Benefits of Ceramic Inclusions in Terra Preta

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Introduction: Terra Preta is an anthropogenically made soil in the Amazon. It is drastically different from the surrounding soils. It possesses a fertility that allows for crop production and cultivation that the adjacent soils do not. The pH of Terra Preta ranges from 4.3 to 6.6, while the adjacent soils only range from 4.0 to 5.0. The infertility of the adjacent soils is due to the extreme leaching that happens in tropical rainforests. However, Terra Preta has not seen the same degradation. These soils have lasted for thousands of years and still hold their fertility today. Many theories have been put forward explaining the creation of Terra Preta. The main theories are the volcanic theory, the slash and burn theory, and the midden theory. The volcanic theory states that ash from a nearby volcano fell and mixed with the soil to create Terra Preta. The slash and burn theory says that the ancient peoples created Terra Preta by clearing vegetation and then burning it. Finally, the waste theory posits that Terra Preta was made when their middens were full. They burned the waste and worked it in to the soil. Today, we slow leaching through a mineral called perlite. Perlite helps with water retention, drainage, and aeration. Since ceramic shards have similar properties to perlite, I believe they can act similarly in Terra Preta.

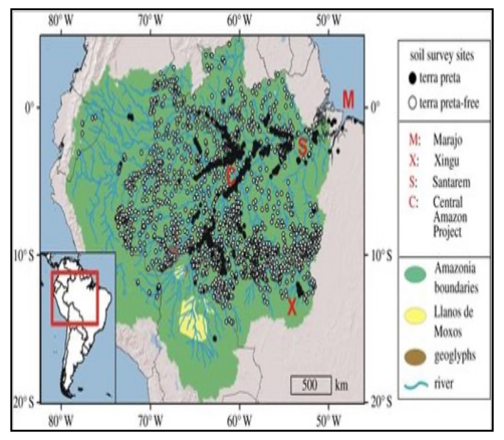

Figure 1: Map of all known Terra Preta Sites

Figure 2: Cross section comparison of Terra Preta and Adjacent soils

Methods:
For this project I wanted to test if ceramic sherds have an impact on soil fertility. To test the ability of ceramics to preserve soil fertility I ran the following experiment:

- I took six 5-gallon buckets and cut the bottoms off of three of them, replacing the bottoms with mesh. I then placed the buckets with mesh inside the buckets without the mesh to catch the water that escaped from the soil. These 3 systems will be called buckets A, B, and C.
- In each bucket I put 7” of clayey soil, 4 cups of biochar, and 4 cups of compost.
- I left bucket A as my control bucket. In bucket B I mixed in 5 cups of perlite and in bucket C I mixed 10 ceramic sherds into the soil.
- I tested the pH of the soil by mixing the soil with purified water, waiting 30min for them to combine, then straining and testing the soil-water mixtures Ph with Ph test strips.
- Every day I poured 1 liter of water into each bucket and let the water percolate through the soil. Then I measured the amount of water that came out using a measuring cup.
- A core of each soil was sent to the Dairy One soil laboratory at Cornell to test the soil chemistry and pH of each batch of soil.

