

This summer I spent 10 weeks in Kisumu, Kenya working on methods of using human urine as an agricultural input. The summer began with attending the Circular Bionutrient Economy Network conference, a lively mix of scientists, farmers, and entrepreneurs all united by the interest in turning materials typically classified as wastes into valuable resources. The conference had a focus on the emerging East African biochar industry, a topic I was unfamiliar with. It was interesting to hear about the specific regulatory and financial challenges associated with the rapid rise in biochar production and distribution. We tackled interesting questions like what is biochar in the eyes of a regulator? Where are the sources of agricultural wastes and where is the demand for biochar? How does seasonality affect biochar production? And how can you integrate the benefits of the carbon credit market into a biochar business without becoming overly reliant?



After 3 days of lectures, Kahoot games, and informal conversations, the Cornell contingent took a flight from Nairobi to Kisumu. Lasting only 40 minutes (and likely the shortest flight I've ever taken), the flight gave me an opportunity to see the Dandora Waste Water Treatment Plant from above, Africa's largest wastewater stabilization ponds with the capacity to treat 80,000 m³ of sewerage per day.

The day to day of my experience in Kisumu can be divided in two parts: learning about the agricultural research and extension landscape of western Kenya and diving into the scientific challenges of utilizing large volumes of urine. Throughout the summer we had meetings with [SOFDI](#) and [FIPS Africa](#), two NGO extension agencies operating in the region. We discussed ways they'd heard of farmers already utilizing urine as a fertilizer and how the model of Farmer Research Networks (FRNs) and Farmer Field Schools could be harnessed to test the efficacy of excreta derived fertilizers. In less than a week, SOFDI organized an event where over 30 farmers came together to share with us and each other how they were already applying urine on their farms and what concerns still remained. After learning about the use of



urine as a fertilizer in a lab setting, it was exciting to hear about people actually implementing the practice on their farms (and to great success!). On the more urban side of the story, we also held a focus group with employees in Maseno university about their willingness to donate urine if special urine collecting toilets were provided. The results of these discussions were coalesced in the form of a handbook that answered frequently asked questions from urine collection to on farm usage strategies.

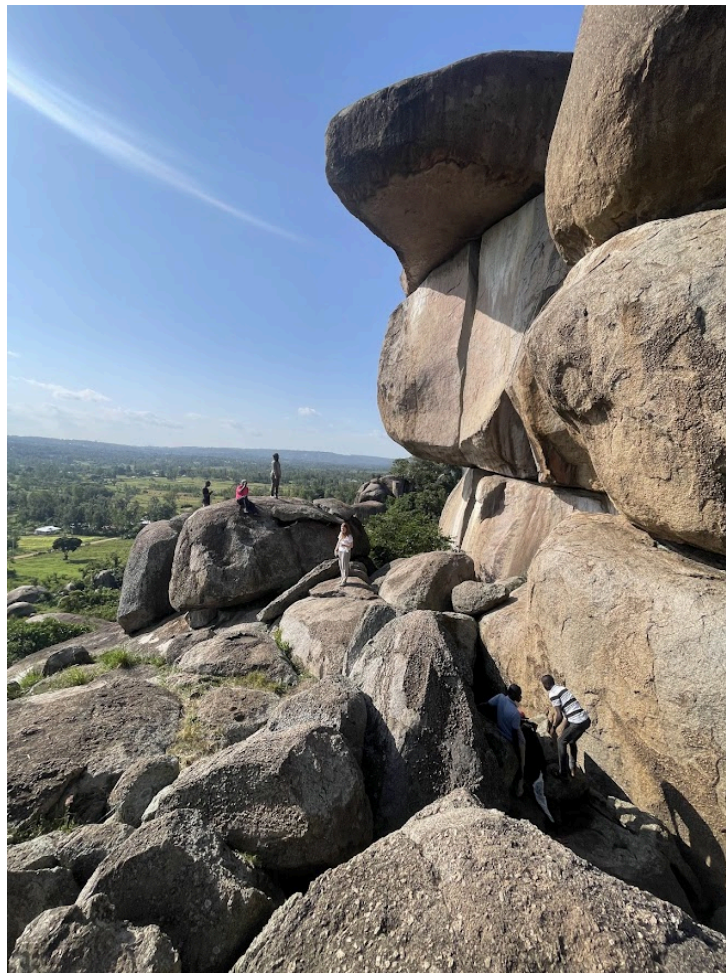
As an aspiring environmental engineer I was excited to use this technical skillset to address some of the logistical challenges of using urine as a fertilizer. In my first Laidlaw summer I worked on a project using biochar as a medium in a bioreactor to “extract” the nitrogen and phosphorus from urine. This research is still ongoing, but the prospect of a high nutrient biochar product is exciting! This summer I worked on ways to dehydrate urine into a powder form. While urban areas produce lots of waste, the heavy weight of urine, high water content, and volatility of the ammonium compounds lead to transportation challenges. If a dry fertilizer could be produced, this would be a large step in the viability of redirecting nutrients (N and P) from polluting water bodies to enriching rural soil. Lab scale experiments have confirmed the viability of dehydrating urine under alkaline conditions, but the challenge of how to do this at the industrial level in the Kenyan context remains.

Beginning with rough sketches in our notebooks then moving to 3D models made with cardboard scavenged from the supermarket, we eventually settled on a design for a passive solar urine dehydrator. Within a few days, this design became reality through the outstanding work of Duncan, a local “fundi” (craftsman) who hangs out in the basement of Maseno University. It was a joyous experience to see my little notebook sketch turn into reality, and an experience that very few aspiring engineers get to see this early in their careers. As we continued our work with urine dehydration, one of the major issues that came up was the lack of access to scientific instrumentation and lab testing. While accurate scales and thermometers are tools I take for granted in the US, finding these instruments was difficult in Kisumu, not to mention the lack of labs offering nutrient analysis. In a landscape where many new agricultural products from feeds to fertilizers are entering the Kenyan market, it is an injustice that farmers do not have opportunities to truly learn what is in these products. While in some



instances we were able to come up with creative alternatives to these issues, it also highlighted a lasting impact of colonization and perpetuated a dependence on the West.

Given the themes of the Laidlaw Scholars program, throughout the summer I tried to reflect on the ways that research can be beneficial to the community it is embedded in rather than extractive and only for the benefit of the researcher. I wrestled with questions like how much of the motivation to find excreta derived fertilizers is driven by farmer interest vs my own personal interests? Foraging this balance is a hard task for early university students who have so much more to learn about the world than they are ready to give back. Ultimately I tried to spend my time learning about the NGOs and CBOs building networks of farmers and their nuanced attempts to make the distribution of agricultural knowledge and innovation less of a top down system.



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