with my dog.
Play video games during the weekends.

3. Name Briley Siemens	Email: briley.siemens@southcrest.org

In each of the following areas, please place an X next to all the skills or experiences that you believe you have.

Communication Skills	
Write, Summarize, and edit	X
Negotiate, sell, and promote	X
Communicate verbally	X
Listen	X
Facilitate Discussion	X
Ask Questions	X
Interview	X
Hold Conversation	X
Use Languages	

Organization Skills	
Solve Problems	X
Manage Time	X
Give Directions	X

School Information Skills	
Use Math Skills	X
Organize Information	X
Keep Records	X
Use Logic	X
Computer Skills (PowerPoint, Graphs, ideas, Webpage)	X

Carbon Keepers Skill Inventory

Hands-On Ability Skills	
Build and Construct	X
Invent	X
Repair and Restore	X

Research & Exploration	
Analyze Ideas	X
Analyze Data	X
Research	X
Formulate Hypothesis	X
Read Information	X

Business Skills	
Public Speaking	X
Leadership	X
Technical Writing	X
Ability to Interact with the Public	X
Ability to Work Independently	X
Ability to Work in Teams	X
Project Management	X
Accommodating Different Viewpoints	X
Ability to Motivate Others	X
Ability to Give and Receive Constructive Feedback	X

Social Skills	
Care and Encourage	X
Calm people down	X
Help people complete a task	X
Inform or explain to groups	X
Know how to get along with different personalities	X

Artistic Skills	
Drawing, illustrating, sketching	X
Use photography	X
Design	X

Please list any other relevant skills and outside school activity.

Carbon Keepers Skill Inventory

- Dancing (dancer)
- Riding Horses (I have 6 horses)
- Cooking
- Basketball
- Showing pigs and lambs (2 lambs)
- Painting
- Drawing
- Caring for my animals
- Playing with my sister
- Playing with my dog
- Doing Gymnastics
- Reading Books
- Baking
- Playing on Wii U
- Coloring
- Trying new hairstyles
- Doing makeup on my mom and sister
- Playing on the trampoline
- Playing flute
- Playing clarinet
- Playing keyboard

Carbon Keepers

Action Plan

Problem: The amount of carbon has been increasing in the atmosphere and decreasing in the soil.

How can we keep more carbon in the soil?

Investigate the effect of pollutants in soil

The experiment will compare the primary productivity after treating a soil with salt, fertilizer, oil, and detergent pollutants

Farmers, consumers, factories and industries will benefit. Ocean health and the fishery industry will be impacted with the reduction of these contaminants.

Investigate the effects of fire on soil properties.

The experiment will compare fire effects on the biological and chemical properties of soil organic matter.

USA States that have been affected with wildfire and countries that have this problem too

Investigate the effects of drought and flood.

The experiment will compare productivity and sequestration of carbon on soil.

Farmers, consumers, undeveloped countries, and big developed cities will benefit from the results

Soil diversity and Regenerative Agriculture and its role in controlling soil organic matter

Different soils from Texas will be studied and the consequences of improving the organic material in the soil.

We will help identify plant, soils, and organic matter to fight climate change.

Work Schedule

Date	Job	Teammate
09/15/2019	1st meeting and problem statement planning	Briley, Eliza, Felipe
09/15/2019	Making work schedule	Briley
09/15/2019	Answer team strengths folder	Briley, Eliza, Felipe
09/19/2019	Rolls and responsibilities	Briley, Eliza, Felipe
09/22/2019	Assigned research topics	Briley, Eliza, Felipe
09/24/2019	Chose the research topics	Briley, Eliza, Felipe
09/28/2019	Sign the contract and did the research plan	Briley, Eliza, Felipe
09/28/2019	Ecybermission Mission Folder Checklist	Briley,Eliza, Felipe
09/29/2019	Planting rye grass for the pollutant experiments	Briley, Felipe
09/30/2019	Planting clover seeds for the bacteria experiment at school lab	Eliza
10/04/2019	Email Community Experts	Felipe
10/06/2019	Got together to discuss their findings on research topics	Briley, Eliza, Felipe
10/06/2019	Planting rye grass for the pollutant	Briley, Felipe

Work Schedule

	experiments	
10/09/2019	Planting more rye grass for the drought and fire experiments	Eliza
10/13/2019	Got together to talk about project	Briley, Eliza, Felipe
10/10/2019	Planting clover seeds for the bacteria experiment	Eliza
10/11/2019	Go to Texas Tech University to interview Dr. Weindorf and Dr.van Gestel	Felipe and Briley
10/11/2019	Made carbon keepers logo	Felipe
10/11/2019	Went back to the lab and experimented.	Briley, Eliza, Felipe
10/15/2019	Made a new logo	Felipe
10/27/2019	Team meeting	Briley, Eliza, Felipe
11/01/ 2019	Made a email address and webpage for carbonkeepers	Felipe
11/05/2019	Research	Briley, Eliza
11/06/2019	Team meeting	Briley, Eliza, Felipe
11/09/2019	Research at public library	Felipe
11/10/2019	Collected soil samples	Briley
11/12/2019	Made survey	Briley
11/19/2019	Took soil samples to NRCS	Felipe
11/20/2019	Collected horse manure	Briley
11/24/2019	Team meeting	Briley, Eliza, Felipe

Work Schedule

11/25/2019	Watered the plants	Eliza
11/26/2019	Interview Gay Cline	Briley, Felipe
12/01/2019	Interview the Farmer -Matt Caswell	Briley, Eliza, Felipe
12/02/2019	Created the Facegroup page	Felipe
12/02/2019	Created a Twitter account	Felipe
12/03/2019	Collected water samples	Briley
12/03/2019	Interviewed Joey Alvarez, City of Whiteface Employee	Briley
12/06/2019	Celebrated soil day	Briley, Eliza, Felipe
12/08/2019	Team Meeting	Briley, Eliza, Felipe
12/14/2019	Team Meeting	Briley, Eliza, Felipe
12/26/2019	Collected compost	Briley
12/27/2019	Planted with addictant	Briley, Felipe
12/28/2019	Made slide show Experiment 1	Felipe
12/30/2019	Made slide show experiment 2	Eliza
01/06/2020	Shared bibliography	Briley, Eliza, Felipe
01/07/2020	Shared their research questions	Briley, Eliza, Felipe
01/08/2020	Made the webpage QR code	Felipe
01/22/2020	Worked at Texas Tech Lab	Briley, Felipe
01/23/2020	Shared more research	Briley, Eliza, Felipe
01/27/2020	Shared experiments data	Briley, Eliza, Felipe

Soil: Climate's Solution
C Keepers

Work Schedule

01/29/2020	Worked at Texas Tech Lab	Briley,Eliza
01/29/2020	Shared Data analysis- Excel	Felipe
01/31/2020	Worked at Texas Tech Lab	Felipe
02/01/2020	Made the webpage QR code	Felipe
02/06/2020	Worked on speaking presentation via Google Hangout	Briley, Felipe
02/07/2020	Had lunch together before the presentation	Briley, Eliza, Felipe
02/07/2020	Project Presentation at TTU Arena	Briley, Eliza, Felipe
02/08/2020	Interview Dr. Bruno Ribeiro	Felipe
02/09/2020	Email several foundations	Felipe
02/09/2020	Contacted UN Foundation	Felipe
02/09/2020	Wrote a cartoon book	Felipe
02/11/2020	Bought flower and wrote a thank you note to give to Dr.Van Gestel at the conference	Briley, Eliza, Felipe
02/12/2020	No-Till Soil Symposium at Overton Hotel	Briley, Eliza, Felipe
02/15/2020	Team meeting- Ecyberfolder	Briley, Eliza, Felipe
02/22/2020	Edit all answers and attachments	Briley, Eliza, Felipe
02/23/2020	Last day to edit ecybermission answers.	Briley, Eliza, Felipe

Carbon Keepers
Problem Statement Planning

Scheduling

1. How much time will our problem take?

1-month -researching
4 months – executing the experiments
1-month -analyzing and concluding data

2. What time of the day/night will our project need to take place in?

Morning/afternoon – meetings and experimentation

3. When will our experiment need to take place in order to complete it before the eCYBERMISSION deadline?

October-December – doing the experiments

4. Where can we complete the experiment that will allow us to take the least amount of time?

School Lab, greenhouse, Texas farm fields for soil samples, our houses, and backyards.

5. Why will time be important in our experiment?

To grow the plants and check the variable.

6. Who will decide how much time our experiment will take?

Our deadline is end of January.

Materials

1. How will we obtain the materials to conduct the experiment?

Buy, collect, or use recycled materials

2. What materials do we think we need in order to conduct the experiment?

Seeds, soils, trays, pipets, graduate cylinders, scale, thermometer, greenhouse,

3. When will we need to obtain the materials for our project?

After the research time and the experimentation design

4. Where will we get our materials for the experiment?

From the stores: Home depot, Wal-Mart, and Lowes
Online: Amazon, Carolina, and Flinn Scientific
Field soil –Farmers
Technical Analysis Equipment: Texas Tech University Plant and Soil department
Regular lab Equipment: School

5. Why do we need the materials for our experiment?

We need the materials to plant and test the organic matter in the different variables and conditions.

6. Who will get the materials for our experiment?

Briley will get soil, oil, manure, and compost
Felipe will get seeds, pots, labels, and lab supplies.
Eliza will get microorganisms, boards, and extra supplies

Safety

1. How will we maintain proper laboratory safety procedures?

Following all safety rules – write a safety rule procedure and follow it

2. What safety precautions need to be in place for our experiment?

Wear safety glasses and gloves – look up soil and compost safety for more

3. When will we determine the safety precautions necessary to complete our experiment?

Before the beginning of each experiment

4. Where will we conduct our experiment in order to have the maximum amount of safety?

Depends on the stage of the experiment.

5. Why do we need to have safety procedures for our experiment?

To conduct a responsible research experiment

6. Who will determine that our safety precautions are enough for our experiment?

Our Mentor: Mrs. Laura Wilbanks

Benefit to Community

1. How will be able to show our project's benefit to the community?

Since 1950s "Lubbock emerged as a major cotton market and center for cotton and cottonseed processing" (cited Brooks, E. and Emel, Jacque The Llano Estacado of the US Southern High Plain) in the USA.

This means that in our city the economy depends how agriculture is doing and our climate too.

2. What benefit to the community will our experiment have?

Farmers will learn that they can be part of a solution to climate change problem. They are always considering the problem. Also, better soil fewer droughts and more production.

3. When will the community benefit from the results of our experiment?

Immediately

4. Where in the community will our experiment have the most effect or impact?

Agriculture

5. Why does this experiment benefit the community?

The economy in the Texas South Plains region is direct proportional to the cotton production.

6. Who in the community will benefit from our experiment?

Everybody! We all have a role in climate change and we depend on agriculture

Appropriateness

1. How will we know that our experiment is appropriate for eCYBERMISSION?

This project is an application of science and engineering knowledge and concepts to care for the natural environment and solve environmental problem in our community

2. What makes our research statement an appropriate experiment to conduct?

Only one independent variable will be changed. We can do several experiments

3. When would be an appropriate time to conduct our experiment?
As soon as the research is done
4. Where would be the most appropriate location to conduct our experiment?
Our backyard, school lab, greenhouse, in the farm field, and university lab
5. Why do we need to determine if our research statement and experiment are appropriate?
To see if it can be tested
6. Who will determine the appropriateness of our research statement or experiment?
Our mentor and university professors who give advice

Team member	Roles and Responsibilities
Briley	1. Manager 2. Thinker 3. Checker 4. Explorer 5. Soil Chemistry Researcher 6. Prioritize 7. Agronomic Researcher 8. Climate Change Researcher 9. Writer
Eliza	1. Timekeeper 2. Speaker 3. Recorder 4. Harmonizer 5. Resource Investigator 6. Explorer 7. Pollution in Soil Researcher 8. Climate Change Researcher 9. Editor
Felipe	1. Innovator 2. Safety Officer 3. Computer Guru 4. Runner 5. Artist 6. Wildcard 7. Carbon Sequestration and Organic Matter Researcher 8. Climate Change Researcher 9. Writer

Main Roles and Responsibilities

1. **Manager**: Ensures that the team achieves its goals on time and moderates team discussion and keeps the group on task.

2. **Recorder**: Takes notes of the discussions and decisions and keeps them on Google Docs.

3. **Speaker**: Acts as group spokesperson.

4. **Timekeeper**: Keeps the group alert of time constraints and deadlines.

5. **Thinker**: Presents different explanations and solutions.

6. **Harmonizer**: Create a friendly and positive team atmosphere and try to reach agreement

7. **Prioritize**: Place things in order of importance and do not get caught up in details.

8. **Explorer**: Seeks and explores new areas of inquiry.

9. **Innovator**: Promotes imagination and provides new ideas.

10. **Checke**r: Checks to make sure everybody understands the ideas and the group's conclusions.

11. **Runner**: Gets all the materials ready.

12. **Wildcard**: Assumes the role of any missing member and fills in wherever needed.

13. **Artist**: Draw and design team logo and presentation

14. **Computer Guru**: Try to use the technology to help achieves the team goals and technical assistance

15. **Agronomic Researcher**: Researches soil and plants topics related to the project goal

16. **Climate Change Researcher**: Researches about Climate Change

17. **Carbon Sequestration and Organic Matter Researche**r: Researches all about Carbon (Carbon Sequestration and Organic Matter)

18. **Pollution Researcher**: Researches Pollution in soil

19. **Safety Officer**: Remind teammates about safety issues.
20. **Writer**: Mission folder answers writer
21. **Editor**: Mission folder editor

Carbon Keepers

Monthly Timeline + Project Milestones

Soil: Climate's Solution

C Keepers

SEPTEMBER

Team formation 1st meeting

- Walk through the team scheduled for 2019/2020
- Write and sign the contract
- Share ideas and goals
- Talk about budget
- Make a Google site for our team
- Take a personal inventory to decide roles

Take pictures

OCTOBER

Make a list of all the tasks that need to be done for your Mission Folder and put them in order of when they need to be completed.

1. Select a Topic
2. Identify a Problem
3. Research the Problem we will work on
4. Propose a solution to this problem and make a hypothesis about how to solve this problem.
5. Design experiments

Contact and Interview researchers and professors

NOVEMBER

Conduct the experiment.

1. Select a Topic
2. Identify a Problem
3. Research the Problem we will work on
4. Propose a solution to this problem and make a hypothesis about how to solve this problem.
5. Design experiments
6. Make a webpage and blogg
7. Write a scientific survey

DECEMBER

Analyze our data

Use our data to construct a conclusion and benefits

Outreach the community: Writing to the farmers, congress representative, newspaper

JANUARY

Identify the benefit to the community

Write the folder

FEBRUARY

Review the folder answers

Upload the pictures and attachments

Submit the answers

Celebration party at ... to be announced

Dr. Weindorf - Interview Questions about Peer-reviewed Journal Writing based on his work with Kagiliery

https://today.ttu.edu/posts/2019/12/Stories/weindorf-kagiliery

Did the Florida teenager come here to lubbock to work with you, or how did you meet up?
Was it easy to collect samples at the coal mine?
How long did it take to get ahold of all the 250 samples?
What materials did you use during this project?
Were there tough problems when working with the teenager?
Did she write a scientific paper?
How did this project have an influence on the environment?
Did your results have a surprise of some sort?
What parts of this project could you not do?
Who did most of the work?
What was your intended goal during the project?
What inspired you two to start the project?
Did you learn any new information or was it all the same before?
Was there a deadline to the project, and if so then was there time to spare?
What was the daily schedule for the project?
What delayed the project/made it harder?
Were there times when you felt like it was a little too advanced?
Is she planning on taking this a step forward for future projects?

Ecybermission Project Safety Rules ~ *Carbon Keepers*

Soil: Climate's Solution

6
C
carbon
Keepers

Project Safety Rules

Carbon Keepers

1. Lab Coats and safety goggles will be worn throughout the experiment when in the laboratory.
2. Never work alone in the laboratory; use the buddy system.
3. Do not eat or drink in the laboratory.
4. Turn off heating apparatus and water faucets when not in use.
5. Keep the laboratory floor dry and clear of all objects.
6. Follow all lab safety guidelines.
7. Wash hands throughout the experiment.
8. Do not touch your face before you wash them.
9. Use protective gloves when collecting soil samples, compost, or manure.
10. Use protective gloves when working with addictant: fungi, compost, or manure.
11. Wear shoes that cover the whole foot when going to the field.
12. Always use a spatula or scoop to remove soil or chemical from a container.
13. Label all manure and compost compounds.

Resources

- ❖ Natural Resources Conservation Service Soil Survey Office Laboratory Safety Guide (https://prod.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052292.pdf)
- ❖ Safety Data Sheets (www.flinnsci.com)
- ❖ School Chemistry Laboratory Safety Guide (https://www.cdc.gov/niosh/docs/2007-107/pdfs/2007-107.pdf?id=10.26616/NIOSHPUB2007107
- ❖ American Chemical Society (ACS) http://www.acs.org
- ❖ Department of Health and Human Services Centers for Disease Control and Prevention (CDC) http://www.cdc.gov
- ❖ Department of Health and Human Services National Toxicology Program (NTP) http://ntp-server.niehs.nih.gov Laboratory Safety Institute (LSI) http://www.labsafety.org

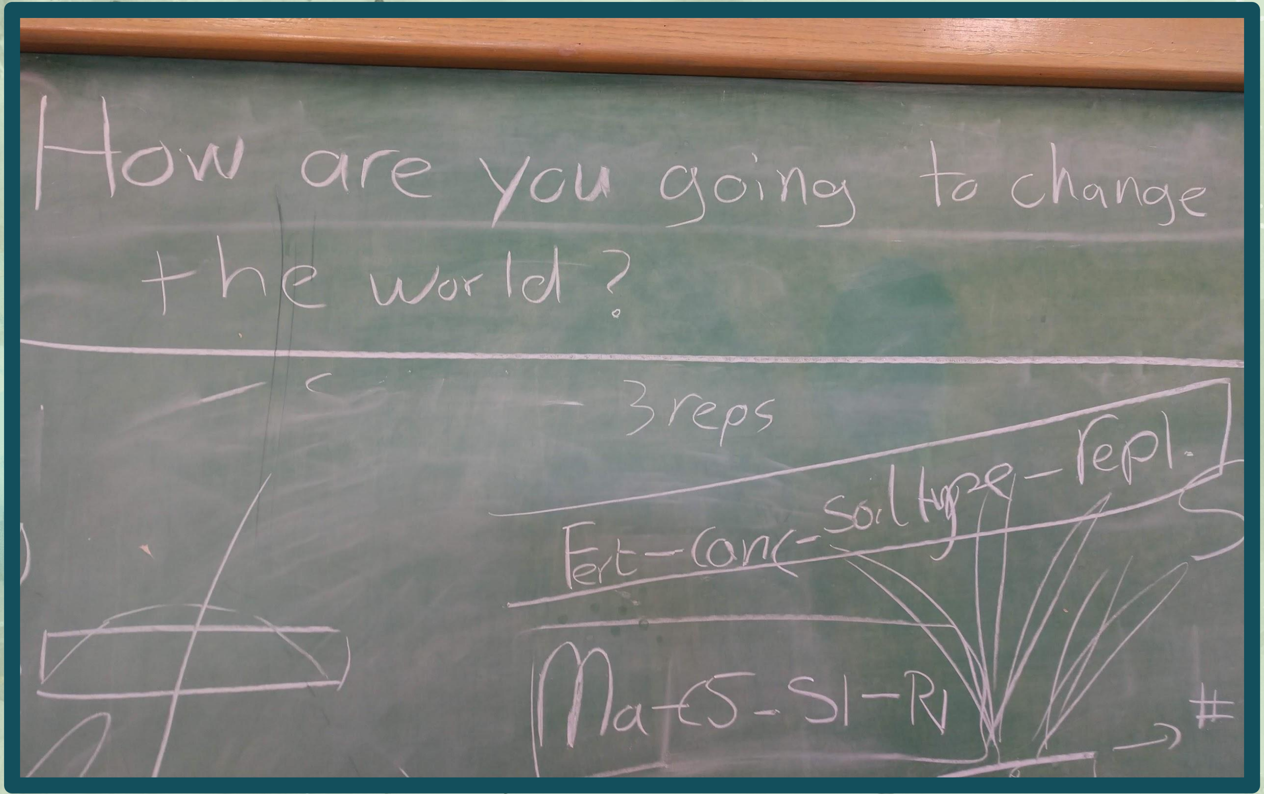
Lessons Learned from the University Soil Science Lab

- How to use an analytical scale to the 4th figure
- How to separate aboveground from underground plant matter
- How to analyze and record our information
- How to properly use lab materials
- New ideas and information for future or present projects
- If we had a furnace , our first experiment will be done quickly.


Fisherbrand


First Aid Kit
Fisherbrand
1000
mL
900
800
700
600
500
400


Warriors



Dr. Weindorf leaves great messages for our team and his graduate students and this one was perfect for eCYBERMISSION!