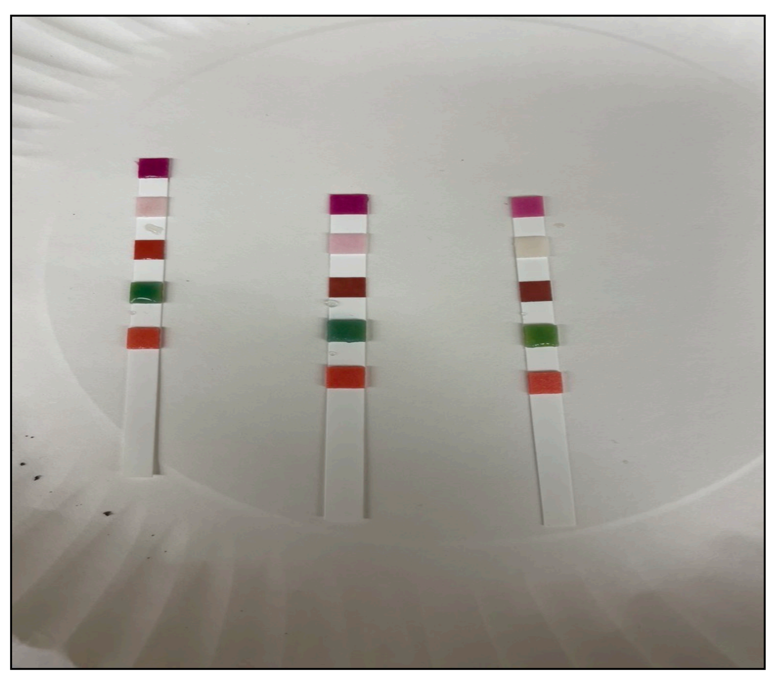

Figure 3: Image of the pH strips used

Figure 4: Picture of the soil buckets

Results: During the experiment I noticed that the ceramics acted comparably to or better than the perlite in terms of water retention, permeability, and pH stability. There were multiple times where all the buckets released the same amount of water, but this was not the norm. Overall, bucket B and bucket C did better. There was only once where bucket A released the least amount of water. The pH fluctuated throughout this experiment, but bucket B and C's pH's was much more stable. The ceramics were equally if not more effective than the perlite, with both being more effective than no additives. I also sent a portion of the soil to the Dairy One soil laboratory at Cornell to test the soil chemistry and pH. These lab results showed that bucket B and bucket C stayed the most stable, but the relationship between the three buckets was much closer than the pH strips suggested.

