Rich Earth Institute: On Farm Field Day - July 10, 2025

Who We Are

The Rich Earth Institute advances food nutrient cycling through research, demonstration, and education. Based in Brattleboro, Vermont, our flagship program is the first and largest community-scale urine recycling program in the US. By reclaiming urine as an agricultural resource, communities can prevent downstream pollution, access an abundance of local fertilizer, and conserve clean water.

The Rich Earth Institute has been researching the production and use of fertilizer derived from human urine since 2012. It operates the first urine nutrient reclamation program in the United States, providing over 13,000 gallons of urine-derived fertilizer to local farmer partners each year.

Past Research

Pharmaceuticals: When urine is applied to the soil as a fertilizer, our own research and a number of other studies have found that pharmaceuticals do not accumulate in crop tissues at significant levels.[1-5] A Rich Earth study of urine-fertilized carrots and lettuce found extremely small levels— in the nanogram per gram (or parts per billion) range—of pharmaceuticals in plant tissue.[6] Caffeine was the most abundant drug we detected in human urine, but it was present in such tiny amounts in urine-fertilized lettuce that a person would have to eat a pound of the lettuce every day for over 1,000 years in order to ingest the equivalent of one large cup of coffee. The levels of other pharmaceutical compounds (including antibiotics, over-the-counter anti inflammatories, and other drugs found in significant concentration in wastewater), were comparable to or even lower than this.

PFAS: Some levels of PFAS may be present in urine, since they are common in human blood and leave the body slowly over time, mostly through urine.[7] A study of highly exposed individuals found an average PFOA concentration of 27 ng/L in urine.[8] Recent third-party testing of urine collected through two community-scale programs in Vermont (operated by Rich Earth Institute and by Wasted*) revealed no detectable PFOA, PFOS, or other regulated PFAS compounds.

Concentrate: Urine concentrate fertilizer is a novel product produced using freeze concentration technology developed by Brightwater Tools LCC (a spin-off of the Rich Earth Institute). The increased ammonia concentration requires immediate incorporation into the soil in order to prevent ammonia volatilization.

In a prior field trial at John Janiszyn's farm, a spider wheel hiller effectively buried the urine as it was applied to the corn hill.

Biochar from Biosolids and Source Separated Human Urine: Soil Health Impacts and Farmer Perspectives

Funder: USDA Sustainable Agriculture Research and Education (SARE): Research for Novel Approaches in Sustainable Agriculture

Collaborators: Cornell University, Cornell Cooperative Extension

Project Overview

In this research project, we are exploring soil health effects and farmer perspectives concerning soil amendments derived from a range of waste streams. Biosolids–solids recovered from wastewater treatment–are commonly applied as a recycled, nutrient-rich soil amendment. However, biosolids may contain harmful microcontaminants such as PFAS that pose health risks when applied to farmland. Transforming biosolids into biochar—a charcoal-like material that can be made from any organic material—could potentially eliminate these contaminants. Recent research suggests that the high heat used in the pyrolysis process can break down harmful substances like PFAS, making biochar a potential alternative to traditional biosolids for agricultural use.

Field Trial Methods

This project examines soil amendments including urine, biochar made from biosolids, biochar made from other wood chips, compost, and various combinations of these. The benefits of biochar are known to be enhanced further when biochar has been charged with nutrient rich materials before use, such as urine. Using both the solid and liquid human waste products could be a way to reduce the need for external synthetic fertilizers and use both forms of waste simultaneously.

For plots receiving biochar soil amendments, biochar was charged (soaked) with urine one week prior to application. For plots receiving biomass biochar, biochar was applied at a rate of 0.5 dry tons per acre, and for plots receiving a blend of biomass and biosolids biochar, both biochar types were applied at a rate of 0.37 dry tons per acre (0.74 dry tons per acre total).