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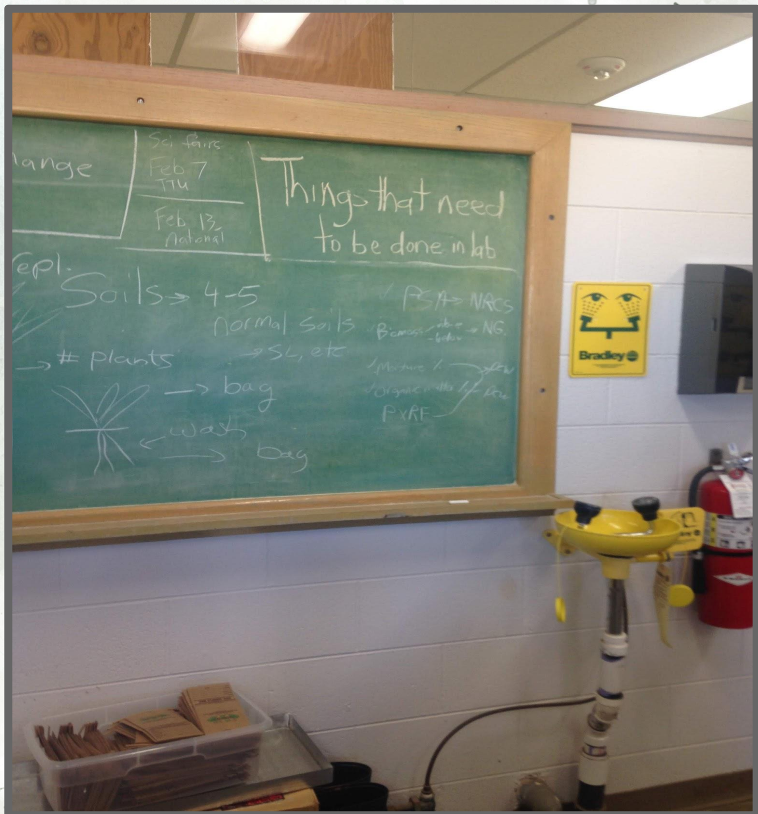
Future Research

- Cover crops
- Different soils
- Different concentration
- Comparing root sizes
- Vertical farming usage comparison
- Agricultural growth
- Comparison of compost
- Agriculture adaptation
- Carbon farming



I. The Effect of Pollutants on the Soil Productivity

Problem

The changes in pH (acidity), fertilizers, and salinity are commonly encountered in agriculture but what are these pollutants doing to the soil productivity - an excellent measure of soil health?

Hypothesis

If pollutants are added to the soil, its productivity will decrease.

Variables: Productivity

Independent

- Type of pollutants

Dependent

- Productivity after a week of treatment

Constants

- Same seeds
- Same soil
- Same time
- Same temperature
- Same amount of light

Control

- Spring water

I. Procedure: Effects of Pollutants in Soil

1. Safety Precautions: Adult supervision is recommended during lab activities. Goggles and gloves are optional with salt but required with fertilizer and acid.
2. Plant grass seeds in potting soil. Divide the tray in pots, 9 cm^2 in size.
3. Water the samples with fresh water and let the grass grow.
4. After 4 weeks, pour a mixture of salt water on the pots plants as described in Step 4.
5. Use table salt percents of 1%, 5% and 10% on part of nine samples of plants respectively during one week. Repeat this for fertilizer and acidity tests as well.
6. After a week, remove the grass plants from the pots and measure the mass.
7. Wrap in paper and let air dry for 1 weeks.
8. Measure the dry mass, record, and calculate the productivity in each sample.
9. Compare the primary productivity.

Material

- Potting soil
- Rye grass seed
- 7 planting trays
- 7 planting tray domes
- 7 clear plastic cups
- Plants labels
- 1 roll of string
- Fertilizer
- Salt
- Pushpin
- Scissors
- Bottles

- Electronic scale
- Spring water
- Weighing tray
- Stirring rod
- 100 mL graduated cylinder
- 250 mL beaker
- 1 L graduated cylinder
- 1000 mL beaker
- Salt Nacl, NaCl
- Fertilizer
- Vinegar

Conducting Productivity Tests

1- Measuring the soil

2- Watering the soil

Conducting Productivity Tests

3 - Planting the seeds

4- Organizing all tests

Conducting Productivity Tests

5 - Making the pollutant solution

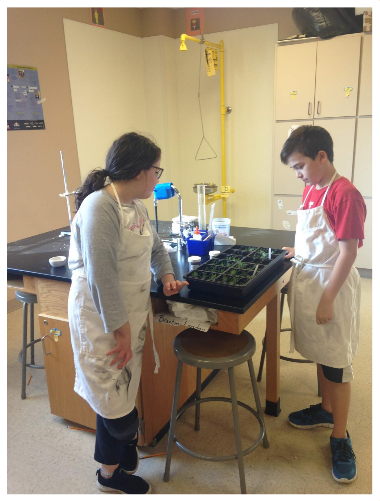
Conducting Productivity Tests

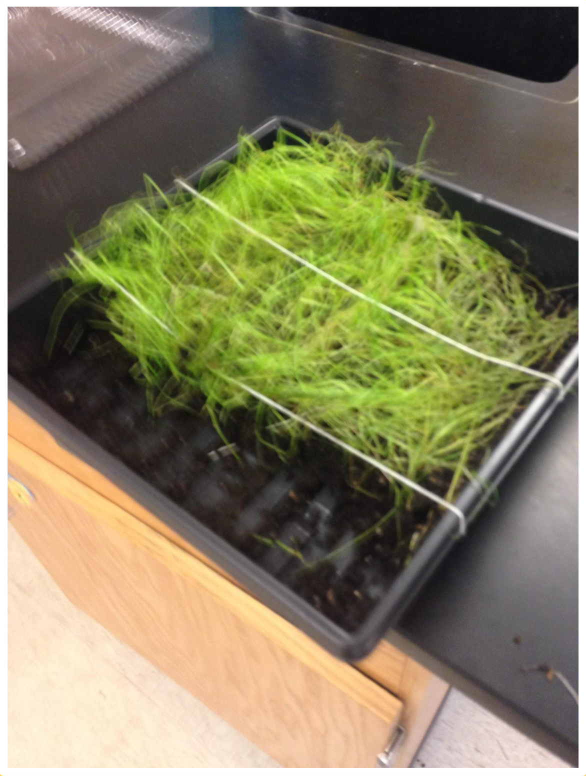
6- Dividing the pots in nine areas

Conducting Productivity Tests

7 - Watering the plants with the pollutant

6- After one week, separate the plots





Conducting Productivity Tests

5- Measuring the wet mass

6- Let the soil and plant dry

How did we Calculate Soil Productivity?

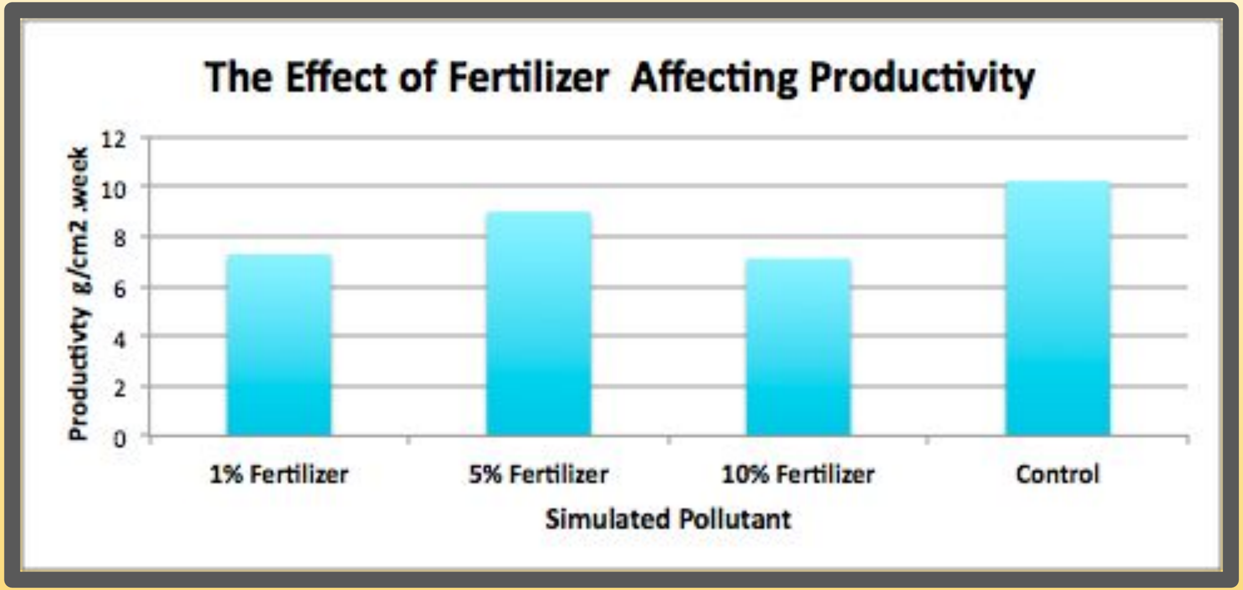
$$\frac{\text{Dry Mass (g)}}{\text{Plot Size (cm}^2\text{)}}$$

= Productivity in 1 Week

* Dry mass divided by Plot Size = Productivity

Productivity is one way to express the volume of organic matter produced in a plot size. Decreasing means losing organic matter.

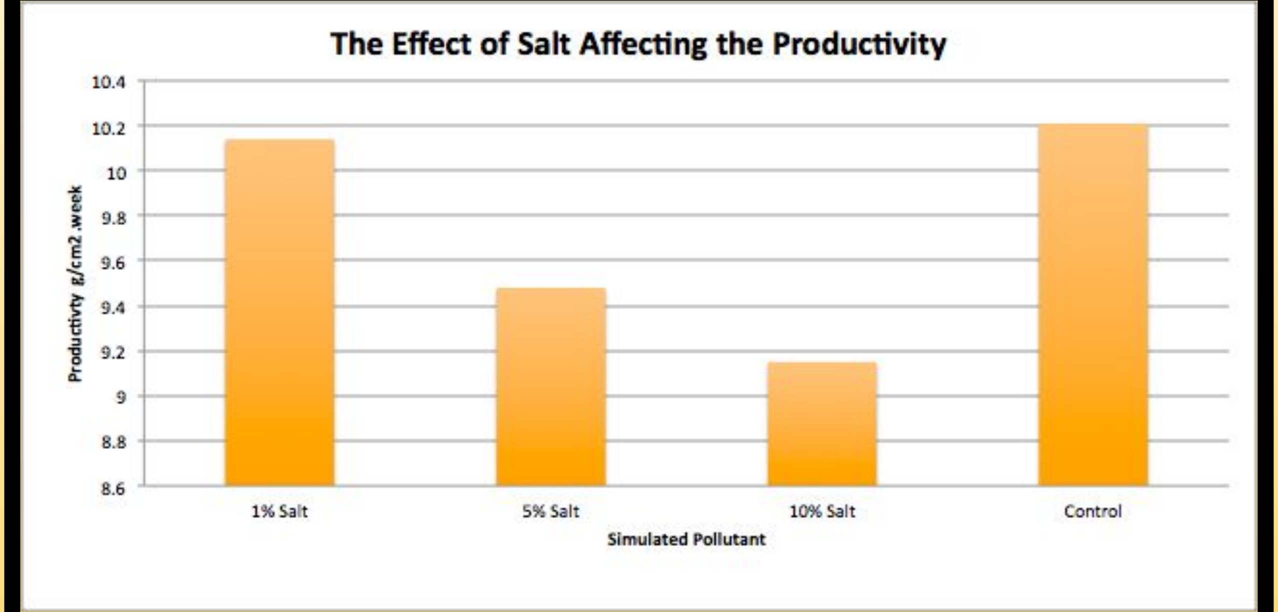
Graph 1: Soil Primary Productivity - Fertilizer



Pollution	Productivity Average g/cm^2
1% Fertilizer	7.28
5% Fertilizer	8.98
10% Fertilizer	7.11
Control	10.21

Table 1. Productivity Average of 9 tests using fertilizer.

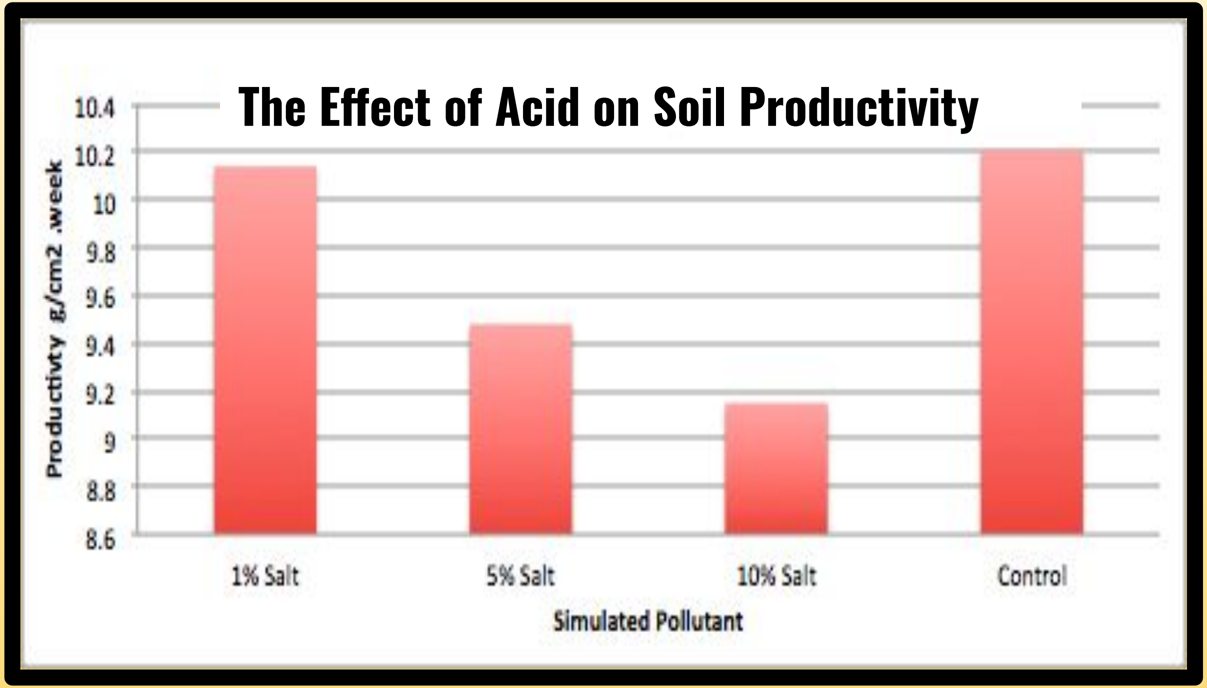
Graph 2: Soil Primary Productivity - Salinity



Pollution	Average Productivity g/cm^2
1% Salt	10.14
5% Salt	9.48
10% Salt	9.15
Control	10.21

Table 2: Productivity Average of 9 tests using salt.

Graph 3: Soil Primary Productivity - Acidity



Pollution	Average Productivity g/cm²
1% Acid	7.24
5% Acid	6.21
10% Acid	5.72
Control	10.21

Table 3: Productivity Average of 9 tests using acid.

Why Pollutants were Tested First

Pollutant	Reasoning
1. Salt	Salts in the soil water can affect the growth of plants, but in the irrigation water is not immediately harmful to plants. It depends on concentration and amount of water
2. Fertilizer	Fertilizer contain plants nutrients and help plants growth. However, the plants roots are smaller.
3. Acid	Acidity can affect plants growth, but there are soils, for example the amazon rainforest, that have a very low pH (4 to 5).

Conclusion

- Indeed the pollutants affected negatively the productivity of the soil.
- After conducting 27 tests on salinity, acidity, and nitrogen (fertilizer) pollutants, it was clear each of these common pollutants have a negative effect on productivity. This knowledge is vital in moving forward with the project and looking at soil additives that will boost productivity and improve soil heath.

II. Do wildfire and drought affect the biomass of plants?

Problem

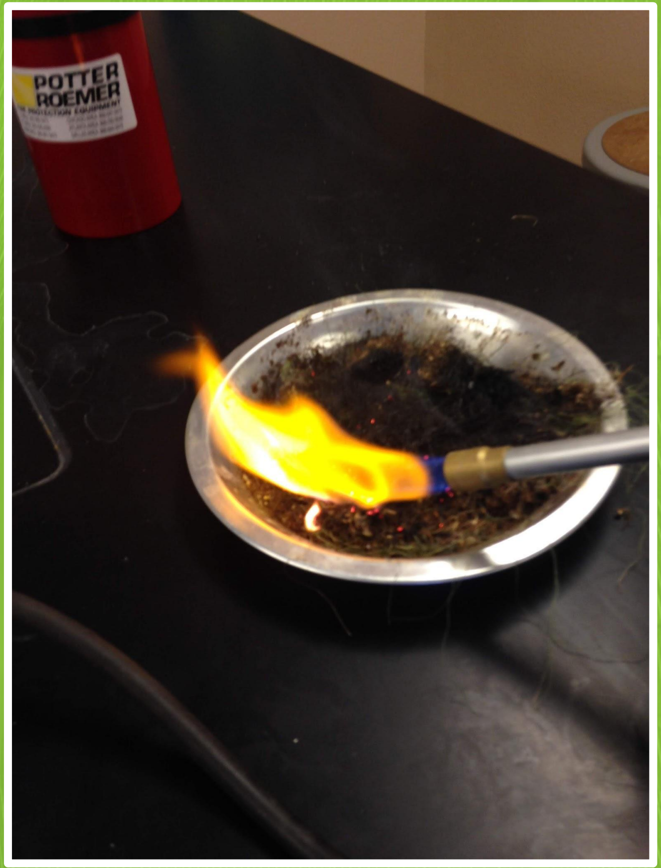
Climate change is bringing unprecedented drought to our area and with drought, comes wildfire across the prairie. Will this affect the soil and plant total biomass?

1. Hypothesis

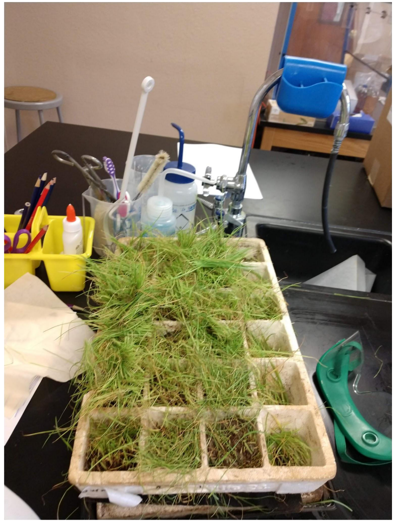
If soil is exposed to climate problems such as drought and wildfire, then the biomass will decrease.


Southcrest
Warriors


VWR
PRINT
CAL


POTTER
ROEMER

Variables



Independent

-

Dependent

- Total mass (Productivity)

Constants

- Same seeds
- Same soil
- Same time
- Same temperature
- Same amount of light

Control

- Spring water (for drought)
- Unburnt soil (for wildfire)

Material

- Rye seed
- Soil
- Gas flame
- Fire extinguisher
- Spring water
- Vent hood
- Beaker
- Graduated cylinder
- Computer
- Spatule
- Electronic scale
- Container for the plant
- Weighing dish
- Paper tower
- Tablespoon
- Ruler

Procedure: Burning the soil

1. Get three planting containers and add soil.
2. Add ¼ tea spoon full of rye seed to the grass .
3. Add spring water to the grass everyday until the grass grows.
4. Cut the grass to 2 cm height.
5. Using a bunsen burner, under the hood, burn all the grass.
6. Let the burnt soil cool down until room temperature.

Procedure: Wildfire soil Experiment

1. Get a planting container with 24 cells.
2. In 12 of the cells add a control soil and the other 12 a burnt soil
3. Label the containers
4. Plant ¼ tea spoon full of rye grass seed in each cell
5. Water your grass everyday until the grass grows
6. Take the grass out of the cell into a weighing dish and let it dry for a week
7. After a week, weigh the grass and record it on a table.
8. Compare the total mass.

Procedure: Drought in soil experiment

1. Get nine planting containers.
2. Add ¼ tea spoon full of rye grass seed in each pot.
3. Add 10 mL of water to the grass everyday for two weeks.
4. Then stop watering 3 containers, keep watering 10 mL to three pots as control, and add 50 mL to the rest during two more weeks.
5. Take the grass out of the pots into a weighing dish and let all samples dry for a week
6. After a week, weigh the grass and record it on a table.
7. Compare the total mass.

Our burned soil had a better productivity than the soil that was not burned. It was 22.7 g in total (average, 1.89 g) and the unburned was 19.2 g (average 1.6 g) so that means that the burned soil kept more carbon.

