Fall 2021

Soils Project

Angela Maligaya

Soils Project

Angela Maligaya
Dr. Carlson
FA21 CHE-141-404H

Sapling in Hand; PowerPoint, Microsoft Office, version 2110, Microsoft, 2021.

Topic

Global Food Demand & Agriculture Intensification

I researched global food demand and the different ways to practice sustainable farming and agriculture. If we are to live on this planet, we must control our agricultural and food habits as our populations grow and as time passes by.

THIS IMPACTS YOU.

Whether you are still alive by 2050 or if you plan on having kids, you must to wonder: will I still have a home and food during that time? What will the world be like then? Will we have recovered from the deadly mistakes that our parents, grandparents, and ancestors made?

Societal Impact

We must eat food in order to survive. Where and how we get our food is important to understanding the social, environmental, and financial implications of our eating habits. My article speaks on how the global crop per capita demand continues to rise, meaning the richer we get, the more food we will demand. As we all hope to get richer (post-college), statistics show that our demand for food will rise; and so will our environmental impacts (Tilman et al. 20260-20264, S1-S8).

All-American Meal; PowerPoint, Microsoft Office, version 2110, Microsoft, 2021.

Fields and Mountains; PowerPoint, Microsoft Office, version 2110, Microsoft, 2021.

Words to Know

Agricultural Extensification

Continuing our agricultural habits; clearing land for farming/crop use and animal grazing.

Agricultural Intensification

Improving our agricultural habits; finding new ways to get higher crop yield and variety with as little environmental impacts as possible.

(Tilman et al. 20260-20264, S1-S8)

What would you choose: easy or efficient?

“Global food demand and the sustainable intensification of agriculture” proposes 2 alternative answers to the issue of rising per capita demand for crops from 2005 to 2050: production either increases agriculture extensificaton or intesification. Should we take the easy way out by continuing our unsustainable habits or change the flawed system and create a sustainable, efficient agricultural process. (Tilman et al. 20260-20264, S1-S8)

Fields; PowerPoint, Microsoft Office, version 2110, Microsoft, 2021.

There is a global issue regarding our food growing and eating habits.

- *Using an already existing database that collects political, economic, agricultural, and climactic data, crop demand and yield patterns and trends were analyzed to estimate the per capita demands of crop by 2050.*
- *They compared the crop demand for richer nations vs. the crop demand for poorer nations based on caloric yields and protein yields. The food/crop per capita demand is rising, where the global demand is and will continue increasing at a staggering 100%-110% from 2005 to 2050.*

“

(Tilman et al. 20260-20264, S1-S8)

If we continue the agricultural habits we have now (e.g., increasing food and crop demand in richer nations and actively making space for farmlands in poorer nations), the damage will continue exponentially growing. (Tilman et al. 20260-20264, S1-S8)

Deforestation; PowerPoint, Microsoft Office, version 2110, Microsoft, 2021.

Fossil Fuel Emission; PowerPoint, Microsoft Office, version 2110, Microsoft, 2021.