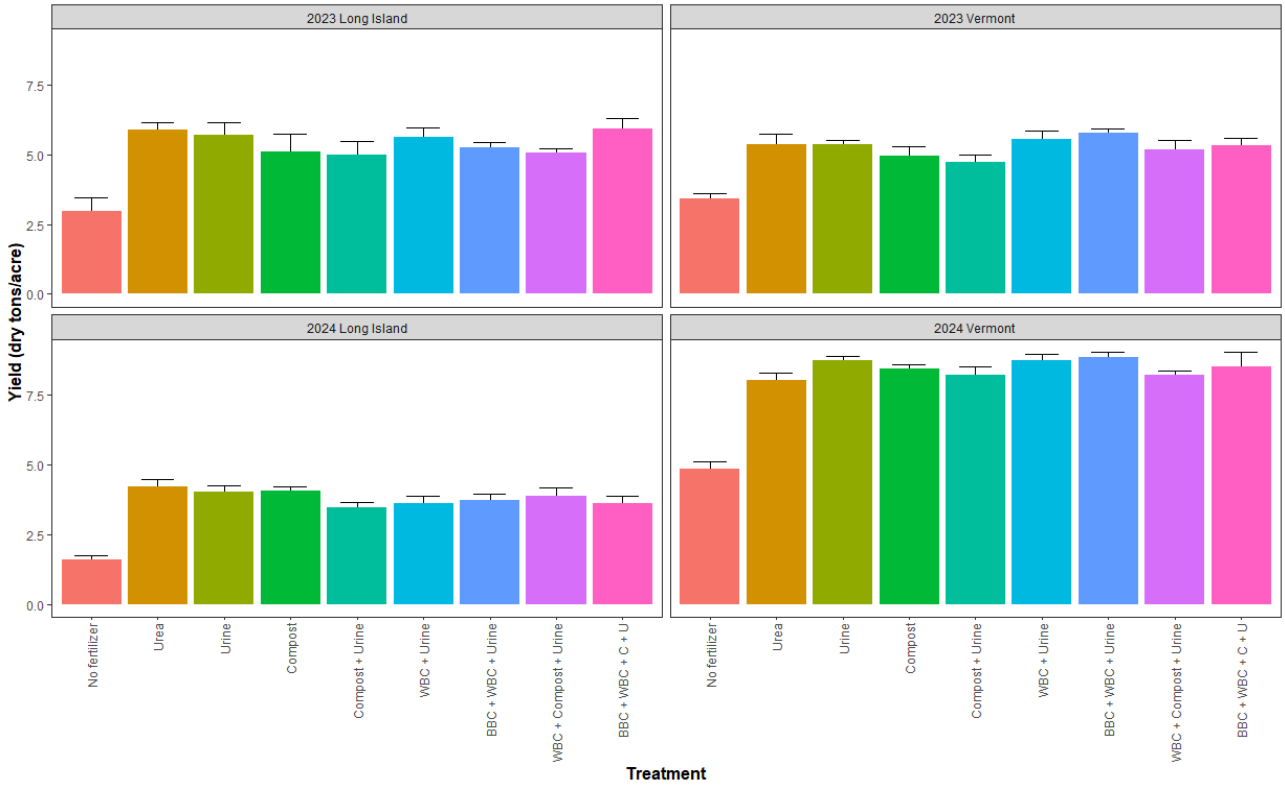
From 2023-2025, we have applied soil amendments to silage corn planted in this field. Amendments, as well as supplemental potassium and phosphorus, were added such that each plot received equal amounts of N, P, K, and C. We are measuring corn yield and indicators of soil health to compare across the nine treatments. In addition to the analyses performed in this project, soil microbial analysis will be performed with funding from the Foundation for Food and Farming from 2023-2027 (https://foundationfar.org/) to understand how microbial communities may be affected by the various

treatments. A parallel experiment is being conducted by research partners at Cornell Cooperative extension at the Long Island Horticultural Farm to compare our results to those in a different soil type.

Preliminary Results

So far, all recycled soil amendment recipes have resulted in comparable yields to synthetic fertilizers and greater yields than controls. This means that in the short term, the treatments receiving urine, compost, and/or biochar all provided sufficient nutrients to the corn crop.

The study will continue for another two seasons, to give longer-term results. We will analyze soil health (using the Cornell CASH test) at the end of this season and after the 2027 season, giving insight into the effect of these treatments on soil health over time.