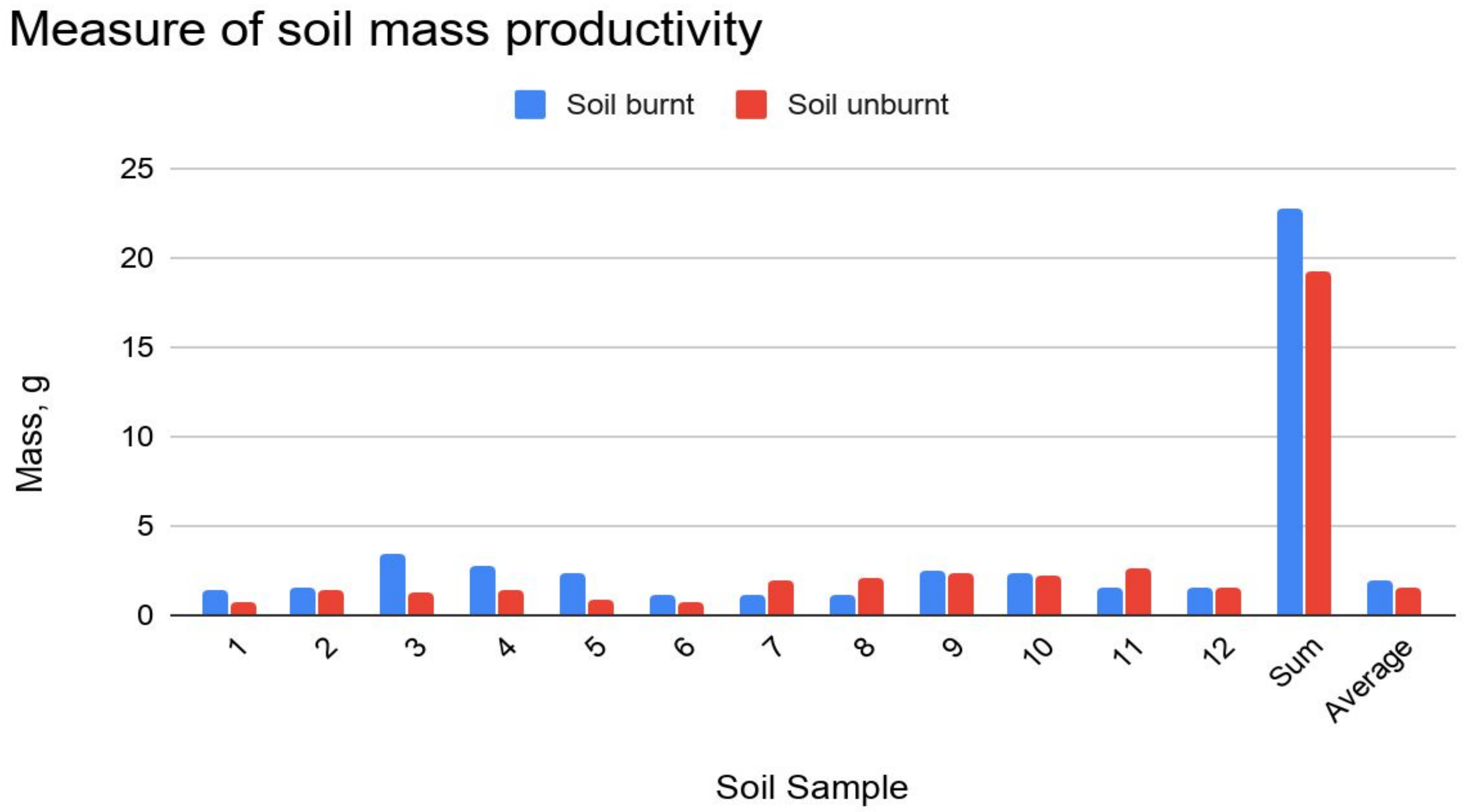
Table 1. Biomass for samples of wildfire conditions

Biomass (grams)		
Sample	Soil burnt	Soil unburnt
1	1.4	0.7
2	1.6	1.4
3	3.4	1.3
4	2.7	1.4
5	2.3	0.9
6	1.1	0.7
7	1.1	2.0
8	1.2	2.1
9	2.5	2.4
10	2.3	2.2
11	1.6	2.6
12	1.5	1.5
	total Mass - 22.7	Total Mass = 19.2

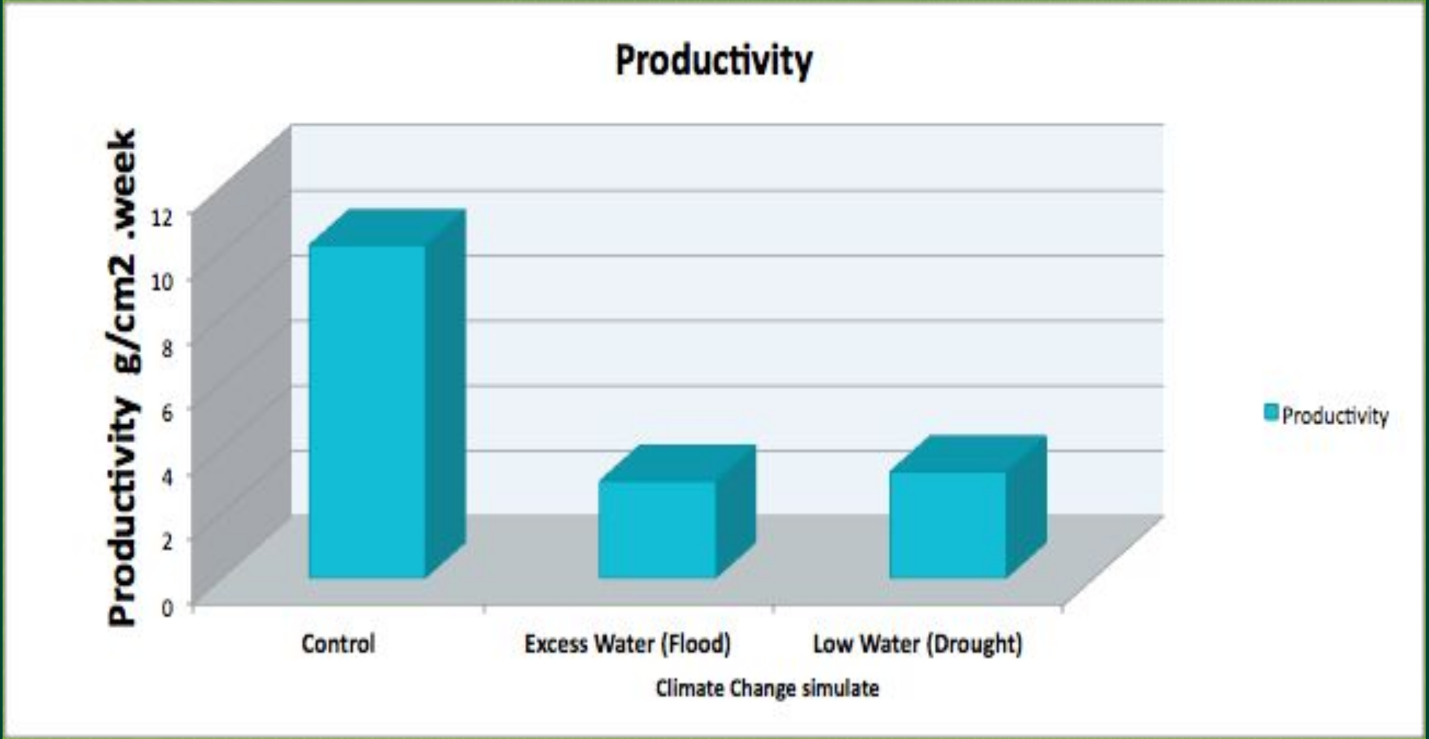
Table 2. Biomass for the average of three samples

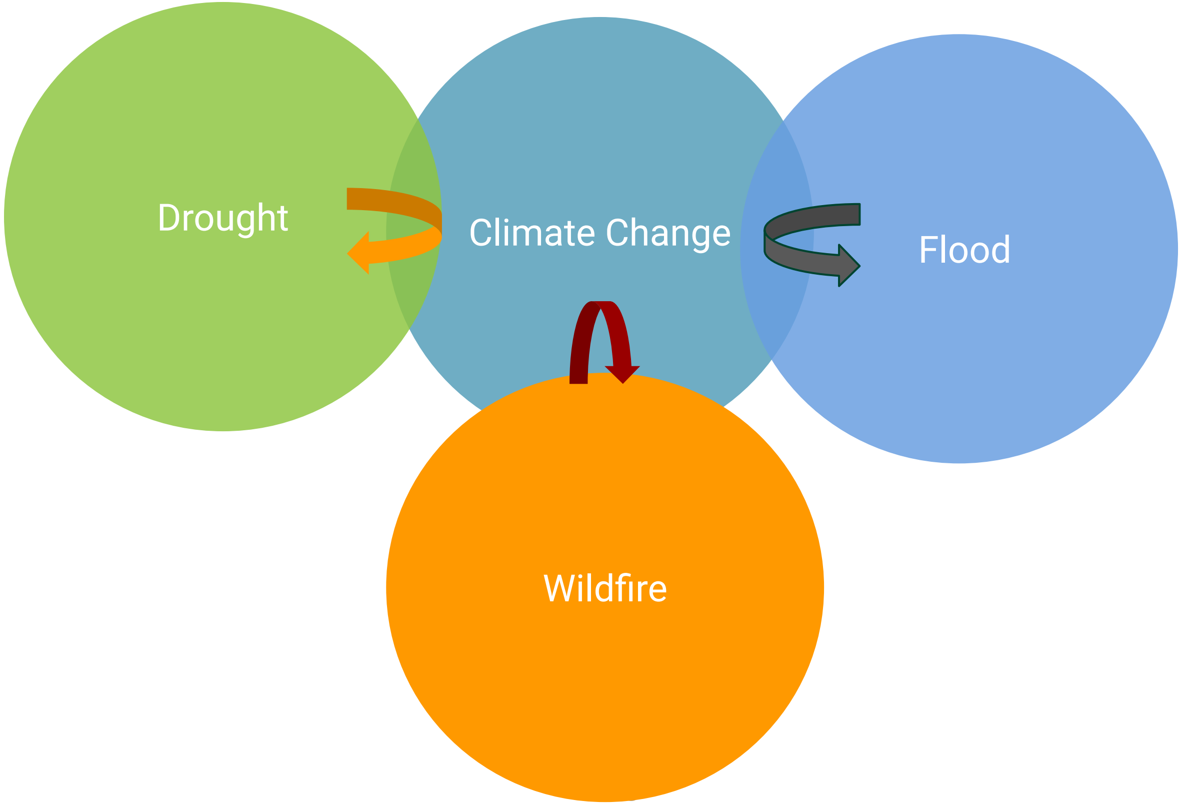
Type of sample	Average Productivity g/cm^2
Control	10.21
Excess Water (Flood)	2.98
Low Water (Drought)	3.27

Graph 1.


Measure of soil mass productivity
Soil burnt
Soil unburnt
25
20
15
10
5
0
Mass, g
1
2
3
4
5
6
7
8
9
10
11
12
Sum
Average
Soil Sample

Graph 2. Measuring soil mass (productivity) in lack and excess of water condition




Drought
Climate Change
Flood
Wildfire

Conclusion

Our hypothesis was not correct for the burnt grass. Its total carbon mass was more than the control. In this case fire helped! However, the amount of water on soil affected tremendously. The productivity decreased in a drought condition and flood condition.

Drought in soil causes organic matter to not stick to the minerals and water absorption to decrease as well.

Fire had a positive impact on organic matter and encouraged plant growth.

II. The Impact of Rhizobium Inoculation of Clover on Root Nodulation and Biomass

Problem

What effect does rhizobium bacteria have on biomass and nodulation of Trifolium?

Hypothesis

If Trifolium is inoculated with rhizobium, then the roots will be longer, have more nodes, and the biomass would be significantly bigger.

Materials

For Measuring the Biomass

- Piece of string
- Metric Ruler
- Beaker of water

For Counting Nodules on Plant Roots

- Stereo Microscope 10x
- Compound light microscope 100x

For Planting the Seeds

- Soil
- Trifolium Seeds
- Trifolium Seeds treated with rhizobium bacteria
- Water
- Graduated Cylinder
- Spoon
- Planting trays
- Clear covers for the planting trays
- Plant identification markers
- Sharpie

Procedure

For Planting the Seeds

1. Gather supplies needed.
2. Place 20 mL of soil in each potting container.
3. To 18 containers, add ⅛ teaspoon of clover seed to each one.
4. To 18 containers, add ⅛ teaspoon of rhizobium-treated clover seeds to each one.
5. Add 5 mL of water to each container.
6. Place a clear lid over the containers and put in a sunny window for germination and growth.
7. Allow plants to grow for 21 days, adding water consistently as needed for moisture.

For Measuring the Biomass

1. Remove the Trifolium plants from the soil and gently wash in water.
2. Measure the length of the roots and the length of the shoots in centimeters.

For Counting Nodules on Plant Roots

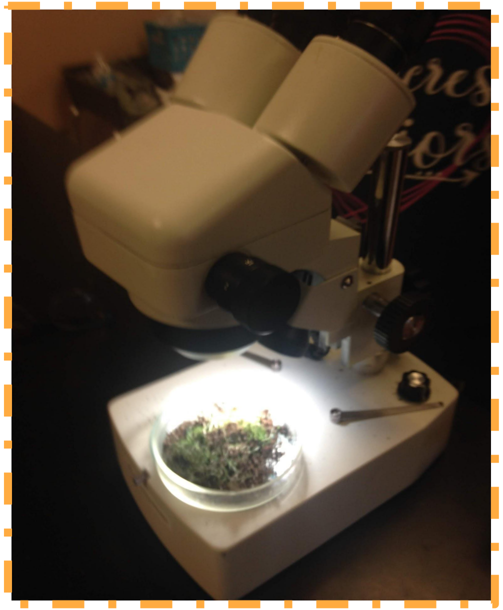
1. Place one Trifolium seedling on the slide and onto the stage of the microscope.
2. Examine the end of the root for the presence of nodes.
3. Record the number of nodes on each root.
4. Repeat for each of the 12 clover plants.

For Measuring the Biomass

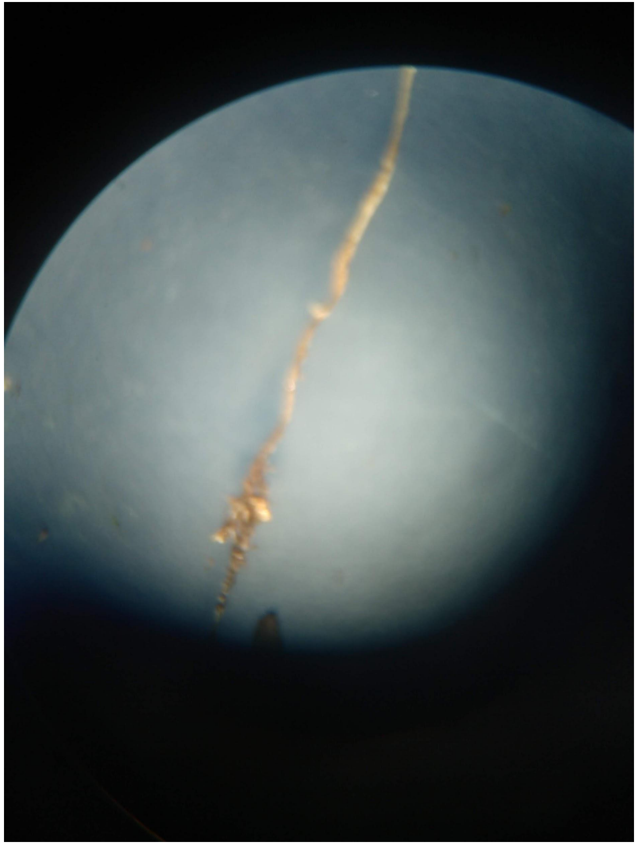
1. Remove the Trifolium plants from the soil and gently wash in water.
2. Measure the length of the roots and the length of the shoots in centimeters.
3. Place 6 samples of the untreated Trifolium plants and place on a scale to find mass. Do the same for treated Trifolium plants.

For Counting Nodules on Plant Roots

1. Place one Trifolium seedling on the slide and onto the stage of the microscope.
2. Examine the end of the root for the presence of nodes.
3. Record the number of nodes on each root.
4. Repeat for each of the 12 clover plants.



Trifolium was weighed to determine biomass and length of the plant recorded as well.



Using a compound light microscope and stereoscope allowed me to see the nodes on the roots (they look like bumps)

Nodulated roots and longer roots hold soil together well, as you can see in the picture on the left.

Using clover inoculated with bacteria (good bacteria - rhizobium) led to the idea of future experimentation on soil productivity levels in fields of legumes. Legumes are important food crops around the world and rely on healthy soil.

Variables

Independent - The treatment on the plant of either rhizobium or no rhizobium is the independent variable.

Dependent - The dependent variable is the length of roots, the length of the green shoots, the biomass of the plants, and the number of nodes on the roots.

Controlled - The untreated Trifolium seeds were the control.

Constants - All these factors were identical for fair testing: the planting containers, the type of seeds, the same kind of soil, the same amount of water used, the same amount of light, the same temperature conditions, the day the measurements were taken.

Table 1: Average Data - *Trifolium*

Result of Trifolium Plants	Treated	Untreated
Average Root Length	2.97	3.03
Average Shoot Length	2.36	1.67
Average Number of Nodes	2.5	3.17
Average Biomass	4.8	0.8

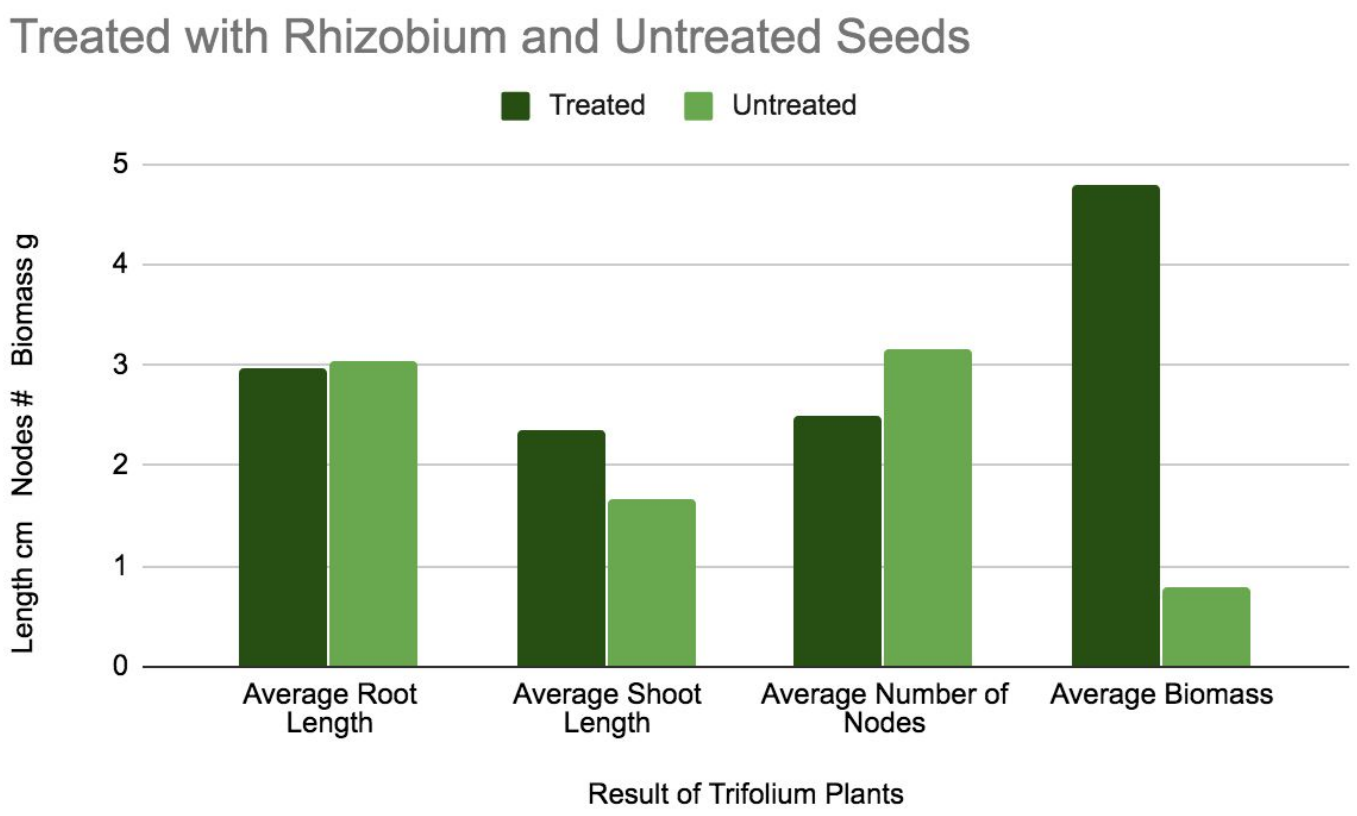
Table 2: Untreated *Trifolium* Seed Data

Untreated *Trifolium* Seeds				
	cm	cm	#	g
Sample	**Root Length**	**Shoot Length**	**Nodes**	**Biomass**
1	4	1	3	0.8
2	3	1.5	4	
3	5	2.5	4	
4	4	1.5	2	
5	5	2	4	
6	2	1.5	2	

Table 3: Treated Trifolium Seed Data

Rhizobium Treated Seeds				
	cm	cm	#	g
Sample	**Root Length**	**Shoot Length**	**# of Nodules**	**Biomass**
1	2	2.5	2	4.8
2	2.5	2.5	2	
3	3	2	1	
4	4	1.5	5	
5	5	1	1	
6	4	2	4	

Graph 1: Average Results



Results

Length of Roots - An average of 2.97 cm treated and 3.03 cm untreated - not a significant difference in root length. The lengths of the roots were basically the same. The Rhizobium Bacteria did not show a difference between the root length.

Length of Shoots - An average of 2.36 cm for treated and 1.67 cm for untreated - a significant difference was shown for the length of shoot. The above ground shoots were taller for the treated seeds. The tray of treated seeds clearly looked taller and healthier than the untreated.

Biomass of Plants - An overall average of 4.8 grams for treated seeds and 0.8 grams for untreated seeds. This was a significant increase in biomass for the treated seeds. There was a 400% difference between the treated and untreated seeds.