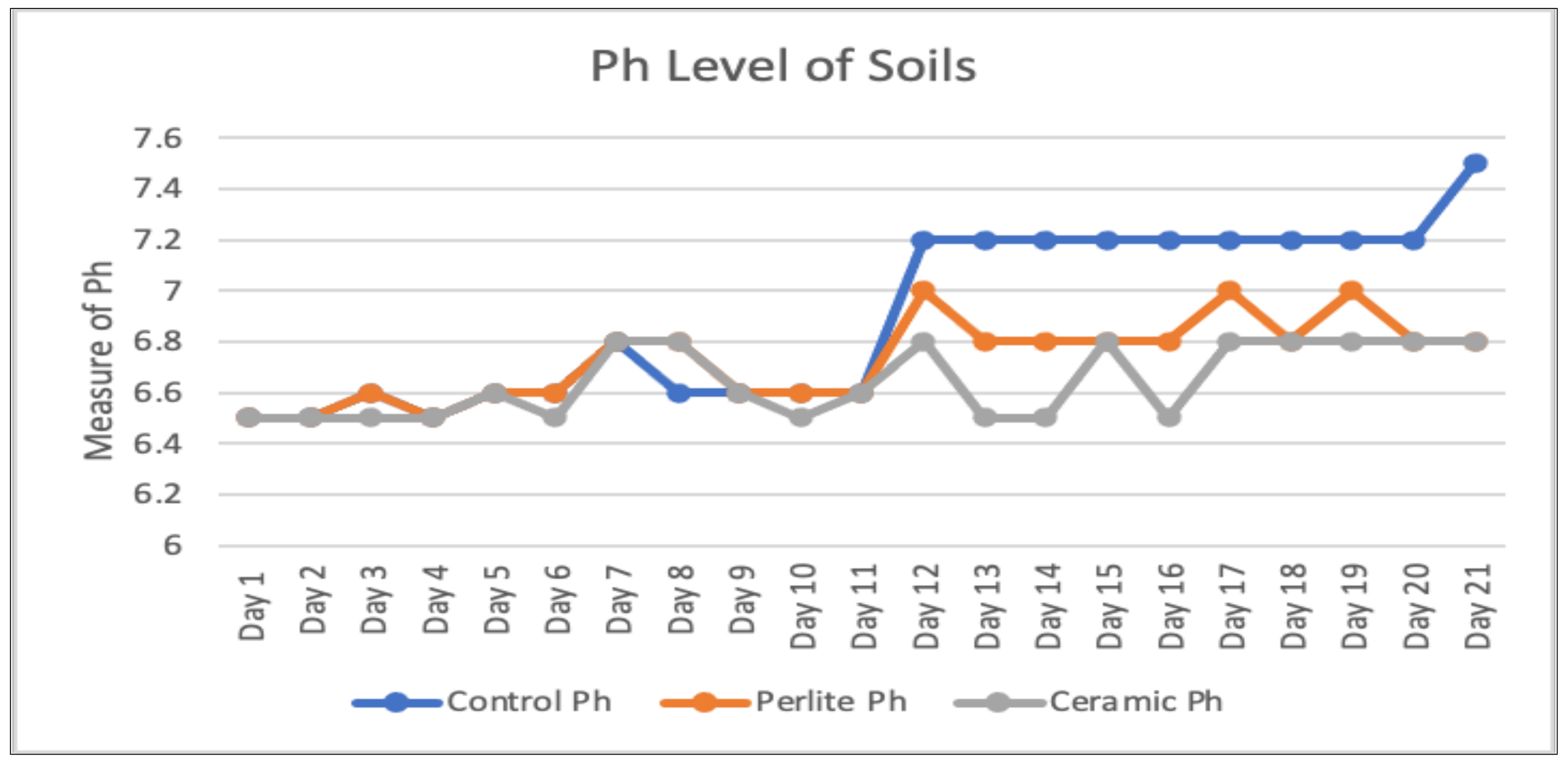

Figure 5: Graph of the pH levels through the experiment

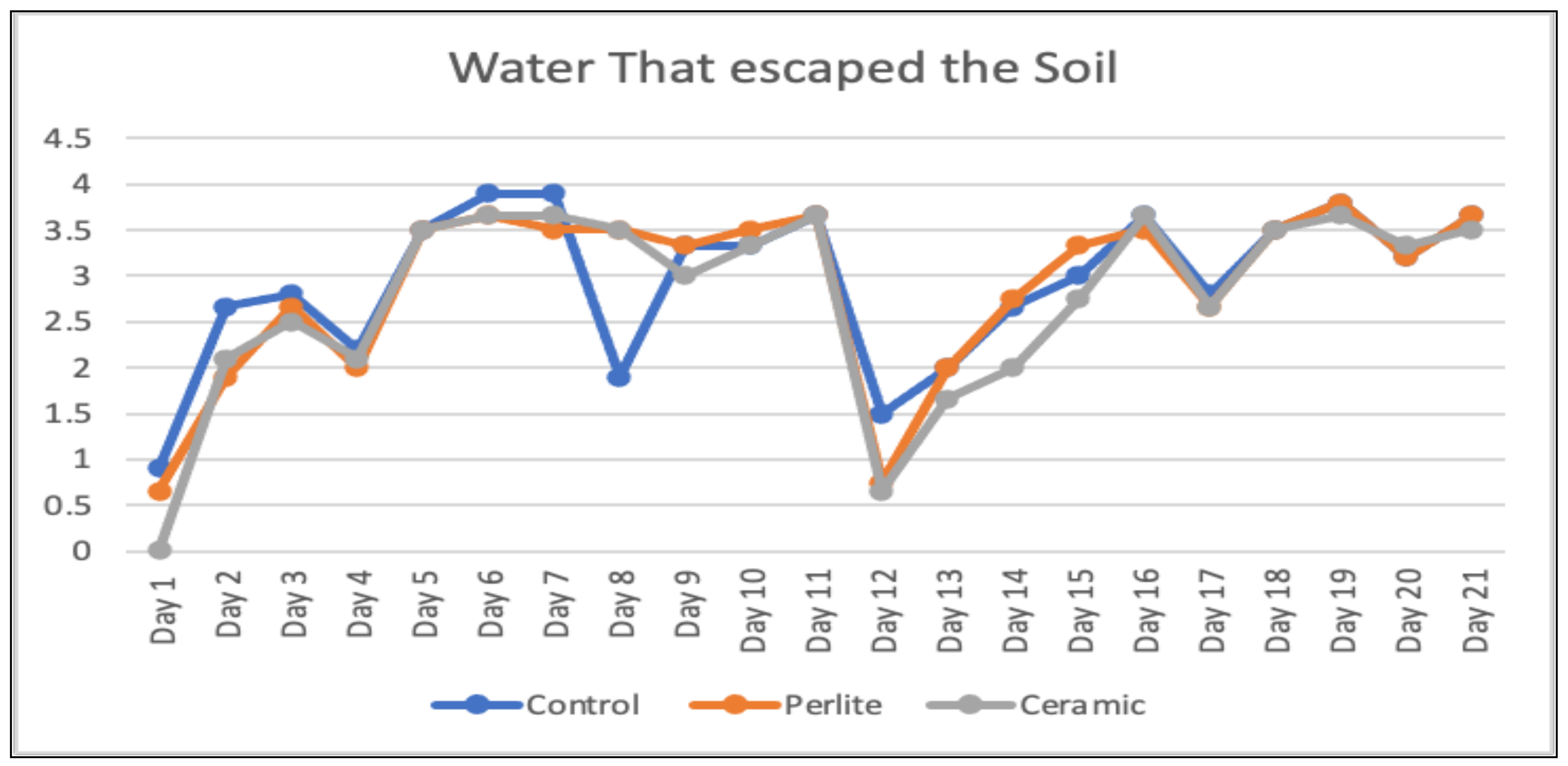

Figure 6: Graph of the amount of