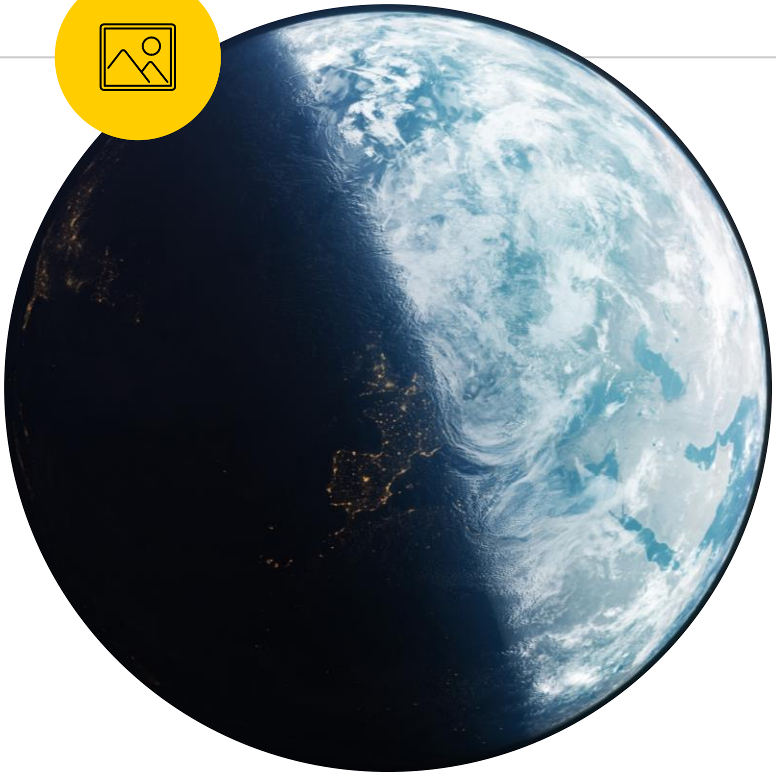
But if we modify and moderate our habits, such as efficiently working with the crop lands we have now and improving accessible and farming technology, we could see large declines in CO_2 emissions and overall greenhouse gas emissions. (Tilman et al. 20260-20264, S1-S8)

Woman Hoeing Field; PowerPoint, Microsoft Office, version 2110, Microsoft, 2021.

Community Gardening; PowerPoint, Microsoft Office, version 2110, Microsoft, 2021.

Switching to more sustainable management practices is our best bet for reducing, or rather, slowing down, the effects and impacts of climate change. We must use the designated farmlands we have now and make realistic plans as to how to enhance their use and how to yield more crops over time, rather than cutting down and clearing space for new crop land. (Tilman et al. 20260-20264, S1-S8)

Biodome Farming; PowerPoint, Microsoft Office, version 2110, Microsoft, 2021.



Earth; PowerPoint, Microsoft Office, version 2110, Microsoft, 2021.

So…What do we do now with all this information?

We must improve the state of the poorer nations and implement agricultural intesitification. This will allow the poorer nations to provide and receive adequate food supplies while decreasing greenhouse gas emissions (since more efficient agricultural processes will be used). This will ultimately impact the consequences for richer nations as well, for the better. (Tilman et al. 20260-20264, S1-S8)

Experimental Research

I chose my backyard and front yard gardens. I was interested in finding out how similar they are since they grow life into the world. My backyard garden grows vegetables and the front yard garden grows flowers and bushes. How can soil that grows life differ from another group of soil that grows different life?

Dana Silt Loam

From the Soil Sampling Lab, I found that both the front yard and backyard gardens are dana silt loam. Their physical appearances were different, though. Backyard soil was dry, had lots of weeds/roots, and got darker in color the deeper I dug. The front yard had lots of rocks, was more moist, and had a consistent dark brown color all throughout. It’s important to note that it rained the night before soil collection. After a week of drying, the backyard soil had more small twigs/roots and styrofoam-like balls.

BACKYARD GARDEN

Panorama of my backyard garden (after harvest, prior to digging)

The spot I dug into (with nearest surroundings)

The spot I dug into (the greater surrounding area included)

The hole that I dug into. You can't really tell, but on the right-hand side of the picture I struggled with digging through that patch because it was very hard (not like a rock, more like clay-ish)

Panorama of my front yard garden (beginning of September)

The spot that I dug up. Surrounded by lots of rocks.

Backyard Garden Soil laid out to dry (light brown)

Front Yard Garden Soil laid out to dry (dark brown)

The spot I dug into (with nearest surroundings). As you can see, it is surrounded by an array of living and nonliving things (rocks, weeds, mulch, etc.)