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Social Research

The social research component of this project builds on our previous SARE projects, which documented strong farmer interest in adoption of source-separated human urine as fertilizer. However, we also identified concerns about urine related to potential soil health effects from residual pharmaceuticals, and concerns about biosolids related to microcontaminants, organic pollutants, and heavy metals. In order to understand how farmers, gardeners and other land managers think about the potential value of these amendments, we plan to interview 20 farmers or other land managers on Long Island and in New England, asking a range of questions in semi-structured interviews. Questions include current management practices, thoughts about various fertilizers and amendments, and indicators of soil health. We will use this information - with more interviews, dialogue groups and further analysis - to continue our research and develop educational materials. The 12 interviews conducted so far include:

- 7 farmers, 1 hort industry, 1 community gardener, 1 planner, 1 landscape company manager, 1 homesteader; ages range from 29 – 65

Key Themes Explored:

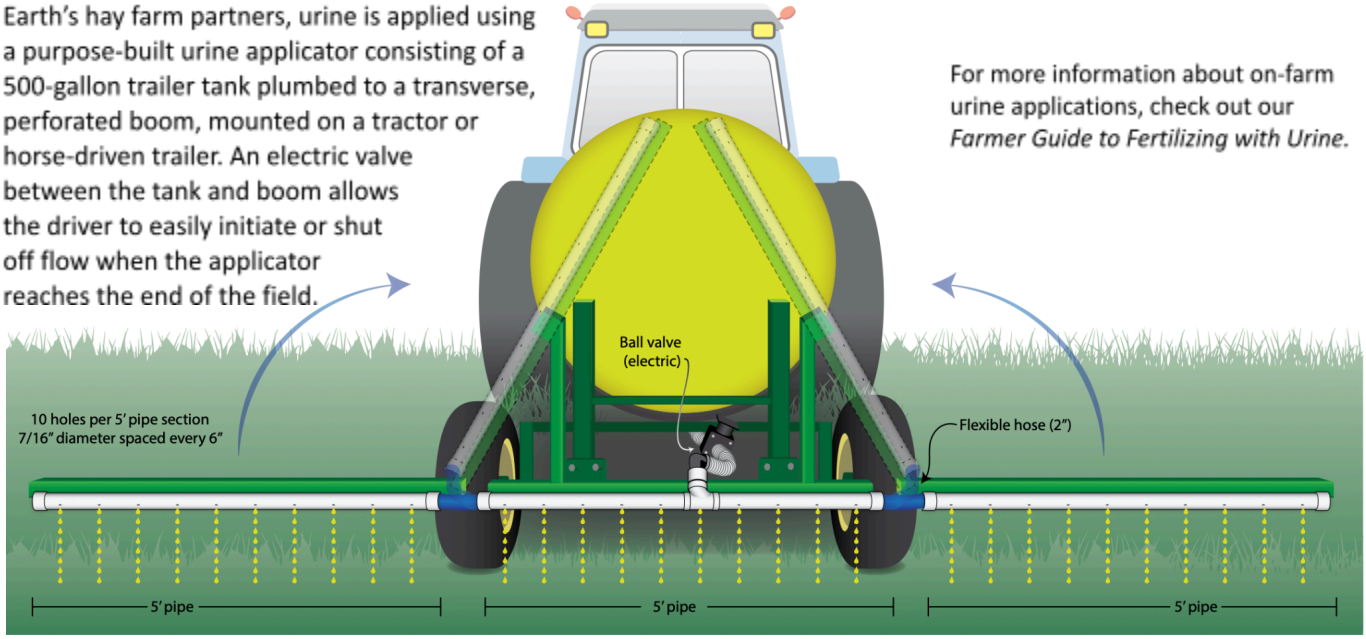
- **Influence of personal philosophy on farming practices**
    - Among these farmers, frugality was a key principle; there was interest in utilizing human waste in a better way, running farms efficiently, "closing loops," recycling, circularity, and connecting to the natural world.
        - *"We think of ourselves as part of nature, not separate from it,"* said an Educational Farm Manager
- **Familiarity with these amendments:**
    - Most, but not all the interviewees were familiar with the idea of urine as a fertilizer; most were not familiar with the idea of making biochar from biosolids, but were generally knowledgeable about biochar from other sources
    - There was confusion about some of the terminology we used such as "biosolids" and "source separation."
- **Soil health indicators:**
    - The soil health indicators most commonly expressed were plant observations such as the health of crops, growth patterns, resistance to disease and yield; intuitive understandings, honed over time; soil tests; microbial life (very important to some, less to others); and soil observations such as texture, color, compaction, erosion and drainage.
    - *"I look at soil as an investment into the future,"* said a hop and cannabis farmer.
- **Key motivations for potential interest in these amendments were:**
    - Reuse of materials otherwise seen as "waste"; using something sourced locally, potentially reducing transportation costs/energy; and that these amendments fit in with their overall farming philosophy or objectives.
    - "*I just know that it's good. It's like, what we eat, it's what we drink, it's full of everything that goes into our body,"* said one vegetable & flower farmer
- **Some concerns farmers expressed were:**
    - Public perception and education needs; unforeseen long-term impacts on soil health or human health; and accumulation of micro-contaminants over time. Most expressed a preference for use on non-edible crops.