water that was able to escape the soil

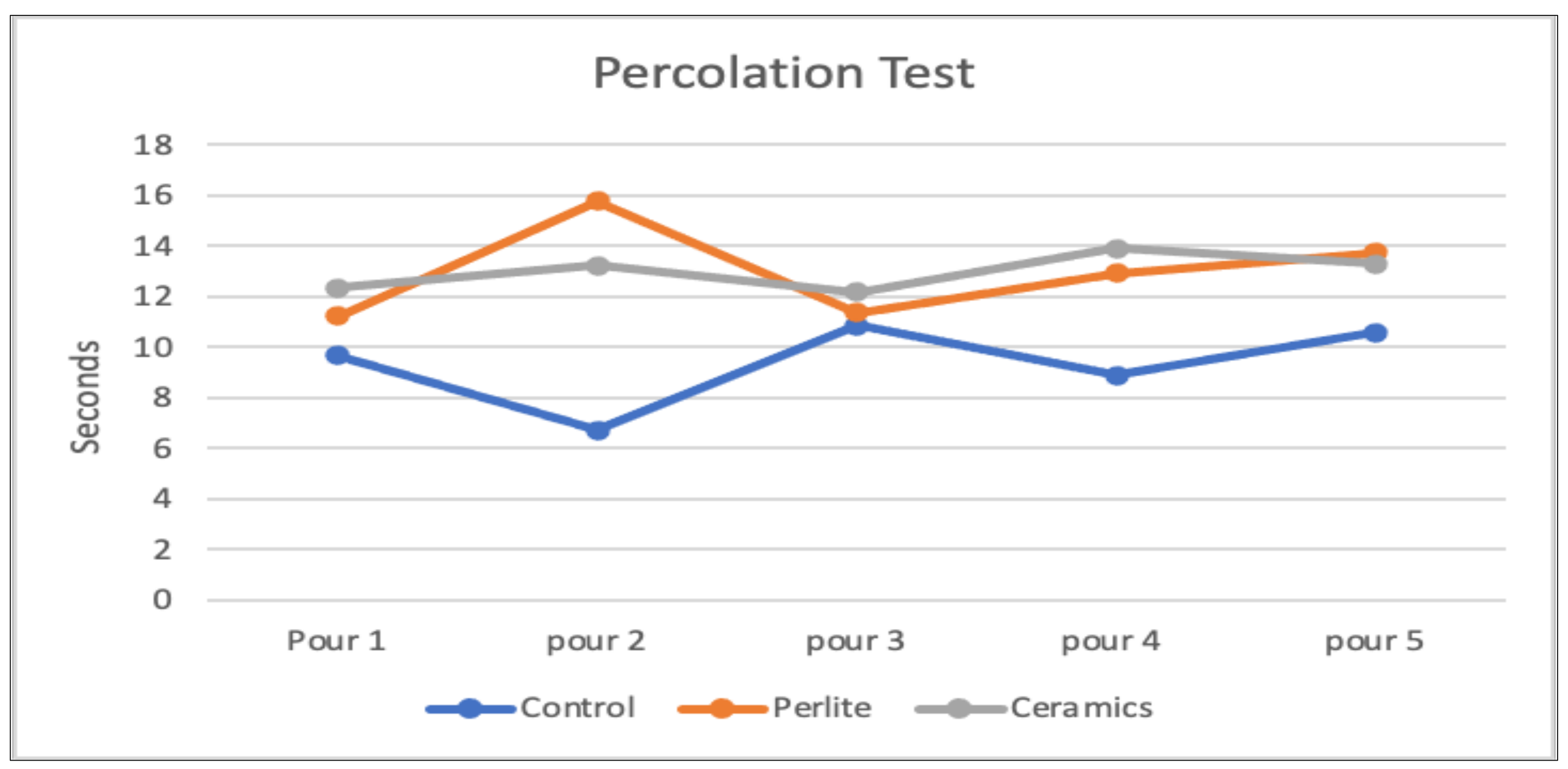

Figure 7: Graph of how fast it took for the first drop of water to come through in seconds