FRONT YARD GARDEN

Front yard vs. Backyard Values

KEY
Soil Texture & pH/EC Lab values
K Analysis Lab values
P Analysis Lab values
POXC Experiment & Calculations Lab values
Microbial Activity Titration Lab values

Front Yard Garden

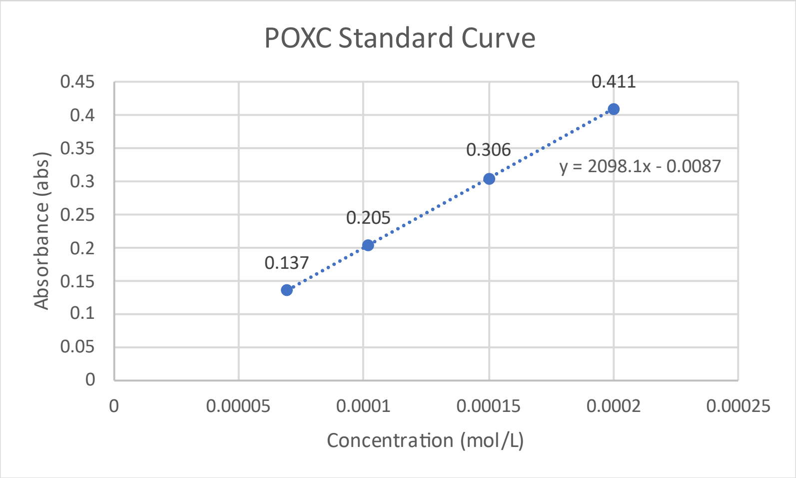
% clay = 34. %
% sand = 23. %
% silt = 43. %
pH value = 8.42 pH
EC value = 194.8 µS
502 lb K/acre
P concentration = 0.950 ppm
19.0 lbs P/acre
0.102 abs
1100 mg RC/kg soil
$14.1 \frac{mg\ CO_2}{kg\ soil \times days}$

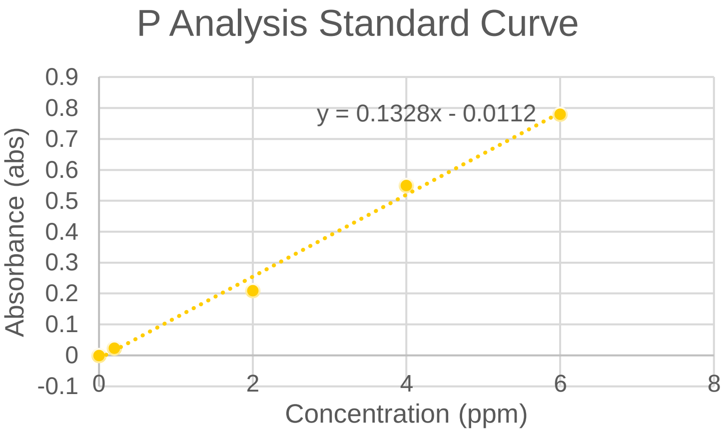
Clay Loam (soil texture)
23.5 degrees C
Above Optimum K levels
Very low P concentrations (grass)

Backyard Garden

% clay = 35. %
% sand = 21. %
% silt = 44. %
pH value = 8.38 pH
EC value = 659 µS
1010 lb K/acre
P concentration = 1.08 ppm
21.6 lbs P/acre
0.069 abs
1200 mg RC/kg soil
$54.6 \frac{mg\ CO_2}{kg\ soil \times days}$

Front yard vs Backyard cont.





The POXC standard curve is very accurate and reliable since the best fit line touches every point and nearly at their centers. It is very reliable when doing calculations.

The P Analysis standard curve is not as accurate as the POXC standard curve, where there's some space between the best fit line and the points. It is still reliable, yet the lack of accuracy must be considered when using the equation.

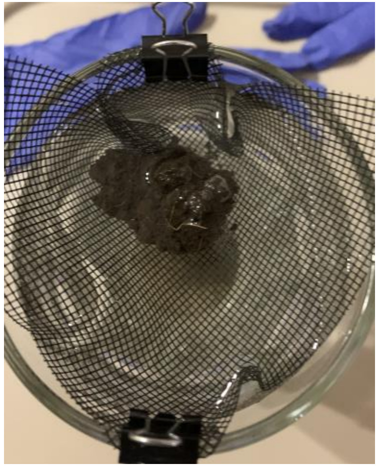
Front yard vs Backyard cont.