    - "*Urine as fertilizer isn't really a folk story that we're cozy with yet. And there's a lot of, a lot of people, my sense, … that vacation on the island and a lot of people that have financial power there are attracted to the pastoral quality of life,"* said a community planner who works with farmers on biochar use.
- **Barriers to adoption included:**
    - Availability and transportation needs; price (some would buy if the price was the same as current amendments, or would pay a higher price if it improved plant growth or soil health); consistency of product; lack of information about release time of nutrients and data on effects for specific crops; and funding if different application equipment were needed.
    - *"If the ball is rolling and you're starting to produce the stuff… you've got to be able to keep going because… when you don't have it available or it's not available they're going to switch to something else and then you're going to lose their interest and concern… in purchasing it,"* said a greenhouse manager.
- **Information and supports requested include:**
    - Data on nutrient composition, both macro and micronutrients; forms of nitrogen and its availability in these products; phosphorus levels to meet Long Island regulations; 2 – 5 years of data on specific crop effects; testing in different soil types and climates; guidance for application, including safety info; data on contaminants (liability concern, especially re PFAS; rigorous testing on microcontaminants from an independent source; and application requirements such as equipment, time and labor needed.
- **Crop recommendations:**
    - The best crops to use urine and/or biosolids biochar for these participants were flowers, hay/pasture, crops grown for industrial use; perennials/trees; container plants; and conservation land. The majority of participants preferred use on non-edible crops even if they had no specific concerns.
- **Education Recommendations:**
    - For farmers, straightforward language is best; the amendments could be "legitimized" by communicating municipal planners' needs; it would make it easier to present to the public if fits in with town planning goals; conservation benefits should be emphasized, as a nature-based solution to water quality and energy concerns.
    - Communication should be via popular formats: social media, Netflix, news, local extension. A wide range of formats were valued by different interviewees.
    - On-farm demonstrations were mentioned by many
- **Some conclusions:**
    - An important point we have seen is that agricultural and environmental communities are coming together and learning from each other. We can foster this dialogue with our research and education.
    - As one grower put it, *"30 years ago, we would go to a roundtable discussion and environmentalists would be here and the agricultural producers here and now that we're kind of, we've come together because we have more of an open mind and having people in the agricultural industry that are environmentalists also and care about the environment really is important and bringing the two key entities together out there."*
    - Urine is generally well accepted by those we interviewed
    - Biosolids biochar is preferred over biosolids (uncharred) and may have potential as a soil amendment, even for those who don't currently use amendments, as a long-term soil building investment.

Using Urine on Farms

Rich Earth's Custom Field Applicator: For Rich Earth's hay farm partners, urine is applied using a purpose-built urine applicator consisting of a 500-gallon trailer tank plumbed to a transverse, perforated boom, mounted on a tractor or horse-driven trailer. An electric valve between the tank and boom allows the driver to easily initiate or shut off flow when the applicator reaches the end of the field.

For more information about on-farm urine applications, check out our *Farmer Guide to Fertilizing with Urine.*



Top: *A schematic of the Rich Earth Institute's custom field applicator.* ***Left:*** *A tractor pulls the Rich Earth applicator, fertilizing a hay field.* ***Right:*** *The Rich Earth applicator with one boom retracted, delivering urine to a bed of nursery trees at Yellowbud Farm*

Fertigation: Fertigation is the application of soluble fertilizers to crops through an irrigation system. Fertigation using drip irrigation systems has special promise with urine fertilization because it:

- Incorporates the fertilizer into the soil, greatly reducing ammonia volatilization potential
- Combines fertilization with an existing process, reducing labor demands
- Avoids compaction caused by tractor-based application
- Allows multiple small, precise fertilization applications, matched to crop needs and field conditions, potentially reducing nitrogen run-off and leaching
- Uses standard and widely-used agricultural equipment

Rich Earth has conducted both controlled experiments and on-farm field trials using fertigation methods. The trials showed that urine can successfully be delivered via fertigation either by mixing it with irrigation water or by delivering it in an alternating fashion with the irrigation water and that measuring the hardness of water to be used can be useful in determining the method of delivery of urine into the irrigation system.

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