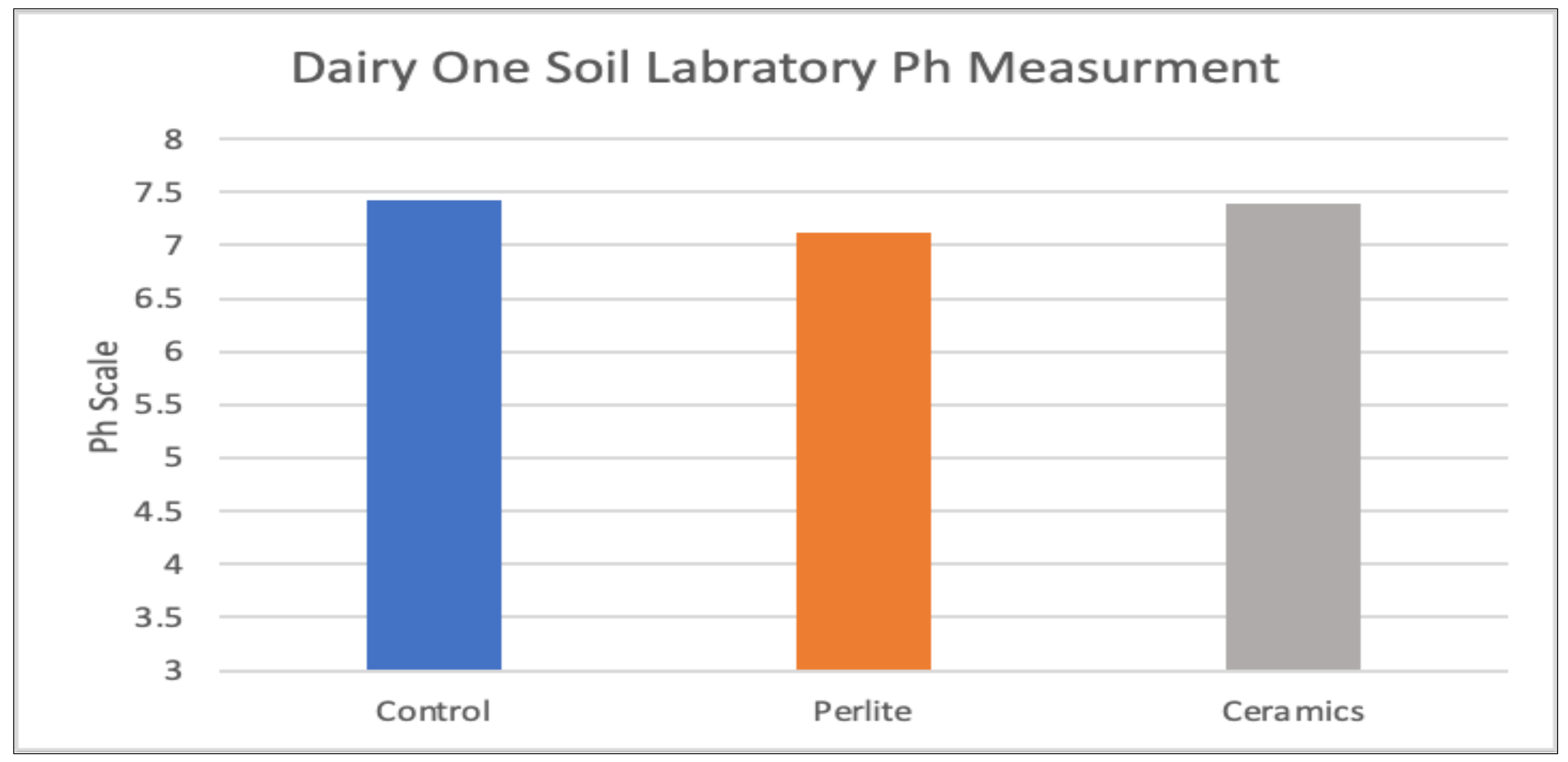

Figure 8: pH of soil measured by the Dairy One Laboratory

Discussion: My research led me to the conclusion that the ceramic inclusion effects are comparable to the perlite effects in soils, and that the ceramic sherds slow the leaching process. This is likely because the sherds allow the water to make its way through the soil with minimal contact with soil nutrients. I also found that the ceramic bucket generally stayed damp longer. This could be because the ceramics absorbed the water and continuously released it back into the soil over time. Additionally, the laboratory test showed comparable results to the testing I did. However, the Dairy One data showed a much closer relationship between the three soils. This difference could be due to where I testes the soil from. During the main tests I would take from the top of the soil, while for the laboratory test, I took a core of the soil. Thus, the nutrients must not have percolated down yet. I do wish that we sent a sample of the soils before the experiment began to see how it changed, as this may explain the difference between the test strips and lab results.

Conclusion: I think that the ceramic sherds added to Terra Preta helped the soil remain stable. It helped the soil with water retention, water drainage, and leaching. I think that this project uncovers another innovation that the ancient Amazonians made to slow leaching and keep their soils fertile for millennia.

Sources:

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