Number of Nodes on Roots - The treated seeds had an average node count of 2.5, and the untreated seeds averaged 3.17 nodes per root.

Further Research for this Experiment

This project might show different results if the plants were allowed to fully grow. The nodules were difficult to see on some of the roots, but if we allowed them to grow more then we might see different results.

If we did this project again, we would have a larger sample size of both the untreated and treated plants. It would be interesting to see the effects Rhizobium Bacteria may have on other types of legumes.

Presenting Rhizobium Information

South Plains Science and Engineering Fair

First Place

Conclusions

The hypothesis was both refuted and supported due to the four tests. The number of nodes was less in the treated seeds and the length of roots was basically the same for treated and untreated.

The hypothesis was supported because the aboveground shoot length was higher for the treated seeds and the biomass was significantly higher for the treated seeds - almost 400% higher.

In conclusion, treated seeds with rhizobium bacteria are more effective in increasing biomass and promoting plant growth.

Carbon Keepers: Hypotheses & Evidence

Experiment	**Hypothesis**	**Proposed Experiment**	**Independent Variable**	**Dependent Variable**	**Evidence of Research-based Information**
1.The Effect of Pollutants in the Soil- **NaCl** **Salinity** **Control:** spring water	If we add salt to the water used to irrigate the soil, the amount of carbon matter will decrease.	Three different concentration solutions of NaCl will be added to the grass for one week. Productivity will be tested after a week.	Different Concentrations of salt solution	Productivity after a week of treatment	Soil pollution is toxic chemicals in the soil harming the environment and its surroundings. There are two types of soil pollution, man-made and natural occurring. Salinity in soil has an impact on agriculture.
2.The Effect of Pollutants in the Soil- **CH_3COOH** **Acidity** **Control:** spring water	If we add acid to the water used to irrigate the soil, the amount of carbon matter will decrease.	Three different concentration solutions of acetic acid will be added to the grass for one week. Productivity will be tested after a week.	Different Concentrations of acid solution	Productivity after a week of treatment	Depending on the concentration acid (lower pH) will have a negative impact on the carbon mass. Roots will be weak. However, rainforest soil are very acidic compared with our soil in USA

3.The Effect of Pollutants in the Soil- **Fertilizer** **(NH_4^+.)** **Control:** spring water	If we add fertilizer to the water used to irrigate the soil, the amount of carbon matter will decrease.	Three different concentration solutions of fertilizer will be added to the grass for one week. Productivity will be tested after a week.	Different concentration of fertilizer	Productiv-ity after a week of treatment	Fertilizer helps plants grow, but the roots do not grow deeper. This happens because nitrogen is available so easily that they do not need to look for. Less roots, less carbon mass.
4. **The Effect of Drought on the Soil Organic Mass** **Control:** watered soil	If soil experiences drought, biomass will decrease.	Three types of soil conditions excess, lack, and normal amount of water will be tested.	Amount of water	Productiv-ity after a week of treatment	Drought in soil causes organic matter to not stick to the minerals and water absorption to decrease as well.
5. **The Effect of Fire on the Soil Organic matter** **Control:** unburnt soil	If soil is exposed to fire, then the biomass will decrease.	Soil is planted and then burned, and replanted.	Soil before and after a fire spread through	Productiv-ity after a week of treatment	Fire had a positive impact on organic matter and encouraged plant growth
6. **The Impact of Bacteria on Root Nodulation and Plant Biomass** **Control:** untreated seed	If Trifolium is inoculated with rhizobium, then the roots will be longer, have more nodes, and the	To study the Impact of Rhizobium Inoculation of Clover on Root Nodulation and Plant Biomass, we will plant seeds	The treatment on the plant of either rhizobium added or no rhizobium added	The length of roots, the length of the green shoots, the biomass of the plants, and the number of	Rhizobium bacteria and legumes have a special relationship. Rhizobium bacteria helps make the plant grow larger and healthier, so

	biomass would be significantly greater.	inoculated with the bacteria and compare with the ones that have not been treated.		nodes on the roots.	more carbon mass.
7. **Soil Treatment to Increase Carbon Sequestra-tion** **Control:** Untreated soil (no additive)	If fungus (mycorrhi-zae) is added to the soil, it will provide the greatest root stimulation, increasing the amount of organic matter and holding more carbon in the soil.	Additives will be put into the West Texas soil in different concentra-tions and tested for the total carbon mass.	Soil Additive (Fungus, compost, and manure)	Total Carbon Mass	Fungus, compost and manure have been added to soil to accelerate the growth of the plant, based on scientific research focused on the plants. **Our focus was on the carbon mass in the soil - the amount of organic matter holding carbon in soil.**

Fertilizer 1%	Wet Mass	Dry	Plot size (cm	Productivity	(g/cm2) in 1 week
	121.8	103.6	9	11.5111111	
	86.5	51	9	5.66666667	
	90.4	61.7	9	6.85555556	
	99.3	82.6	9	9.17777778	
	80.4	72.9	9	8.1	
	79.3	66.8	9	16.4222222	
	87.3	56.5	9	6.27777778	
	93.1	44.9	9	4.98888889	
	99.8	49.3	9	5.47777778	
			Average	8.27530864	

Fertilizer 5%	Wet Mass	Dry	Plot size (cm	Productivity	(g/cm2) in 1 week
	116	60.3	9	6.7	
	131	56.9	9	6.32222222	
	141.3	50.6	9	5.62222222	
	67.6	66.3	9	7.36666667	
	68.3	67.7	9	7.52222222	
	75.6	58.6	9	15.5111111	
	83.1	79.5	9	8.83333333	
	74.6	49.1	9	5.45555556	
	97.5	76.4	9	8.48888889	
			Average	7.98024691	

Salt 10%	Wet Mass	Dry	Plot size (cm:	Productivity	(g/cm2) in 1 week
	Wet Mass	**Dry**	**Plot size (cm**	**Productivity**	**(g/cm2) in 1 week**
	126.1	54.6	9	6.06666667	
	137	51.5	9	5.72222222	
	105.5	110.4	9	12.2666667	
	101.7	26.2	9	2.91111111	
	98.3	35.8	9	3.97777778	
	87.3	42.9	9	13.7666667	
	86.2	76.1	9	8.45555556	
	97.9	50.2	9	5.57777778	
	97.3	47.7	9	5.3	
			Average	7.11604938	

Control	Wet Mass	Dry	Plot size (cm2	Productivity (g/cm2) in 1 week
	81.1		9	9.01111111
	103.4		9	11.4888889
	84.2		9	9.35555556
	99		9	11
		Average		10.2138889

Salt 10%	Wet Mass	Dry	Plot size (cm	Productivity	(g/cm2) in 1 week
	116	93.9	9	10.4333333	
	131	109.3	9	12.1444444	
	141.3	120.4	9	13.3777778	
	67.6	46	9	5.11111111	
	68.3	45.9	9	5.1	
	75.6	54.3	9	15.0333333	
	83.1	61.4	9	6.82222222	
	74.6	52.5	9	5.83333333	
	97.5	76.6	9	8.51111111	
			Average	9.15185185	

Salt 1%	Wet Mass	Dry	Plot size (cm:	Productivity	(g/cm2) in 1 week

Wet Mass	Dry	Plot size (cm	Productivity	(g/cm2) in 1 week
126.1	107.3	9	11.9222222	
137	108.3	9	12.0333333	
105.5	86.4	9	9.6	
101.7	82.3	9	9.14444444	
98.3	79	9	8.77777778	
87.3	68.6	9	16.6222222	
86.2	68.1	9	7.56666667	
97.9	78.6	9	8.73333333	
97.3	78.5	9	8.72222222	
		Average	10.3469136	

Salt 5%	Wet Mass	Dry	Plot size (cm	Productivity	(g/cm2) in 1 week
	78.8	66.8	9	7.42222222	
	86.5	74.6	9	8.28888889	
	90.4	78.9	9	8.76666667	
	99.3	87.1	9	9.67777778	
	80.4	68	9	7.55555556	
	79.3	67.8	9	16.5333333	
	87.3	75.4	9	8.37777778	
	93.1	81.3	9	9.03333333	
	99.8	87.1	9	9.67777778	
			Average	9.48148148	

Acid 1%	Wet Mass	Dry	Plot size (cm	Productivity	(g/cm2) in 1 week
	78.8	56.8	9	6.31111111	
	70.1	50.2	9	5.57777778	
	80.4	67.9	9	7.54444444	
	87.3	62.4	9	6.93333333	
	70.2	62	9	6.88888889	
	81.5	59.2	9	15.5777778	
	75	60.4	9	6.71111111	
	84.3	32.6	9	3.62222222	
	75.2	53.8	9	5.97777778	
			Average	7.2382716	

Acid 5%	Wet Mass	Dry	Plot size (cm	Productivity	(g/cm2) in 1 week
	98	40.3	9	4.47777778	
	84.2	42.9	9	4.76666667	
	97.6	50.6	9	5.62222222	
	66.4	46.8	9	5.2	
	58.2	60.1	9	6.67777778	
	70.2	50.9	9	14.6555556	
	82.6	53.1	9	5.9	
	71.9	44.1	9	4.9	
	83.2	33.9	9	3.76666667	
			Average	6.21851852	

Acid 10%	Wet Mass	Dry	Plot size (cm2)	Productivity	(g/cm2) in 1 week
	Wet Mass	**Dry**	**Plot size (cm**	**Productivity**	**(g/cm2) in 1 week**
	88.4	44.1	9	4.9	
	63.7	51.5	9	5.72222222	
	83.7	54.8	9	6.08888889	
	34	26.2	9	2.91111111	
	98.3	34.7	9	3.85555556	
	65.3	33.9	9	12.7666667	
	86.2	55.3	9	6.14444444	
	64.1	43.3	9	4.81111111	
	90.5	38.9	9	4.32222222	
			Average	5.72469136	

Table 1: Untreated *Trifolium* Seed Data

Untreated *Trifolium* Seeds				
	cm	cm	#	g
Sample	**Root Length**	**Shoot Length**	**Nodes**	**Biomass**
1	4	1	3	0.8
2	3	1.5	4	
3	5	2.5	4	
4	4	1.5	2	
5	5	2	4	
6	2	1.5	2	

Table 2: Treated Trifolium Seed Data

Rhizobium Treated Seeds				
	cm	cm	#	g
Sample	**Root Length**	**Shoot Length**	**# of Nodules**	**Biomass**
1	2	2.5	2	4.8
2	2.5	2.5	2	
3	3	2	1	
4	4	1.5	5	
5	5	1	1	
6	4	2	4	

Table 3: Average Data - *Trifolium*

Result of Trifolium Plants	Treated	Untreated
Average Root Length	2.97	3.03
Average Shoot Length	2.36	1.67
Average Number of Nodes	2.5	3.17
Average Biomass	4.8	0.8

Table1: Biomass for samples of wildfire conditions

Sample	Soil burnt, g	Soil unburnt, g
1	1.4	0.7
2	1.6	1.4
3	3.4	1.3
4	2.7	1.4
5	2.3	0.9
6	1.1	0.7
7	1.1	2
8	1.2	2.1
9	2.5	2.4
10	2.3	2.2
11	1.6	2.6
12	1.5	1.5
Sum	22.7	19.2
Average	1.891666667	1.6

CARBON KEEPERS

Data collected on January 22-28, 2020

All data in grams

SAMPLE	Pan ID	PAN WEIGHT (without soil)	SOIL WT. +PAN (pan + fresh soil)	After drying ODW + PAN (pan and dry soil)
1	1	31.93	41.93	41.83
2	2	30.25	40.25	40.15
3	3	33.56	43.56	43.47
4	4	31.19	41.19	40.98
5	5	36.69	46.69	46.57
6	6	30.69	40.69	40.55
7	7	31.72	41.72	41.54
8	8	32.14	42.14	42.02
9	9	33.46	43.46	43.27
10	10	28.39	38.39	38.26
11	11	28.63	38.63	38.42
12	12	31.85	41.85	41.61
13	13	29.89	39.89	39.64
14	14	32.36	42.36	42.11
15	15	31.11	41.11	40.88
16	16	16.57	26.57	26.43
17	17	15.25	25.25	25.08
18	18	15.80	25.80	25.65
19	19	15.42	25.42	25.24
20	20	15.45	25.45	25.24
21	21	17.54	27.54	27.34
22	22	14.16	24.16	23.95
23	23	16.75	26.75	26.54
24	24	17.14	27.14	Bad
25	25	17.06	27.06	26.95
26	26	17.68	27.68	27.56
27	1	31.92	41.92	41.82

28	2	30.24	40.24	41.98
29	3	33.55	43.55	43.43
30	4	31.18	41.18	41.02
31	5	36.69	46.69	46.53
32	6	28.68	38.68	40.57
33	7	31.72	41.72	41.57
34	8	31.72	41.72	41.98
35	9	33.46	43.46	43.36
36	10	28.39	38.39	37.90
37	11	28.62	38.62	38.56
38	12	31.85	41.85	41.78
39	13	29.89	39.89	39.82
40	14	32.37	42.37	42.30
41	15	31.11	41.11	41.04
42	16	16.57	26.57	26.52

Do not alter this blue column

% soil moisture
0.97
0.99
0.89
2.13
1.18
1.33
1.81
1.28
1.87
1.40
2.11
2.41
2.59
2.64
2.32
1.47
1.77
1.51
1.87
2.13
2.06
2.14
2.08
#VALUE!
1.14
1.21
1.04

-14.80
1.26
1.61
1.57
-15.88
1.49
-2.57
1.01
5.19
0.64
0.64
0.69
0.71
0.63
0.52

IV. Soil Treatment to Increase Carbon Sequestration

Problem

Which soil treatment provides the greatest root stimulation, increasing the amount of organic matter and holding carbon in the soil?

Manure, compost, or mycorrhizae fungi?

Hypothesis

If fungus (mycorrhizae) is added to the soil, it will provide the greatest root stimulation, increasing the amount of organic matter and holding more carbon in the soil.

Conducting Total Mass Carbon Tests

1- Collecting soil in Whiteface, TX

Conducting Total Mass Carbon Tests

1- Collecting soil in Whiteface, TX


Conducting Total Mass Carbon Tests

2 - Collecting soil in 5 counties & regions

Conducting Total Mass Carbon Tests

2 - Collecting soil in 5 counties & regions

Conducting Total Mass Carbon Tests

3. Measuring the soil

Conducting Total Mass Carbon Tests

3. Adding soil to the pots

Conducting Total Mass Carbon Tests

4. Adding the additive

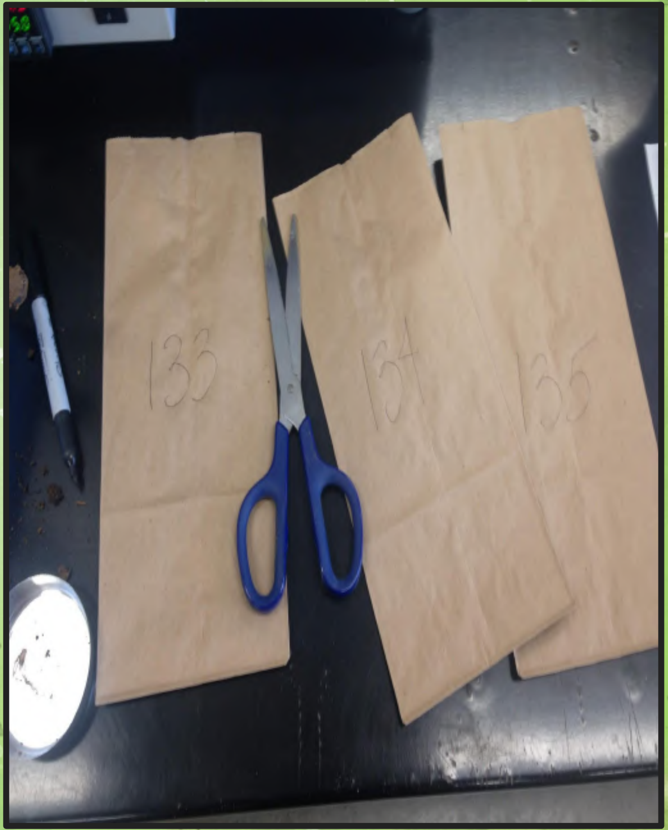
Conducting Total Mass Carbon Tests

5- Planting the seed

6. Plastic cover over the cell containers

Conducting Total Mass Carbon Tests

7. Remove plant from container

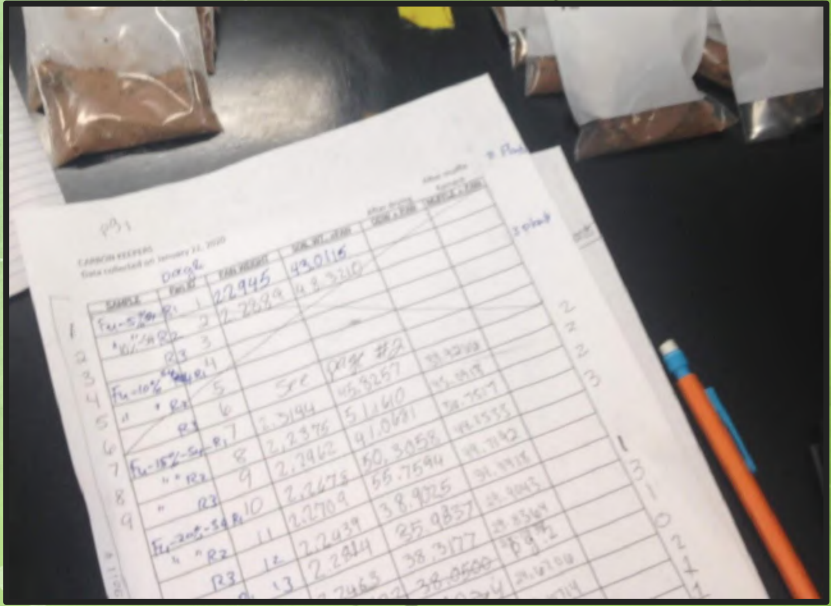


Conducting Total Mass Carbon Tests

8- Separating leaves from roots

Conducting Total Mass Carbon Tests

9 - Weighing the wet soil



Conducting Total Mass Carbon Tests

10. Drying the soil in the furnace

Conducting Total Mass Carbon Tests

10. Weighing the leaves

11 - Weighing the roots

II. Procedure: Total carbon mass

1. Collect the soil sample representing soil in west Texas.
2. Measure 50 g of soil in each cell pot.
3. Add a 5% concentration of each treatment (manure, compost, and fungi)in individual plant cups.
4. Mark a planting bar at 3 centimeters depth, according to the instructions for the seed.
5. Dig the planting bar in the soil until you can see the 3cm line.
6. Drop three seeds in each hole.
7. Cover the seed with the soil.
8. Water the plants and place a plastic cover over the cell containers to hold in moisture and create a greenhouse effect
9. Replicate the experiment three times.

1. Measure 50 g of soil in each cell pot.
2. Add a 5%, 10%, 15%, and 20% concentration of fungi in individual plant cups.
3. Mark a planting bar at 3 centimeters depth, according to the instructions for the seed.
4. Dig the planting bar in the soil until you can see the 3cm line.
5. Drop three seeds in each hole.
6. Cover the seed with the soil.
7. Water the plants and place a plastic cover over the cell containers to hold in moisture and create a greenhouse effect
8. Replicate the experiment three times.

Carbon Mass Test

1. After 4 weeks, remove one plant from the container cell using a scoopula.
2. Separate the roots from the soil carefully, collecting the soil in a separate container.
3. Wash the roots using water to remove remaining soil.
4. Cut the roots from the green shoots, thus separating the plant growth above ground from the plant growth below ground.
5. Put shoots in a lunch-size paper bag and use a Sharpie permanent marker to label the bag with the corresponding number on the data table in Excel and on our hard copy that was used during experimentation.

Label System

1. In order to be sure the correct soil additive, in the correct concentration, and in the exact type of soil remains clear throughout the data collection process, a labeling system for everything must first be established.
2. Devise a system of initials for the soil additives:
   Ma = Manure   Cp = Compost   Fun = Fungi   Co = Control

3. Devise a system of numbers for the concentration of the soil additives put in the soil:
   5% = 5% additive + 95% soil
   10% = 10% additive + 90% soil
   15% = 15% additive + 85% soil
   20% = 20% additive + 80% soil

4. Devise a way to label the three different samples of each to insure a repeated and replicated experiment whose results could be trusted:
   Rep 1 = Replicate #1, Rep 2 = Replicate #2, Rep 3 = Replicate #3

5. For the complete labeling system, put the initials together in a code that looks like this:
   Ma5%Rep1 = Manure 5% and this sample is replicate #1
6. To simplify labeling of the paper bag, small cup, and aluminum pan, number each sample on the data sheet next to the codes using numerals. Instead of writing the entire code on every sample, just write the number 12 or whatever sample corresponds with the code recorded on the data sheet.

Final Steps to the total carbon mass procedure

1. Set the furnace to 105 ^{0}C
2. Put pan with soil in furnace and apply this heat for 24 hours.
3. Remove the pan from the oven and reweigh the pans with soil. Record on the data sheet.
4. Subtract the resulting mass (dehydrated) from the initial weight of the soil to obtain the weight of the soil without moisture.
5. Record the amount of moisture in the soil on the data sheet.
6. Measure the mass of the roots and leaves.
7. Record these amounts the data sheet.
8. Add the total mass calculation formula to the Excel.
9. Compare the results.