Cotton Test (56 days)

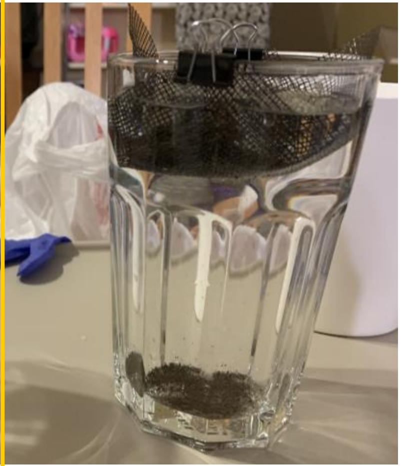
- Front yard soil had nearly completely decomposed the cotton, while the backyard soil had done a smaller amount of damage.
- Front yard soil had done more decomposing in the same amount of the time, indicating more microbial activity that the backyard.
- Backyard soil's cotton was still one piece and had some give when stretching.

Slake Test

- The front yard soil ped lost its structure, breaking down into crumbles while the backyard soil ped kept it shape and barely lost any soil.
- Front yard soil had low resistance to slaking and continuously flaked in both the initial & second processes.
- Backyard soil was very resistant to slaking yet had more air bubbles in its container.



Backyard Slake and Cotton Tests Pictures



Front Yard Slake and Cotton Tests Pictures

Comparisons to Spreadsheet

pH and Electrical Conductivity

Compared to the people who put their pH's in the spreadsheet, my samples had the highest pH levels. Compared to Josh (who had similar locations as me (garden and pond bank)), our pH were similar, where his locations had pH's of 8.14 and 8.17, respectively, and I had pH's of 8.42 and 8.38, respectively.

I had one of the largest differences in my conductivity values (194.8 and 659 μS) compared to everyone else.

K Analysis

Compared to the values of the spreadsheet, my front yard value was like the majority of everyone else's. Both of my values were in the normal and slightly higher-end of the range.

P Analysis

Compared to the values of the spreadsheet, my lbs P/acre value was average. What's interesting is that Benjamin, Josh, and I all had soil samples from (different) gardens but got very different values, varying from one end of the range to the other.

Comparisons to Spreadsheet

Microbial Titration Activity

Compared to the people who put their values in the spreadsheet, my samples were within the normal range. It was interesting to see that there were negative values in the spreadsheet, especially Josh L's because we both had samples from gardens.

POXC Calculations Lab value

Compared to the values of the spreadsheet, my values were on the higher end of the spectrum but was not out of the ordinary. A lot of other people had values above 1,000 mg RC/kg soil with some above 10,000 mg RC/kg soil. Mine were high, but I'd say fell within the middle of all the values.

Conclusion

- Both of my soils are healthy in their own way. They had normal % clay/silt/sand values and pH levels. They both had above optimum K values yet low P concentrations. Their microbial activity also differed, where the front yard had more activity than the backyard. This must be attributed to their different management practices and the plants they sustain.
- They share some traits, like growing plants and sustaining the life of microorganisms. But they also have their differences, which can be explained by how they are looked after and taken care of. What these soils consist of depend on what they grow, and since they grow different plants (vegetables vs. flowers/bushes).

Error Analysis & Future Directions

I ran into typical problems, such as the human error of splashing around my H_2O_2 treatment as I was driving to school, or how the H_2O_2 treatment didn't get to sit for the full 24 hours (and just 16 hours). I didn't see a major issue in the calculations from these errors. I also added too much HCl into the solution during the Microbial Activity Titration Lab while using the burette. I did not see this impact my values a lot, since my second run used up the same amount (and that was without error). My biggest piece of advice is to be efficient with how a student spends their time in the lab.

- What types of plants can my soils sustain with their low P concentrations? I would follow-up by doing extra research, specifically on what types of plants grow at such low P concentrations. I would assume it is the plants that grow and thrive in my garden now (or mutations of them).

Work Cited

Tilman, David, et al. “Global food demand and the sustainable intensification of agriculture.” *Proceedings of the National Academy of Sciences of the United States of America*, vol. 108, no. 50, 2011, pp. 20260-20264. https://www.pnas.org/content/108/50/20260