Material

- Sandy Loam Soil from West Texas
- Pots
- Water
- Heater
- Lamp
- Winter Wheat seeds
- Electronic scale
- Scoopula
- Scissors
- Trays
- Paper bag

- Fungi
- Horse manure
- Plant labels
- Pans
- Compost
- Crucibles
- Spoons
- Furnace
- Weight dish

Variables: Total Carbon Mass

Independent

- Type of Soil Additive

Dependent

- Amount of Carbon mass
- Height of the plants
- Number of leaves

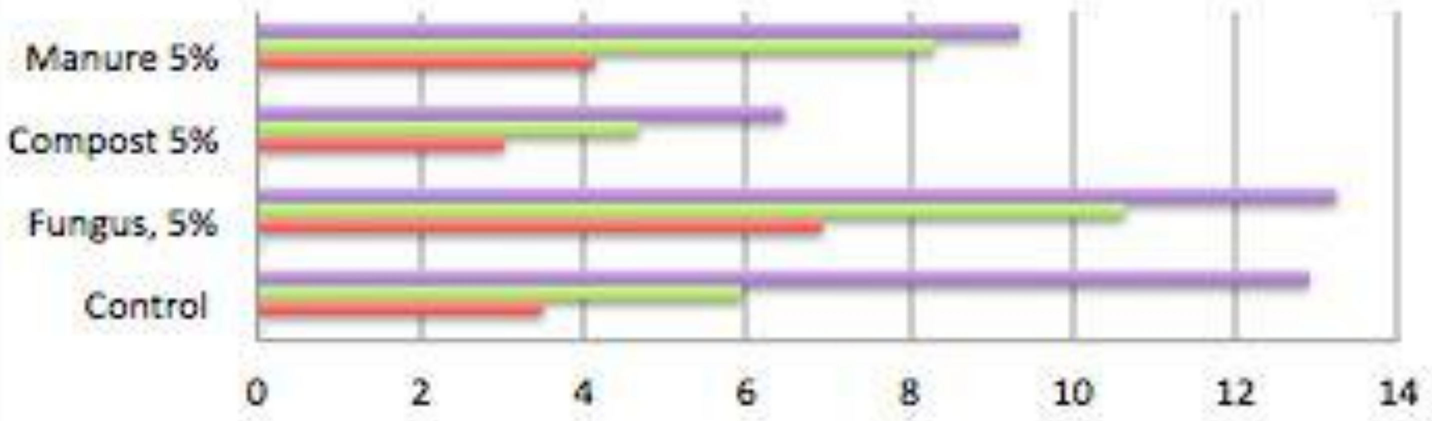
Constants

- Same seeds
- Same soil
- Same water
- Same temperature
- Same amount of light

Control

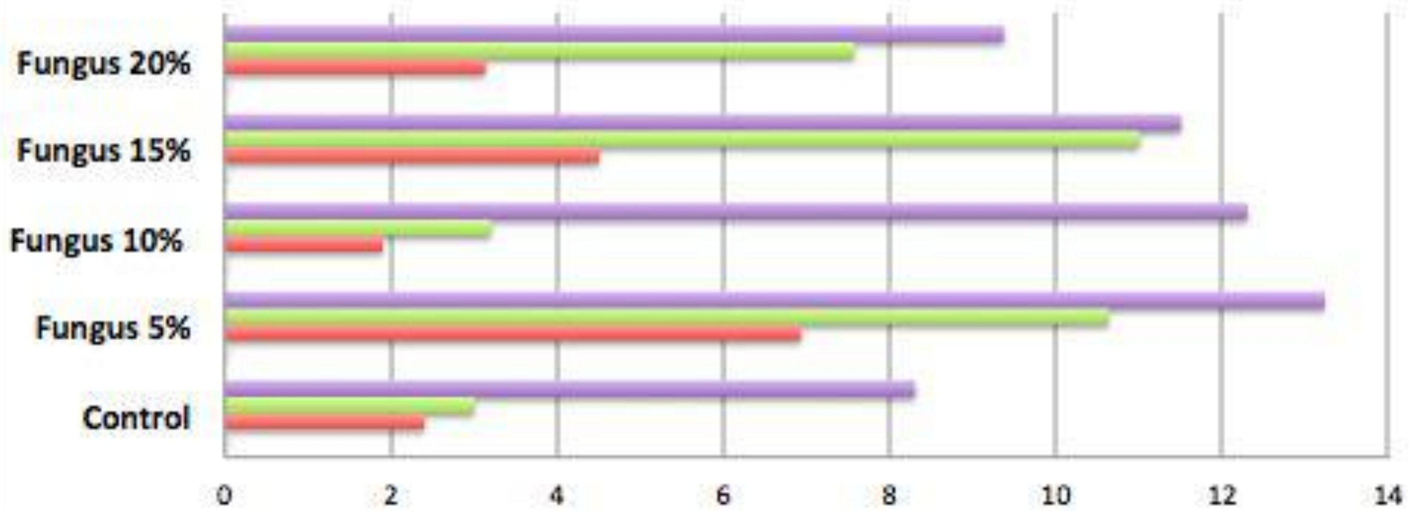
- No Additive

Graph 1: Measurement of the average results of height of the plant (in cm) during two weeks - Different additives



	Control	Fungus, 5%	Compost 5%	Manure 5%
Day 14	12.9	13.23	6.46	9.35
Day 11	5.93	10.63	4.67	8.3
Day 8	3.5	6.93	3.03	4.15
Day 1	0	0	0	0

Graph 2: Measurement of the average results of height of the plant (in cm) during two weeks- Different concentration of fungus



	Control	Fungus 5%	Fungus 10%	Fungus 15%	Fungus 20%
Day 14	8.3	13.23	12.3	11.5	9.37
Day 11	3	10.63	3.2	11	7.57
Day 8	2.4	6.93	1.9	4.5	3.13
Day 1	0	0	0	0	0

Height, cm

Table 1: Example of the data for the measurement of total carbon mass

SAMPLE	Pan ID	PAN WEIGHT (without soil)	SOIL WT. +PAN (pan + fresh soil)	After drying ODW + PAN (pan and dry soil)	% soil moisture
1	1	31.93	41.93	41.83	0.97
2	2	30.25	40.25	40.15	0.99
3	3	33.56	43.56	43.47	0.89
4	4	31.19	41.19	40.98	2.13
5	5	36.69	46.69	46.57	1.18
6	6	30.69	40.69	40.55	1.33
7	7	31.72	41.72	41.54	1.81
8	8	32.14	42.14	42.02	1.28
9	9	33.46	43.46	43.27	1.87
10	10	28.39	38.39	38.26	1.40
11	11	28.63	38.63	38.42	2.11
12	12	31.85	41.85	41.61	2.41
13	13	29.89	39.89	39.64	2.59
14	14	32.36	42.36	42.11	2.64
15	15	31.11	41.11	40.88	2.32
16	16	16.57	26.57	26.43	1.47
17	17	15.25	25.25	25.08	1.77
18	18	15.80	25.80	25.65	1.51
19	19	15.42	25.42	25.24	1.87
20	20	15.45	25.45	25.24	2.13
21	21	17.54	27.54	27.34	2.06
22	22	14.16	24.16	23.95	2.14
23	23	16.75	26.75	26.54	2.08
24	24	17.14	27.14	26.95	1.97
25	25	17.06	27.06	26.95	1.14
26	26	17.68	27.68	27.56	1.21
27	1	31.92	41.92	41.82	1.04

Table 2: Size of the Leaves for Fungus in different Concentration

Sample	Day 1	Day 8	Day 11	Day 14
Control 1	0	3.5	8.7	12
Control 2	0	0	0	0
Control 3	0	3.7	9.1	12.9
Fungus 1, 5%	0	8.5	12.5	16.7
Fungus 2, 5%	0	8.5	12.5	16.0
Fungus 3, 5%	0	3.8	6.9	7.0
Fungus 1, 10%	0	0	0	0
Fungus 2, 10%	0	0	0	0
Fungus 3, 10%	0	1.9	3.2	12.3
Fungus 1, 15%	0	0	0	0
Fungus 2, 15%	0	0	0	0
Fungus 3, 15%	0	4.5	11	11.5
Fungus 1, 20%	0	3.9	7.5	10
Fungus 2, 20%	0	0	7.0	9.7
Fungus 3, 20%	0	5.5	8.2	8.4

Conclusion

- Our hypothesis was proven correct and thus supported. The mycorrhizae did indeed provide the greatest root stimulation, increasing the amount of organic matter and holding more carbon in the soil.

The **team logo** was designed and developed by Felipe after all members gave their input. It was edited and refined several times until it represented exactly what we would convey to others.

- The Earth - our home
- The atmosphere around the Earth is controlled by the soil under our feet
- Soil health is the key to controlling climate change
- Carbon can be held in the soil
- Carbon organic matter is vital in our soil - carbon farming is critical
- Carbon from the atmosphere is captured by plants and stored in carbon sinks in the soil

Soil: Climate's Solution

C Keepers

Carbon Keepers

THE GLOBAL GOALS
For Sustainable Development

Our team is investigating the effects of pollutants, fire, drought, and flood in soil, and we are using soil diversity and regenerative agriculture techniques to keep carbon organic matter levels high.

SCAN ME

Visit: https://thecarbonkeepers.wixsite.com/ecybermission

Let's Carbon Farm!

In Lubbock → In Texas → In the USA → All over the World

Soil Treatment Investigation - Public Presentation

These are our abbreviated notes used for science presentations - hints to help us talk.

Intro- Introduce ourselves Ex: Hello I'm Felipe de Farias and I'm a 6th grader at Hutchinson Middle School.

Briley- Hi, I'm Briley and I'm in 6th grade at Whiteface Middle School. title of project

Felipe- 4-5 yrs of soil

Briley- 4 seed 5 lead and soil

Climate change * ag helps keep carbon in the soil

Problem Felipe

Hypo-Felipe

Materials & procedure - show the pictures

1. Planted, productivity to see amount of carbon

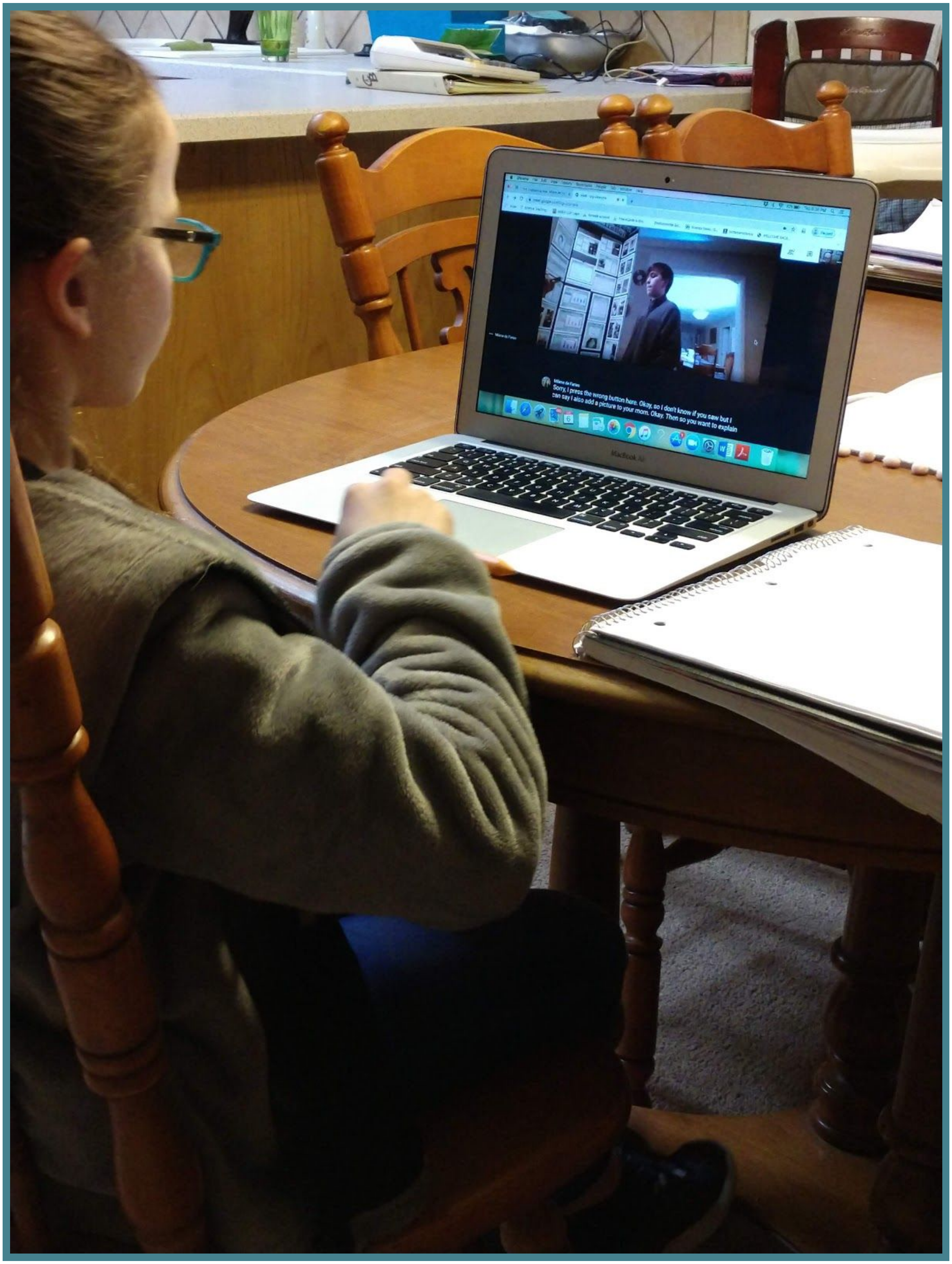
   -salinity -acidity - fertilizer & n role

   Now we are so curious we needed a way to measure the carbon mass in the plant and soil so we contacted dr. david weindorf and dr. natashia van gestel. Met them, recommended we use soils from this region instead of potting soil and seed.

   Briley- talk about planting * only got one soil* and in the soil we planted winter wheat

   Felipe- 50g soil, 3 seeds per cell

Control Winter wheat 9 cells. Fungus 5.0 3 cells Compost 5.6 3 cells Maure 5.6 3 cells



We used video chatting online to practice science presentations since Briley lived 50 miles from Felipe & Eliza.

Soil: Climate's Solution

C Keepers

Reference List

Contact	Email/phone#	Job	Team contributions
Dr. Asmeret Asefaw Berhe	E-mail: AABerhe@UCMerced.edu Web: http://www.aaberhe.com TED2019 Speaker: A climate change solution that's right under our feet	Professor, Soil Biogeochemistry Ted and Jan Falasco Endowed Chair in Earth Sciences Department of Life and Environmental Sciences University of California, Merced	Research from websites and TED Talks. Email correspondence with the team about soil and climate change. Inspiration for the topic.
Dr. John Zak	John.Zak@ttu.edu	Professor and Chair, Biological Sciences Co-Director TTU Climate Center	Soil Conference Presentations and offer of Mentorship
Dr. Katharine Hayhoe	(806) 834-8665	Political Science & Climate Change	Research from TED Talks and Seminars
Dr. Natasja Van-Gestal	806 834 7089 Natasja.Van-Gestel@ttu.edu	Assistant Professor Department of Biological Sciences Texas Tech University	Primary mentor for the team. Assisted in the experimental design process and oversight of the project.

Reference List

Dr. David Weindorf	david.weindorf@ttu.edu Phone: (806) 834-5287	Department of Plant and Soil Science Texas Tech University	Primary mentor for the team and will oversee the written work for the peer-reviewed journal. The team worked in his university laboratory and used his equipment.

Contact	**Email/phone#**	**Job**	**Team contributions**
Mrs. Gay Cline	806-797-2816 gbell@door.net	Former director of the gardens at South Plains Food Bank	Donated the use of her greenhouse for growing plants in winter
Matt Caswell	Unlisted	Farmer	Showed the team fields and discussed farming techniques
Joey Alvarez	City of Whiteface PO box 248 Zip code 79379 (806)-287-1111	Water Treatment Plant	Assisted the team in collecting treated wastewater for soil additives in the future
Don Gates	PO box 581 Zip code 79379 (806)-598-2698	Rancher	Assisted the team in collecting soil samples for planting seed
Rusty Trull	Zip code 79346 rtrull65@aol.com	Farmer	Offered advice and land for planting in the future

Reference List

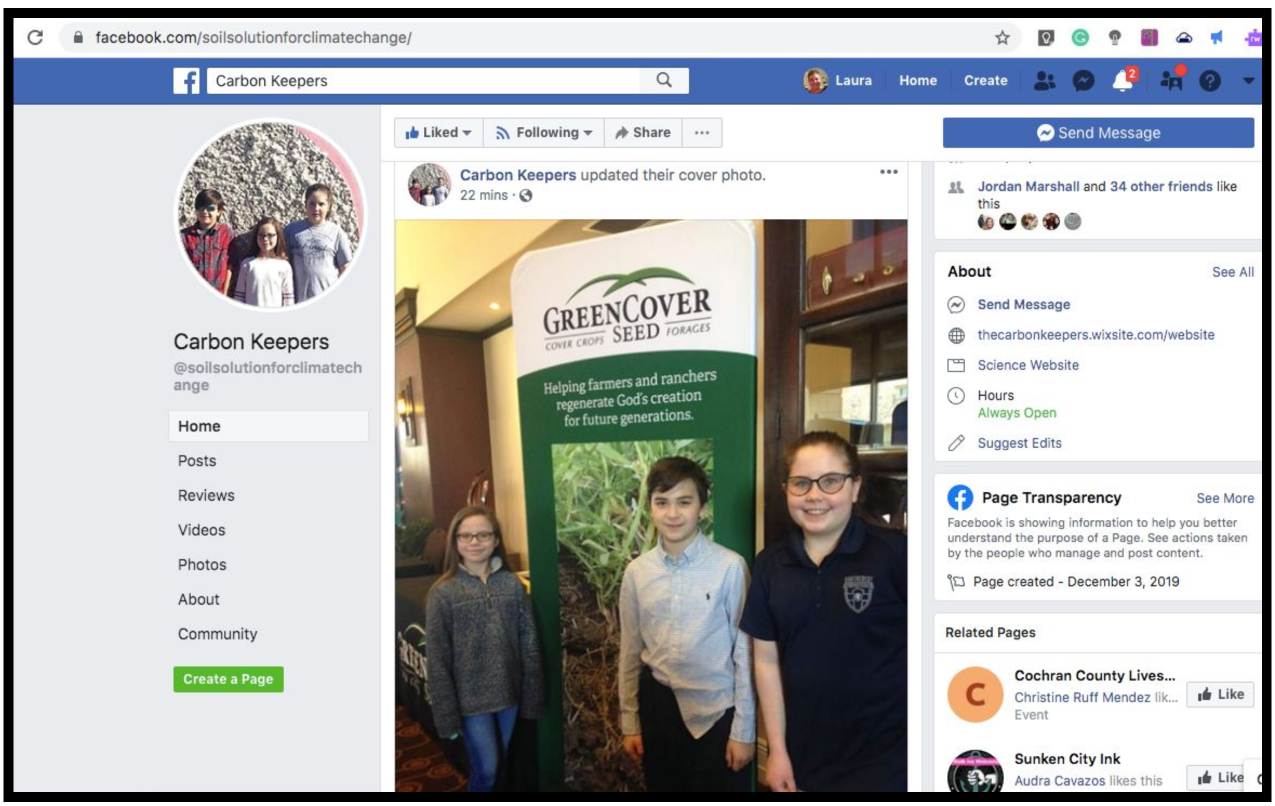
Kenneth Cox	Zip code 88132 kennethcox4375@gmail.com	Farmer	Assisted the team in collecting soil samples for planting seed
Donnie Merrit	Zip Code 79346 leannmerrit2808@icloud.com	Farmer	Assisted the team in collecting soil samples for planting seed
Freddie Brown	Zip code 79346 freddiebrown007@hotmail.com	Farmer	Offered advice and land for planting in the future
Jake Timmons	Zip code 79346	Farmer	Offered advice and land for planting in the future
Landon Kerby	Zip code 79346	President of Kertec & Conservation at NRCS	Offered advice and land for planting in the future
Corey Ayers	Zip code 79379 ayersfarms@windstream.com	Farmer	Offered advice and land for planting in the future

Reference List

Carbon Keepers

Social Media Outreach

The ***Carbon Keepers* established an educational page on Facebook** to provide community outreach locally, regionally, nationwide, and globally.



Carbon Keepers Twitter Account

The ***Carbon Keepers* established a Twitter account** to update others on carbon and farming, while allowing us to follow many important researchers around the nation. The knowledge gained has been valuable as the **project moves from benefiting our own community to benefiting others** as well.

In our Twitter account, we are following:

1. DSVUK Cover Crops

@DSVUKTerraLife

"Over 90 years experience with research and developing #covercrops for the end user. They are also breeders of Oilseed Rape, Wheat, Maize & Forage crops - visit @DSVUKSEEDS

United Kingdom dsv-uk.co.uk/cover-crops"

2. **Soil Science Society**

@SSSA_soils

“This is an International scientific society, home to 6k+ soil scientists, peer-review journals, presentations and notes from their annual meeting and more. They have news tweets and not endorsements to lend bias to the information.

Madison, WI soils.org”

3. **United States Department of Agriculture**

@USDA

“Leadership on #food, #agriculture, natural resources, #rural development, #nutrition, & related issues based on public policy, science, & effective management.

Washington, DCusda.gov”

4. **EU Agriculture**

@EUAgri

“Food, farming and the future of agriculture Sowing the seeds of EU Agriculture & Rural Development policy #FutureofCAP

europa.eu/!Gm77XX”

5. **Texas Department of Agriculture**

@TexasDeptofAg

“Texas Department of Agriculture #TxAgMatters

Austin, TXtexasagriculture.gov”

6. **Texas Young Farmers**

@TXYoungFarmers

“The purpose of the Texas Young Farmers is to provide educational programs designed to meet the needs of men and women with a vested interest in agriculture.

Fairfield, Texas txyoungfarmers.org”

7. **United States Environmental Protection Agency Research**

@EPAresearch

“Science news, links, and conversation from the US Environmental Protection Agency's Office of Research and Development (ORD). RTs /mentions are not endorsement.

11 states + DCepa.gov/research”

8. The EPA Blog

@EPAblog

“The official blog of the U.S. Environmental Protection Agency

USAblog.epa.gov”

9. United States Environmental Protection Agency

@EPA

“Our mission is to protect human health and the environment.

USAepa.gov”

10. Carbon Farming

@CFI_aus

“Carbon Farming Initiative in Australia - news, projects, research, on-ground work, resources, methodologies and opinion.”

11. UN Climate Change

@UNFCCC

“Official twitter account of UN Climate Change. Also in Spanish @CMNUCC, French @CCNUCC and German @UNKlima. Our head: @PEspinosaC

Bonn, Germanyunfccc.int”

12. eCYBERMISSION

@ecybermission

“A web-based science, technology, engineering and math competition for students in grades 6 through 9 sponsored by the U.S. Army and administered by NSTA.

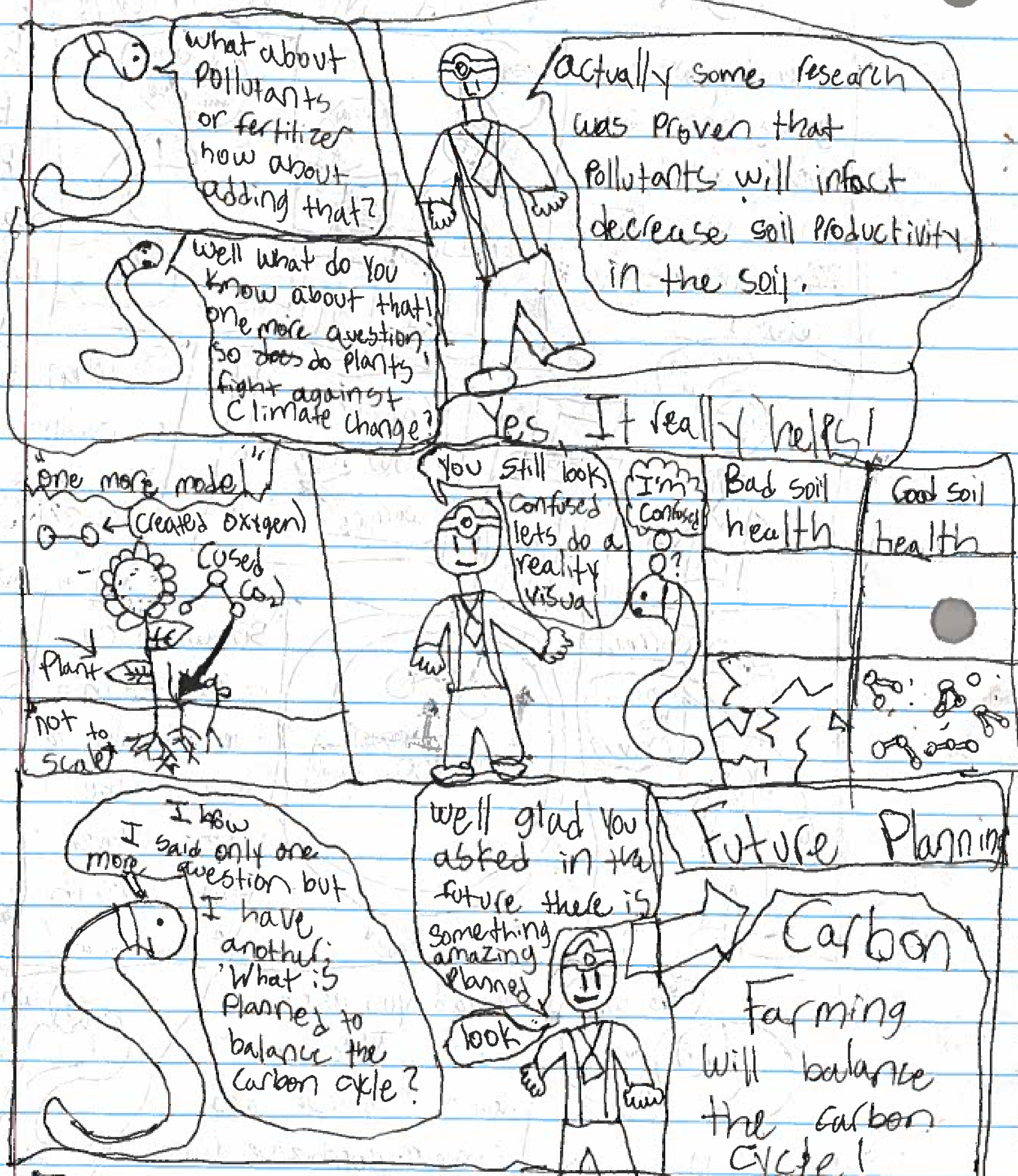
Ecybermission.com”

13. Climate Outreach

@ClimateOutreach

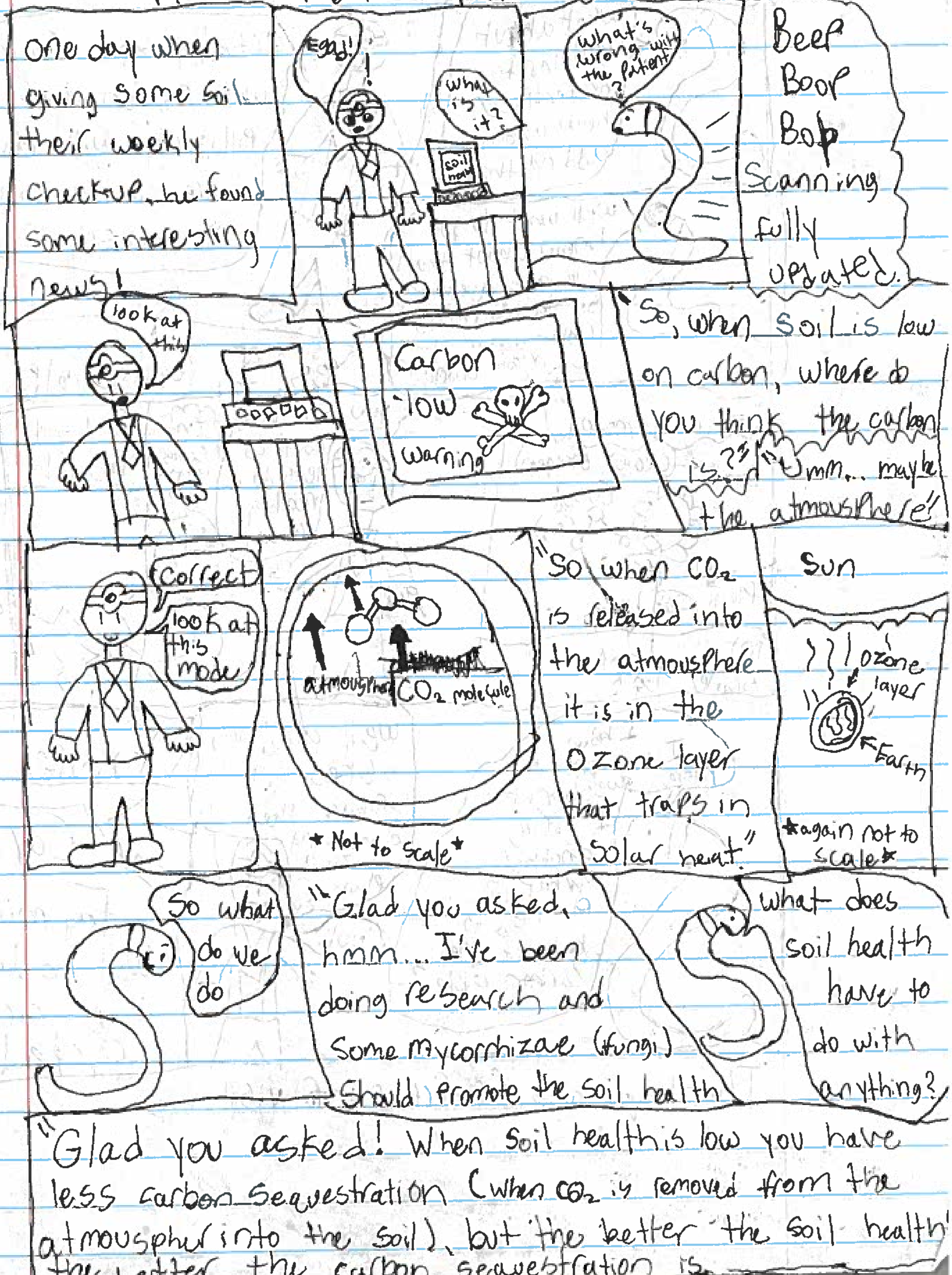
“We're a team of social scientists & communication specialists working to deepen & widen public engagement with climate change beyond the green bubble.

UKclimateoutreach.org”



Thank you and for further info visit

Dr. Soil and Mr. Nutrients



Website and Quick Response Code

Carbon Keepers created an educational website and made a QR code to link to this easily.
Please visit the site to view much of our work online.

https://thecarbonkeepers.wixsite.com/ecybermission

SCAN ME

Important Contact Information in our Global Community

I. **Lubbock, Texas, USA**

1. Lubbock MLRA Soil Survey Office (**Natural Resources Conservation Service Soils**

4613 W. Loop 289
Lubbock, TX 79414

Thomas (Craig) Byrd
MLRA Soil Survey Leader, Soil Scientist
Phone: (806) 283-9950
E-mail: craig.byrd@usda.gov

Alain Basurco
Soil Scientist
Phone: (806) 283-9949
E-mail: alain.basurco@usda.gov

Todd Carr
Soil Scientist
Phone: (806) 283-9948
E-mail: todd.carr@usda.gov

Lori McMorrough
Cartographic Technician
Phone: (806) 655-2578 (Canyon, Texas)
E-mail: lori.mcmorrough@usda.gov

2. Plains Cotton Cooperative Association (PCCA)

Corporate HQ (Mail)

P.O. Box 2827
Lubbock, TX 79408-2827

806-763-8011
https://www.pcca.com

3. PLAINS COTTON GROWERS, INC.

4517 West Loop 289, Lubbock, TX 79414

Phone: (806) 792-4904

https://www.plainscotton.org/

4. Bayer Museum of Agriculture

1121 Canyon Lake Dr.
Lubbock, TX 79403

https://agriculturehistory.org/

II. National and International

1. United States Department Of Agriculture
Https://Www.Usda.Gov/

- National Agricultural Library (NAL)

"NAL ensures and enhances access to agricultural information for a better quality of life."

https://www.nal.usda.gov/main/

- **National Agricultural Statistics Service (NASS) "**NASS serves the basic agricultural and rural data needs of the country by providing objective, important and accurate statistical information and services to farmers, ranchers, agribusinesses and public officials. This data is vital to monitoring the ever-changing agricultural sector and carrying out farm policy."

https://www.nass.usda.gov/

3. **United States Environmental Protection Agency (EPA)**

United States Environmental Protection Agency
https://www.epa.gov/

- **Agriculture and Sustainability**

https://www.epa.gov/agriculture/agriculture-and-sustainability

- **Agricultural Crops**

https://www.epa.gov/agriculture/agricultural-crops

- **Agriculture and Climate**

https://www.epa.gov/agriculture/agriculture-and-climate

- **Sustainability**

https://www.epa.gov/sustainability

4. Carbon Cycle Institute
245 Kentucky Street, Suite A
Petaluma, CA 94952
email: info@carboncycle.org
phone/text: (707) 992-5009
https://www.carboncycle.org/

5. The National Aeronautics and Space Administration (NASA)
https://climatekids.nasa.gov/carbon/
https://climatekids.nasa.gov/food/

6. United Nations (UN)
The 17 Sustainable Development Goals (SDGs)

https://sustainabledevelopment.un.org/

7. European Union Agriculture Department- Agriculture and Rural development DG AGRI develops and carries out the Commission's policies on:

https://ec.europa.eu/info/departments/agriculture-and-rural-development_en

8. **National Farmers Union**
20 F Street NW, Suite 300 | Washington, DC 20001
(202) 554-1600
https://nfu.org/

9. **Food and Agriculture Organization of UN**
http://www.fao.org/home/en/

10. **Australian Government: Departament of Agriculture, Water and the Enviroment**
https://www.agriculture.gov.au/

11. **Brazilian Agricultural Research Corporation**
Ministry of Agriculture, Livestock, and Food Supply

Parque Estação Biológica - PqEB s/nº.

Brasília, DF - Brazil - Postcode 70770-901

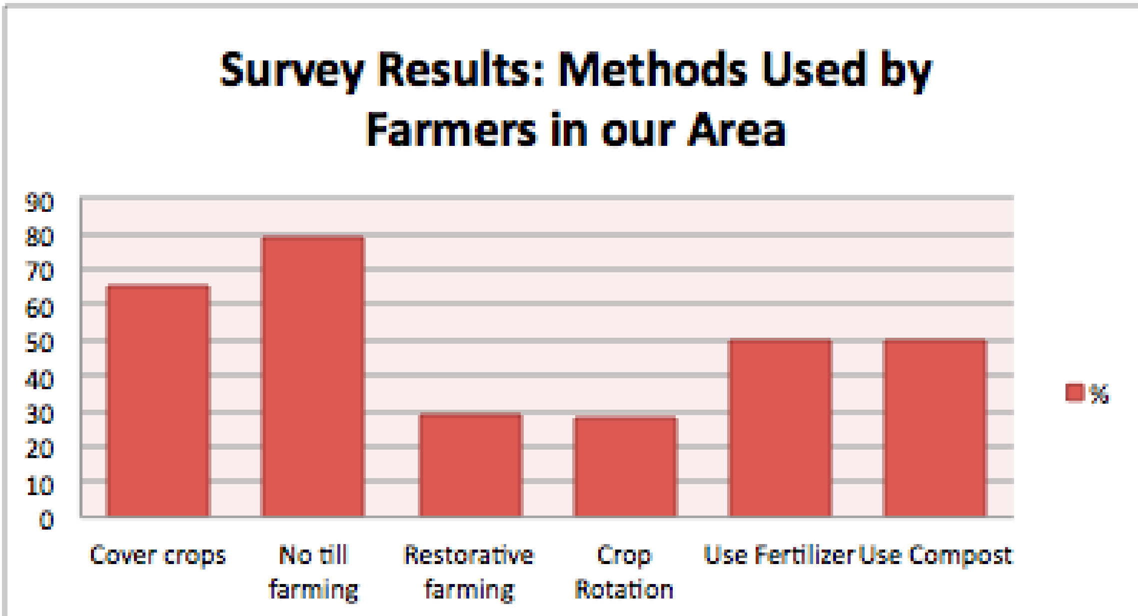
Tel: +55 61 3448-4433 - Fax: +55 61 3448-4890 / 3448-4891

https://www.embrapa.br/en/international

Survey Results

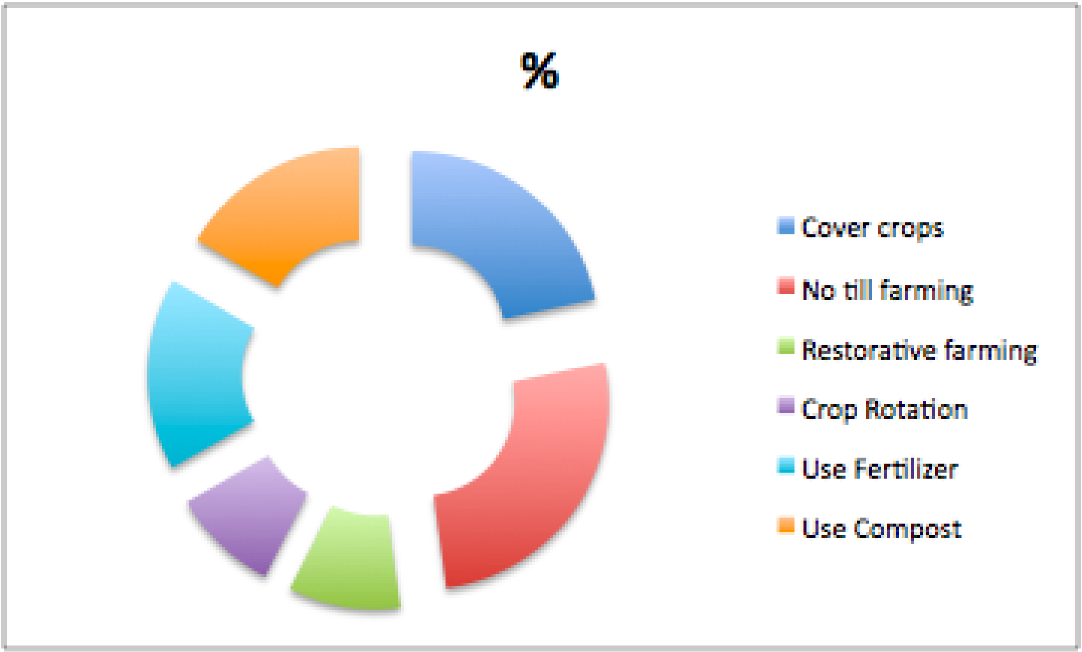
Carbon Keepers created a survey for farmers in which we looked for knowledge about climate change, how they viewed their role in the climate, what methods of mitigating carbon release they are using,

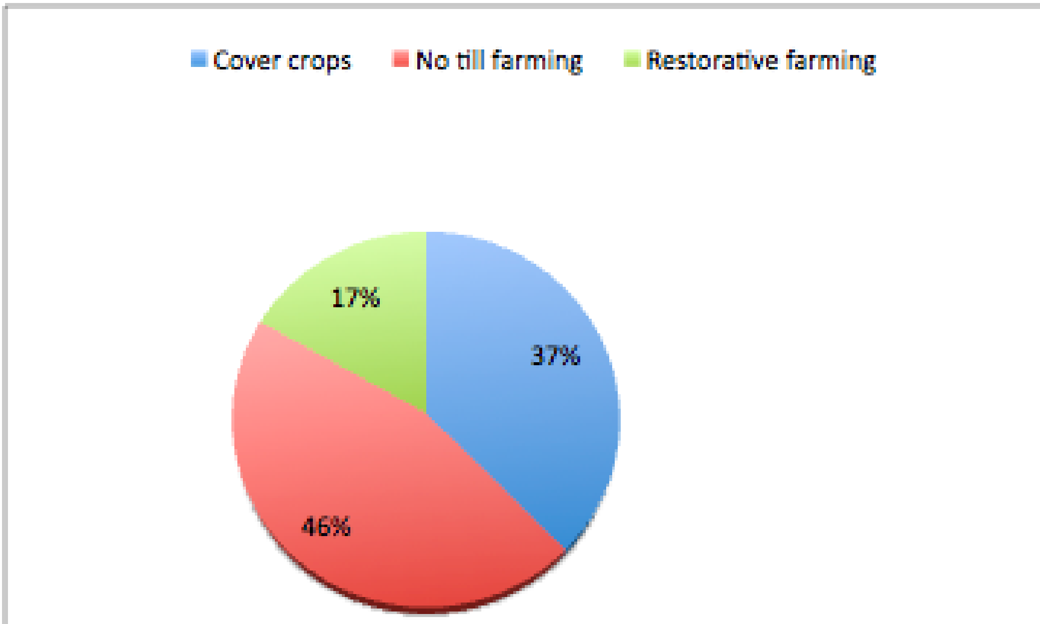
Type of mitigation	% of farmers
Cover crops	65
No till farming	79
Restorative farming	29
Crop Rotation	28
Use Fertilizer	50
Use Compost	50



While no-till farming is one of the very best ways of keeping carbon in the soil and out of the atmosphere, of the farmers who took our survey 80% report they use no-till farming. However, farm records in Texas show 30% at the most use no-till, while actual acreage counts show only 8.2% of Texas agricultural land has adopted no-till farming. This doesn't necessarily show that we can't trust the survey results, but

rather it shows that the farmers willing to take our survey report 80% using no-till systems. There is a lot of progress needed in these areas.





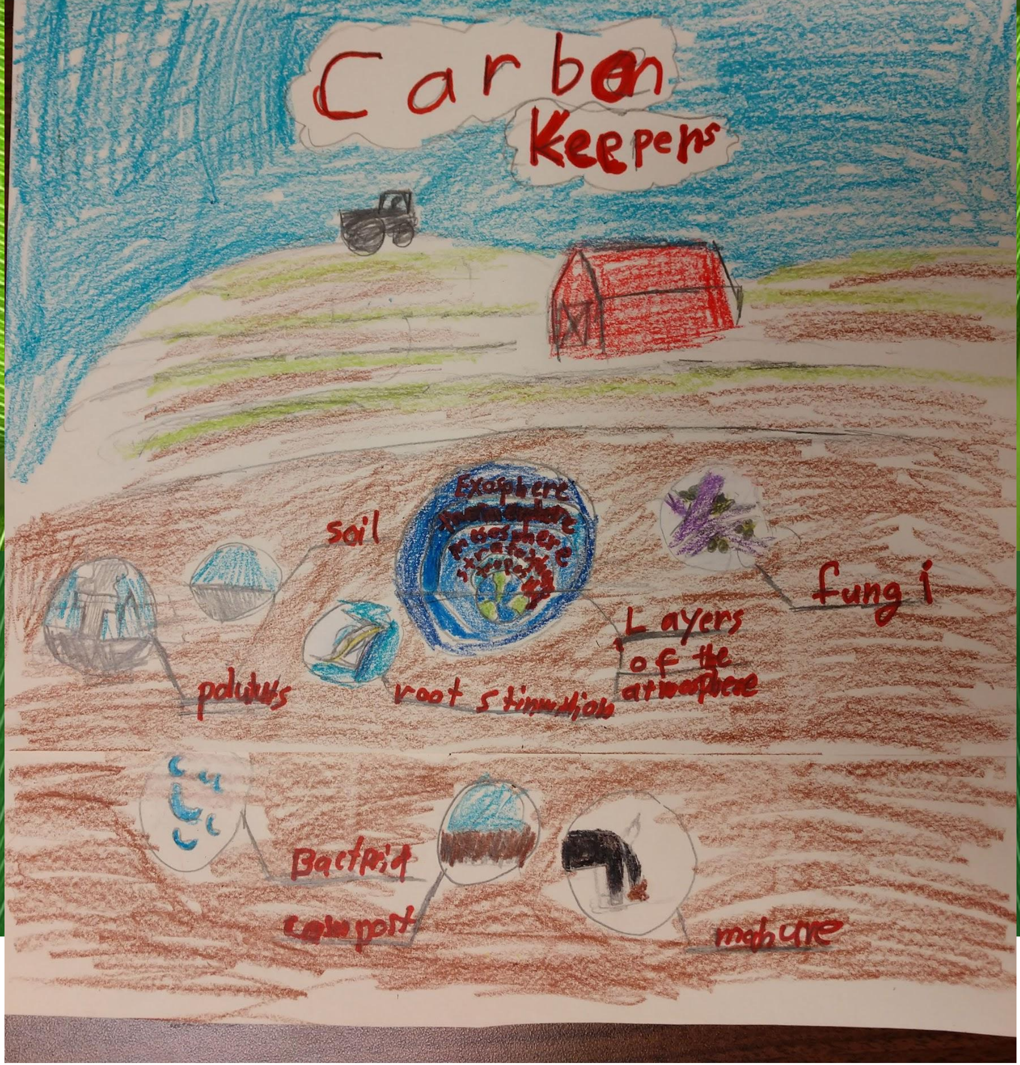
Cover crops remain a popular choice for area farmers who plant cotton in the spring/summer and then plant winter wheat for use by cattle in the late fall/winter months.

46% No-till farming is the report for these farmers who chose to take the survey but it does not represent the percent of acres in Texas using no-till farming. That percentage is actually 8.2%. (Dobberstein, July 2019)

The majority of farmers (89%) agree that the climate is changing, however they attribute these changes in climate to natural environmental causes.

Only 1% of the farmers across the South Plains of Texas believe that climate change is occurring and is caused by human activities .

One in ten farmers (10%) selected the category, "caused more or less equally by natural changes in the environment and human activities".



A poster describing the connections between the Earth and soil, atmosphere, fungi, pollutants, bacteria, and roots

No-till Texas Soil Health Symposium

February 12, 2020

Carbon Keepers

A Scientific Research Team

6th Grade * 2019-2020

We attended the ***No-Till Texas Soil Conference*** at the Overton Conference Center in Lubbock, Texas where **we were featured** by keynote speaker Dr. Natasja van Gestel because of our work to improve soil health in this region.

No-till Texas Soil Health Symposium Itinerary

No-Till Texas 3rd Annual Soil Health Symposium

Tuesday February 11, 2020

8:00 am to 8:50 am	Registration: Doughnuts and Coffee
8:50 am to 8:55 am	Welcome: Kelly Kettner, Farmer, Muleshoe, TX
8:55 am to 10:15 am	"Seeing with New Eyes: How Ecosystems are Designed to Function" Dr. John Zak, Texas Tech University
10:15 am to 10:35 am	Break
10:35 am to 11:05 am	"Economics of a Cotton/Sorghum Rotation" Barry Evans, Farmer, Kress, TX
11:05 am to 11:35 am	"Unconventional Cotton Farming" Patrick Middlebrook, Farmer, Shallowater, TX
11:35 am to 12:00 pm	Rainfall Simulator: Brandt Underwood, NRCS
12:00 pm to 1:00 pm	Lunch
1:00 pm to 2:10 pm	"Unintended Consequences" Willie Durham, Soil Health Specialist, NRCS
2:10 pm to 2:55 pm	"Growing Cotton and Multi-Species Covers in a No-Till System" Kris Verett, Farmer, Ralls, TX
2:55 pm to 3:15 pm	Break
3:15 pm to 4:30 pm	"Fundamentals of Implementing a Soil Health System" Jim Johnson, Noble Foundation

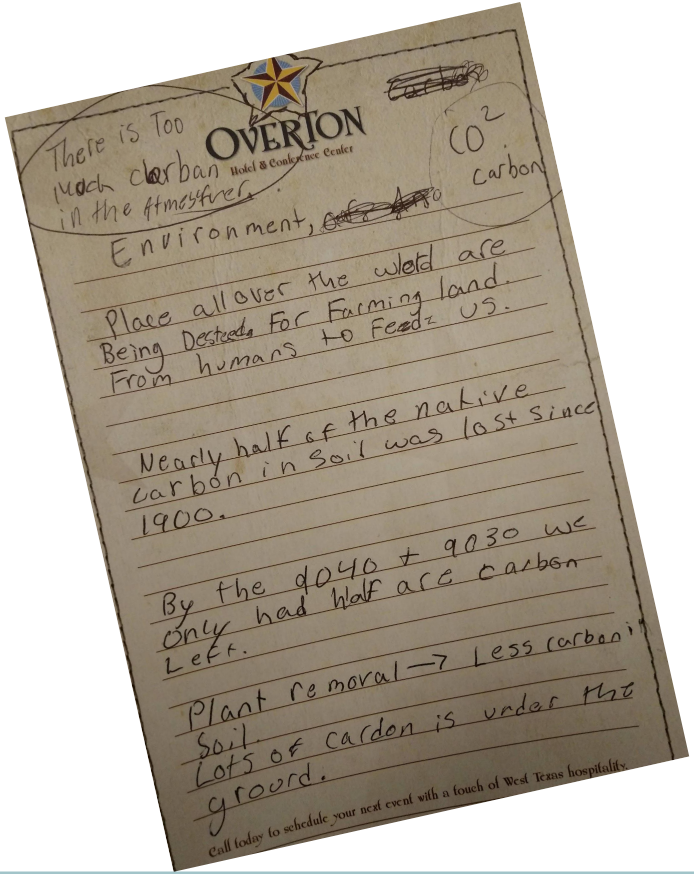
No-Till Texas 3rd Annual Soil Health Symposium

Wednesday February 12, 2020

8:30 am to 9:00 am	Doughnuts and Coffee
9:00 am to 10:15 am	"Benefits and Guidelines for Integrating Livestock into Cropping Syste Dr. Tim Steffens, West Texas A&M University
10:15 am to 10:35 am	Break
10:35 am to 12:00 pm	"How Small Things Can Have Big Consequences in the Long-Term" Dr. John Zak, Texas Tech University
12:00 pm to 1:00 pm	Lunch
1:00 pm to 1:30 pm	"High Plains Dryland Corn Production" John Reznik, Farmer, Dumas, TX
1:30 pm to 2:30 pm	"The Living Soil: The Hidden World Below" Dr. Natasja Van Gestel, Texas Tech University
2:30 pm to 2:50 pm	Break
2:50 pm to 3:20 pm	"Where's the Trash Farmer?" Ronald Meyer, Farmer, Stratford, TX
3:20 pm to 3:50 pm	"Rotation: More Than Going in a Circle" R.N. Hopper, Farmer, Petersburg, TX
3:50 pm to 4:20 pm	Speaker Panel Discussion and Closing Remarks

Partners in the Quest for Soil Carbon

Partners in the Quest for Soil Carbon



OVERTON Hotel & Conference Center

There is Too much carbon in the Atmosfrer.

~~Carbon~~

CO_2 carbon

Environment,

Place all over the world are Being Desteed For Farming land From humans to Feedz US.

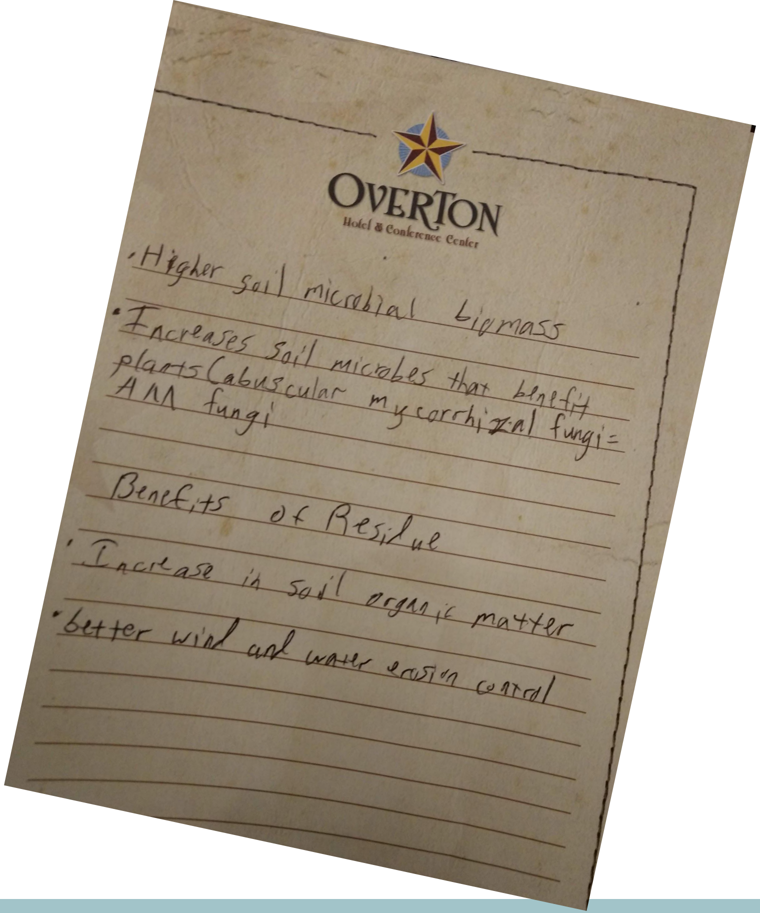
Nearly half of the native carbon in Soil was lost since 1900.

By the 2040 + 2030 we only had half are carbon Left.

Plant removal → Less carbon in Soil.

Lots of cardon is under the ground.

Call today to schedule your next event with a touch of West Texas hospitality.



OVERTON Hotel & Conference Center

- Higher soil microbial biomass
- Increases soil microbes that benefit plants (arbuscular mycorrhizal fungi = AM fungi

Benefits of Residue

- Increase in soil organic matter
- better wind and water erosion control

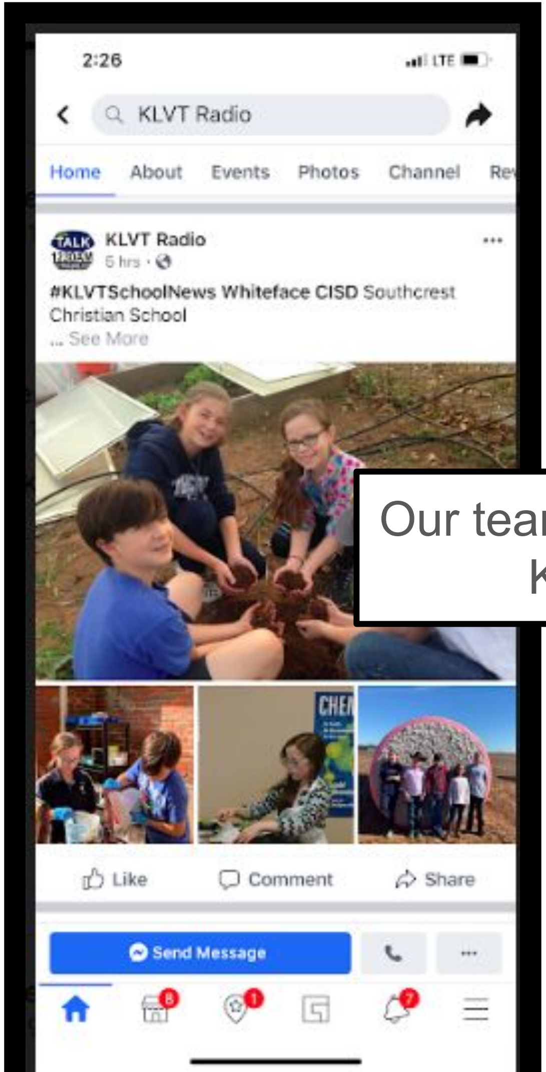
Notes from a conference session

Dr. Natasja van Gestel presenting her talk. She featured our team has **game changers** in the world of carbon and inspirational to her as young people interested in **important global issues.**

The soil conference gave us the ability to **network** and form **connections** with soil scientists from **Poland, Australia, The Netherlands**, and other places working to **increase carbon** in the soil.

Jean Anne Stratton is farmer using no-till and allowed the team to use her expertise this year and going into the future.

Mr. Neil McIver - Soil & Crop Fertility Management - offered resources and helpful advice to the team about productivity and soil health.



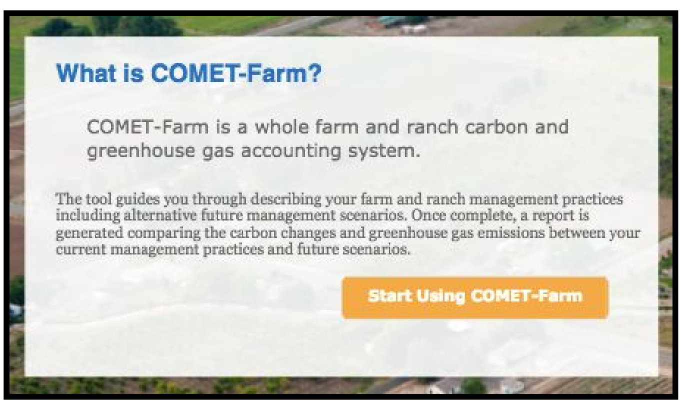
Our team was featured by KLVT Radio

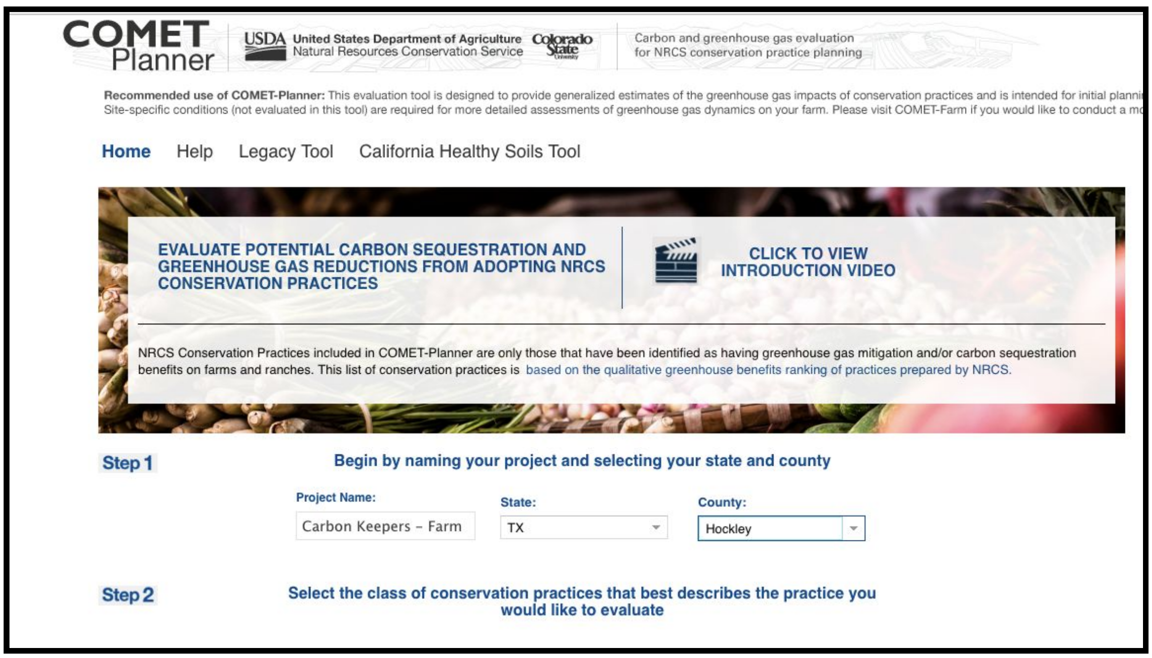
The team received media attention from radio stations, television, and newspapers. We were also featured on Facebook pages and soil health groups as well.

Farm Carbon Footprint Calculator

COMET-Farm is a whole farm and ranch carbon and greenhouse gases accounting system.

http://comet-planner.com/




COMET Planner
USDA United States Department of Agriculture Natural Resources Conservation Service
Colorado State University
Carbon and greenhouse gas evaluation for NRCS conservation practice planning
Recommended use of COMET-Planner: This evaluation tool is designed to provide generalized estimates of the greenhouse gas impacts of conservation practices and is intended for initial
Site-specific conditions (not evaluated in this tool) are required for more detailed assessments of greenhouse gas dynamics on your farm. Please visit COMET-Farm if you would like to conduct a
Home
Help
Legacy Tool
California Healthy Soils Tool
EVALUATE POTENTIAL CARBON SEQUESTRATION AND GREENHOUSE GAS REDUCTIONS FROM ADOPTING NRCS CONSERVATION PRACTICES
CLICK TO VIEW INTRODUCTION VIDEO
NRCS Conservation Practices included in COMET-Planner are only those that have been identified as having greenhouse gas mitigation and/or carbon sequestration benefits on farms and ranches. This list of conservation practices is based on the qualitative greenhouse benefits ranking of practices prepared by NRCS.
Step 1
Begin by naming your project and selecting your state and county
Project Name:
Carbon Keepers – Farm
State:
TX
County:
Hockley
Step 2
Select the class of conservation practices that best describes the practice you would like to evaluate


Step 1
Begin by naming your project and selecting your state and county
Project Name:
Carbon Keepers- Whitef
State:
TX
County:
Lubbock
Step 2
Select the class of conservation practices that best describes the practice you would like to evaluate
Cropland Management
Grazing Lands
Woody Plantings
Cropland To Herbaceous Cover
Restoration Of Disturbed Lands
Step 3
Select a NRCS Conservation Practice Standard and a Practice Implementation that best describes your system. You may add multiple practices. If you would like to add a practice under a different class of practices, return to Step 2.
Conservation Practice Standard (CPS)
Conservation Crop Rotation (CPS 328)
Cover Crop (CPS 340)
Mulching (CPS 484)
Conservation Practice Implementation
Add Legume Seasonal Cover Crop to Irrigated Cropland
Add Legume Seasonal Cover Crop to Non-Irrigated Cropland
Add Non-Legume Seasonal Cover Crop to Irrigated Cropland
Add Non-Legume Seasonal Cover Crop to Non-Irrigated Cropland

COMET-Planner Carbon Sequestration and Greenhouse Gas Estimation Report

Project Name: Carbon Keepers Contact -New Mexico Grazing Farm

State: NM

County: Quay

Date Created: 2/24/2020 5:15:05 PM

	Enter Acreage	**Carbon Dioxide**	**Nitrous Oxide**	**Methane**	**Total CO_2-Equivalent**
NRCS Conservation Practices					
Cover Crop (CPS 340) - Add Legume Seasonal Cover Crop to Irrigated Cropland	350	79	-30	0	49
Residue and Tillage Management - No-Till (CPS 329) - Reduced Till to No Till or Strip Till on Irrigated Cropland	350	110	9	0	119
	Total	189.00	-21.00	0.00	168.00

1Negative values indicate a loss of carbon or increased emissions of greenhouse gases

2Values were not estimated due to limited data on reductions of greenhouse gas emissions from this practice

For more information on how these estimates were generated, please visit www.comet-planner.com.

COMET-Planner Carbon Sequestration and Greenhouse Gas Estimation Report

Project Name: Carbon Keepers - Contact Farm
State: NM
County: Quay
Date Created: 2/24/2020 6:16:09 PM

	Enter Acreage	Carbon Dioxide	Nitrous Oxide	Methane	Total CO_2-Equivalent
NRCS Conservation Practices					
Residue and Tillage Management - No-Till (CPS 329) - Reduced Till to No Till or Strip Till on Irrigated Cropland	350	110	9	0	119
	Total	110.00	9.00	0.00	119.00

1Negative values indicate a loss of carbon or increased emissions of greenhouse gases
2Values were not estimated due to limited data on reductions of greenhouse gas emissions from this practice

For more information on how these estimates were generated, please visit www.comet-planner.com.

COMET-Planner Carbon Sequestration and Greenhouse Gas Estimation Report

Project Name: Carbon Keepers Contact -New Mexico Grazing Farm
State: NM
County: Quay
Date Created: 2/24/2020 5:33:39 PM

	Enter Acreage	Carbon Dioxide	Nitrous Oxide	Methane	Total CO_2-Equivalent
NRCS Conservation Practices					
Critical Area Planting (CPS 342) - Restore Highly Disturbed Areas by Planting Permanent Vegetative Cover	150	157	0	N.E.2	157
	Total	157.00	0.00	0.00	157.00

1Negative values indicate a loss of carbon or increased emissions of greenhouse gases
2Values were not estimated due to limited data on reductions of greenhouse gas emissions from this practice

For more information on how these estimates were generated, please visit www.comet-planner.com.

COMET-Planner Carbon Sequestration and Greenhouse Gas Estimation Report

Project Name: Carbon Keepers - Farm in Whiteface
State: TX
County: Hockley
Date Created: 2/24/2020 5:45:16 PM

	Enter Acreage	Carbon Dioxide	Nitrous Oxide	Methane	Total CO_2-Equivalent
NRCS Conservation Practices					
Residue and Tillage Management - No-Till (CPS 329) - Reduced Till to No Till or Strip Till on Irrigated Cropland	150	60	4	0	64
	Total	60.00	4.00	0.00	64.00

1Negative values indicate a loss of carbon or increased emissions of greenhouse gases
2Values were not estimated due to limited data on reductions of greenhouse gas emissions from this practice

For more information on how these estimates were generated, please visit www.comet-planner.com.

COMET-Planner Carbon Sequestration and Greenhouse Gas Estimation Report

Project Name: Carbon Keepers - Contact Farm
State: NM
County: Quay
Date Created: 2/24/2020 6:18:14 PM

	Enter Acreage	Carbon Dioxide	Nitrous Oxide	Methane	Total CO_2-Equivalent
NRCS Conservation Practices					
Critical Area Planting (CPS 342) - Restore Highly Disturbed Areas by Planting Permanent Vegetative Cover	150	157	0	N.E.2	157
	Total	157.00	0.00	0.00	157.00

1Negative values indicate a loss of carbon or increased emissions of greenhouse gases
2Values were not estimated due to limited data on reductions of greenhouse gas emissions from this practice

For more information on how these estimates were generated, please visit www.comet-planner.com.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6
C
carbon
Keepers

The Effects of Climate Change in our Community and Yours

Research has indicated that climate change has affected agriculture in the USA. Rain patterns and greater incidence of extreme weather events are modifying crop production. One example is the periods of long drought in our area.

Research, however, suggests it may be the other way around! What if agriculture holds the secret for holding onto carbon and keeping it out of our atmosphere?

Agriculture is affecting climate change. According to U.S. Environmental Protection Agency, agriculture and forestry were responsible for 9.0 percent of United States greenhouse gas emissions in 2017, and globally 13.5 % of these gases are directly related to agriculture, with 17% due to land-use change. This sector holds a large mitigation potential -- mainly through reduced deforestation, soil management and increased productivity.

Agriculture is both part of the problem but *also* the best hope for a solution.

Source: USDA
U.S. EPA Inventory

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Global Goals: UN Sustainable Development

Image: UN

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Motivation behind selecting climate change prevention.

Our team selected the issue of increased greenhouse gases in the atmosphere due to our connection with the environment. The area where we live depends on 5 major industries:

1. Agricultural Farms;
2. Agricultural Ranches;
3. Dairies;
4. Oil Production; and
5. Natural Gas Production.

Each of these greatly impact the air and climate through the release of greenhouse gases.

Greenhouse gases that are connected with agriculture

	Atmospheric lifetime (years)	Global Warming Potential (GWP)
Nitrous oxide (N_2O)	114	310
Carbon dioxide (CO_2)	100	1
Methane (CH_4)	12	21

Climate change through the action plan.

- Our team studied ways to mitigate greenhouse gas emissions in agriculture.
- We addressed the problem using perennials, manure, and cover crops.
- The world population is expected to grow to 9 billion by 2050, and agricultural production should also increase by an estimated 70 percent otherwise the world will be in a tremendous problem.
- Using the UN's "Sustainable Goals", we addressed the number 13 goal of climate action. In addition, goals 2 and 12 will have initial impact through our project as agriculture will be impacted and more food produced. Agriculture, climate change, food security and poverty reduction are all linked.

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PART 2 ~ *Step by step Actions to Address the Problem*

SEPTEMBER

1. Shared ideas for project on climate change.
2. Created goals and budget.
3. Formed a team schedule for a December submission to EcoChallenge.
4. Took a personal skills inventory to help refine roles as individuals on a team.
5. Created a Google account to share work with our team.
6. Decided on a plan of action.

OCTOBER

1. Created a task list and deadlines.
2. Conducted research.
3. Conducted interviews with experts.
4. Developed proposal to decrease greenhouse gases.
5. Met with Texas Tech University professors to assess theories.
6. Conducted a series of scientific experiments to test our hypotheses.

NOVEMBER

1. Created data tables and graphs.
2. Analyzed data to quantify results of carbon sequestration experiments.
3. Reached out to community organizations with information for the farming groups.
4. Reached out to government agencies with results and solutions in our city.
5. Developed our social media exposure through a website and social media.
6. Provided information to the media for interviews.

DECEMBER

1. Developed education campaign for land use professionals.
2. Conducted hands-on education for farmers and ranchers.
3. Taught children about climate change and agricultural impact.
4. Presented to community service groups.
5. Continued to survey individuals and farmers.

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Goals for bringing the action plan to life

How will your team measure success?

- Carbon being sequestered in the soil and kept from being released into the atmosphere as greenhouse gases.
- Crop production methods will be analyzed to determine which best holds onto carbon.
- Productivity is a measure of the decrease in emissions.
- When local farmers adopt methods to hold carbon.

Carbon Farming

Implementing practices that improve the rate at which CO2 is removed from the atmosphere and converted to organic matter.

Land management is among the largest contributors to climate change. Agriculture is the <u>ONE</u> sector that has the ability to transform from a net emitter of CO2 to a net sequesterer of CO2. There is no other human- managed realm with this potential.

How will you quantify impact?

- Data collection and multiple test runs will be used to quantify the role soil can play in decreasing greenhouse gas emissions.
- Education and events to inform farmers and those directly involved with land use measure impact.
- Surveys allow for determining the percentages of people preventing gas emissions and improving climate change as individuals.

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The link between **AIR** and **SOIL** underneath your feet can improve climate change and decrease carbon in our **ATMOSPHERE.**

Instead of thinking of AIR, LAND, and WATER separately, we began to look at how SOIL could be the answer to climate change!

"What would life be like if we had no courage to attempt anything?"
Vincent van Gogh

Raising Community Awareness

- PSA
- Email campaign
- Seminars with farmers
- Social media presence
- Radio spots
- News coverage
- Agricultural events
- Survey distribution

USDA United States Department of Agriculture

NRCS Natural Resources Conservation Service

U.S. FISH & WILDLIFE SERVICE DEPARTMENT OF THE INTERIOR

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

SOUTHCREST CHRISTIAN SCHOOL

NOAA

Outreach to area farmers was key to implementation!

Raising Expert Awareness

- Provided information to dairy managers;
- Developed brochures for ranchers;
- Held seminars with farmers;
- Wrote agricultural blog posts;
- Created outreach for 10 counties;
- Partnered with government agencies: NRCS, USDA, USFWS, NOAA, EPA;
- Seeking legislative action;
- Contacted city & county leaders;
- Held school wide events; and
- Reached over 50,000 with our message during blitzes.

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PART 3 ~ Implementation: How did you implement your ideas?

Partnerships with Local Organizations

Carbon Keepers worked with many varied local organizations to decrease climate change in our community. These include:

- **Texas Tech University**
- **Natural Resource Conservation Service**
- **Bayer Museum of Agriculture**
- **Public Libraries**
- **City of Lubbock Municipal Government**
- **Whiteface City Hall**
- **Cochran County Soil and Water District**
- **Science Spectrum**

Composting Tests

Partnerships with Environmental Groups, Government Agencies, Schools, and Clubs

Carbon Keepers worked with amazing people to fight climate change. These include:

- **Future Farmers of America -** distributed brochures and encouraged national projects with topics aligned to climate issues.
- **City of Whiteface Alderman and Mayor -** asked for support throughout the community.
- **Muleshoe National Wildlife Refuge -** focused on mitigation against climate change.
- **Southcrest Christian School -** newsletters spread the word to 150 families.
- **Science Rocks U STEM Club -** built awareness among middle school students.

What we did to decrease greenhouse gases:

- **Advised 25 farm families on emissions based on post-harvest activities**
- **Collected different soil types from farms in our area and tested with different compost**
- **Increase the amount of carbon matter in the soil with higher concentration of organic composting**
- **Reached land use audiences in 9 counties**
- Used farming methods to sequester carbon

We got the word out and educated others about climate change and the difference others can make for the good of us all.

- Facebook - 400 likes (https://www.facebook.com/soilsolutionforclimatechange/)
- Instagram @carbon keepers
- Twitter #carbon-keepers
- News Blasts - in 3 languages, 2 universities
- Website - 234 visitors
- QR Code on Posters - in 5 communities
- Public Service Announcements (PSA)
- YouTube Video
- Blog Posts on the EPA website - whoop!
- Press Releases
- Community Meetings
- School Events - reached **40 4th graders** with the message of climate + soil

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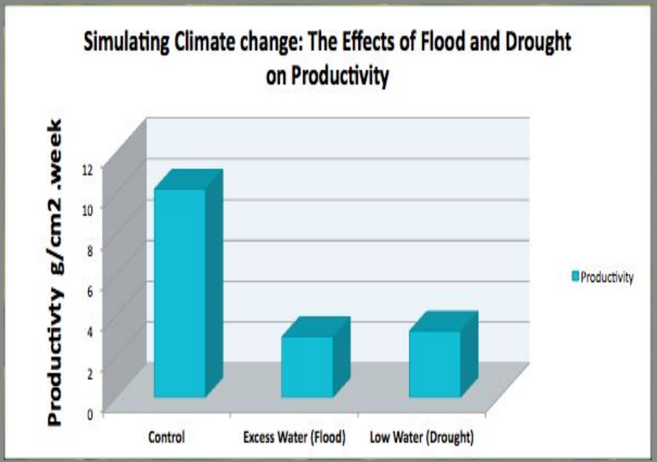
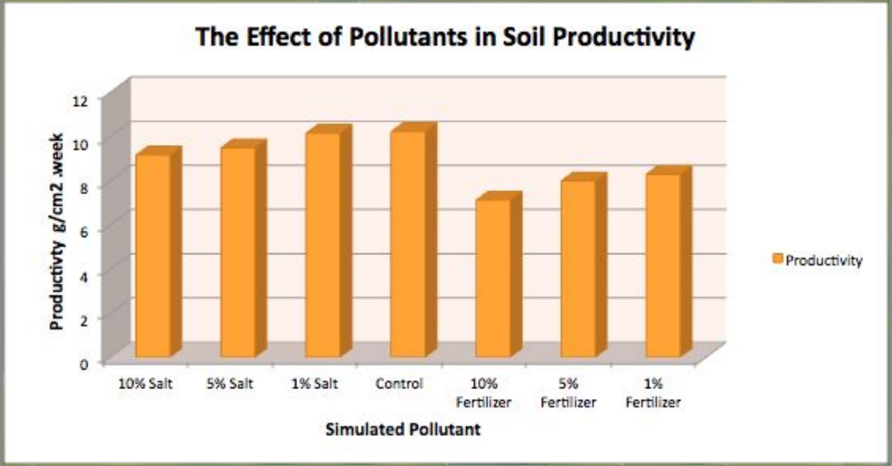
Quantifiable Results

- Since primary productivity fell significantly in both drought and flood conditions, we can conclude that biomass decreased 60%in these plots.
- Carbon is sequestered in soil during times of mild, not extreme, rainfall.





- The plants treated with salt and fertilizer were less productive than the control plots, resulting in less biomass.

Agriculture and innovative farming methods are holding carbon in soil.

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Overcoming Challenges

- Our part of Texas had less than 2% of farmers using methods to sequester carbon before our action plan.
- Many generational farmers said they "do not believe in climate change" so it was a great victory to see *attitudes* change.
- Experiments were able to show and PROVE to landowners that *agriculture can greatly decrease the amount of GHG* released into the atmosphere.
- The link between air, climate and the soil is clear. The challenge was getting the message out that *THIS IS A CLIMATE PROJECT* - not a land project.
-

Keeping carbon in the soil and out of the atmosphere by encouraging *1,500 land use experts* in the state to adopt the following methods of carbon farming for the purpose of :

- ❖ **Zero tillage farming.**
- ❖ **Leave or spread crop remains in fields after harvest.**
- ❖ **Use manure composting.**
- ❖ **Include perennials in crop rotations.**
- ❖ **Bring in grazing lands and legumes.**
- ❖ **Restore and maintain wetlands.**
- ❖ **Plant cover crops.**
- ❖ **Maintain covered manure storage .**

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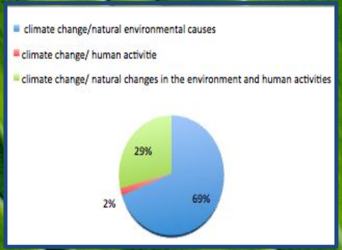
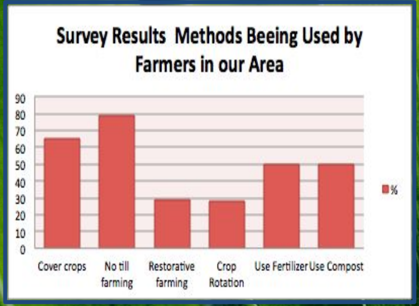
Farmers and Climate Change survey

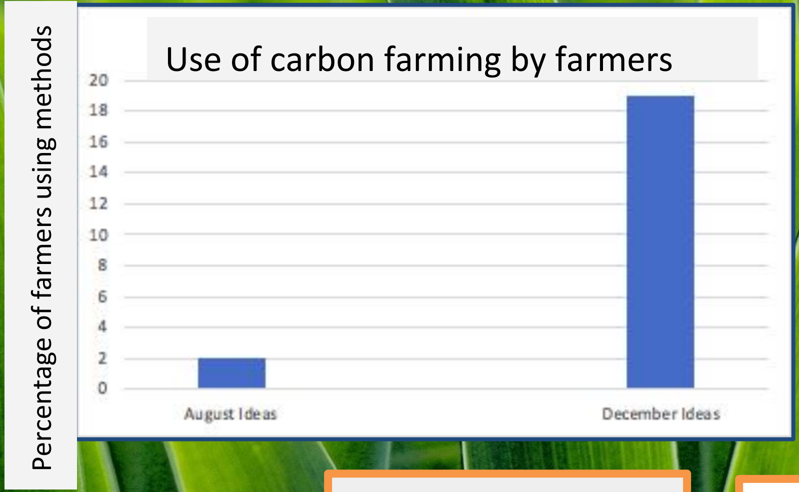
- The majority of farmers (69%) agree that the climate is changing, however they attribute these changes to natural environmental causes.
- Only 2% of the farmers across South Plains, Texas believed that climate change is occurring and is caused by human activities .
- One in ten farmers (29%) selected the category, “caused more or less equally by natural changes in the environment and human activities”.





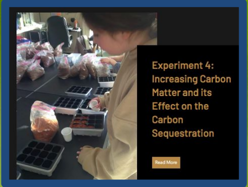
Incredible Results !

After the Carbon Keepers campaign and blitz of information throughout the community, we saw CONSIDERABLE change in attitudes towards personal responsibility in fighting climate change!



PART 5 ~ Project Gallery

Please visit our website for details - https://thecarbonkeepers.wixsite.com/website/



Carbon Keepers are featured online and on the radio through local KLVT radio station with Tania Moody - Texas Radio Broadcaster of the Year! This gives our message a wide audience with a respected leader in state radio broadcasting!

Holding carbon within the Earth results in larger roots and less greenhouse emissions into the atmosphere

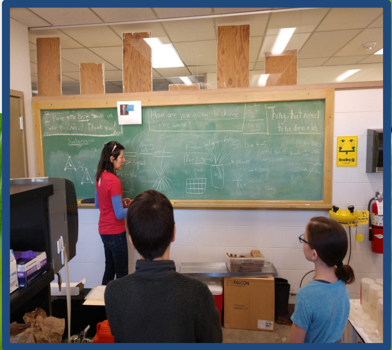
We conducted multiple experiments linking decreased carbon in the air to carbon sequestration in the soil

Working with scientists

Writing children's' books

Making videos

Recording PSA



Climate change solutions are inextricably linked to the soil and its ability to hold carbon

Community organizations and leaders in climate change email us at our address for information:

thecarbonkeepers@gmail.com

Instagram Link ----

#carbon-keepers

https://thecarbonkeepers.wixsite.com/ecybermission

Our website has TONS of information about all aspects of our project to fight climate change.

The Carbon Keepers were featured in the regional newspaper for their work on climate change!

Our contributions to impact climate change are posted on the EPA site and we were nominated for the President's Environmental Youth Award!

https://www.facebook.com/soilsolutionforclimatechange/

Visit our Facebook page to like our story and follow our project!

Twitter Feed --- Check us out!

@carbon keepers

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TEXAS TECH

Natural Resource Conservation Service is a major community partner recognizing that climate's best chance may just be in the soil underneath your feet!

NRCS

Survey results collected for marketing purposes

CLIMATE ACTION

Aligning our goals with the UN means a more powerful impact for ALL of us!

Community partnerships include government agencies, local farmers, climate activists, Texas Tech University professors, regional ranchers, mayors, city councilmen, and municipal organizations.

SCAN ME

A QR code is a fast and easy way to reach us and see our message

Posters hung to educate others about the importance of climate change

Using sites like we.org allows us to raise money for sustainable changes towards a better future and FIGHT CLIMATE CHANGE beyond our community.

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Global Connections Map

aeop ARMY EDUCATIONAL OUTREACH PROGRAM | eCYBERMISSION ACCEPT THE CHALLENGE | U.S. ARMY

eCYBERMISSION Survey Approval Form**

eCYBERMISSION team name: Carbon Keepers

Team Advisor name: Laura Wilbanks

Team Advisor email: sciencerocks4@yahoo.com

Team Advisor phone: 806-797-7400

Student usernames: Barrelracer1, 12212n, wonderwoman

School name: sciencerocks4@yahoo

School address: 2030 Buffalo Drive Levelland, TX 79336

Describe the survey your team will conduct:

We will survey farmers to see what they think makes soil healthier.

Describe the participants you plan to distribute your survey to:

We will serve farmers 18 years and older. Survey on survey monkey for learning from career land managers.

Project approved by school administration?

☑ Yes ☐ No

Approved by: Susie Driscoll

Title: Principal

Date approved: 08-20-19

Signature, School Administrator: Susie Driscoll

*Please have form completed, signed and dated BEFORE surveys are administered.

**As of August 2017, an IRB approval form (below) must be completed for all surveys as well as the information requested above.

AEOP ARMY EDUCATIONAL OUTREACH PROGRAM | eCYBERMISSION ACCEPT THE CHALLENGE | U.S. ARMY

INSTITUTIONAL REVIEW BOARD

APPROVAL FORM

Student(s) User Name(s): Barrelracer1 ~~whatisyourname~~ wonderwoman ~~Orangetrump58~~ 1221zn

Grade: 6th **Team Advisor:** Laura Wilbanks

Team Name: Carbon Keepers

Brief Description of Project:

We are trying to figure out how to keep carbon in the soil.

Team Advisor: Please sign here if the project proposed is a viable eCYBERMISSION Project in which neither animals nor humans will be harmed.

Team Advisor Approval Signature: Laura Wilbanks **Date:** 08-20-19

IRB Waiver of Written Informed Consent for Human or Animal Participation

The IRB may waive the requirement for documentation of written informed consent/assent/parental permission if the research involves **only minimal risk** *and* **anonymous data collection** *and* **if it is one of the following**: (NOTE: This statement only applies to providing the written certification mentioned in 1a or 2a above).

- Research involving normal educational practices.
- Research on individual or group behavior or characteristics of individuals where the researcher does not manipulate the subjects' behavior and the study does not involve more than minimal risk.
- Surveys, questionnaires, or activities that are determined by the IRB to involve perception, cognition, or game theory and do NOT involve gathering personal information, invasion of privacy or potential for emotional distress.
- Studies involving physical activity where the IRB determines that no more than minimal risk (Daily Activity) exists and where the probability and magnitude of harm or discomfort anticipated in the research are not greater than those ordinarily encountered in DAILY LIFE or during performance of routine physical activities.

If there is any uncertainty regarding the appropriateness of waiving written informed consent/assent/parental permission, it is strongly recommended that documentation of written informed consent/assent/parental permission be obtained.

HUMAN or ANIMAL SUBJECTS
Permission Slips needed? (see above to determine) Yes ☐ No ☑ **(Scan and attach slips to Mission Folder)**
Check-up of Human or Animal Subjects required by Doctor, school nurse or Veterinarian? (see above to determine) Yes ☐ No ☑ **If yes, Doctor's, Nurse's or Veterinarian's (before and after experimentation) current evaluation report must be attached to Mission Folder.**

APPROVALS –

[signature] — Principal / Administrator Signature — 08-20-19 Date Reviewed

T. [signature] RN BSN — Doctor or Medical Professional Signature — 08-20-19 Date Reviewed

Michael [signature] — 082019