

Fertilizing with Urine: Recent Findings from the Rich Earth Institute's On-Farm Research

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Farmer Partners: John Janiszyn, Jesse Marksohn, Eric Cornell



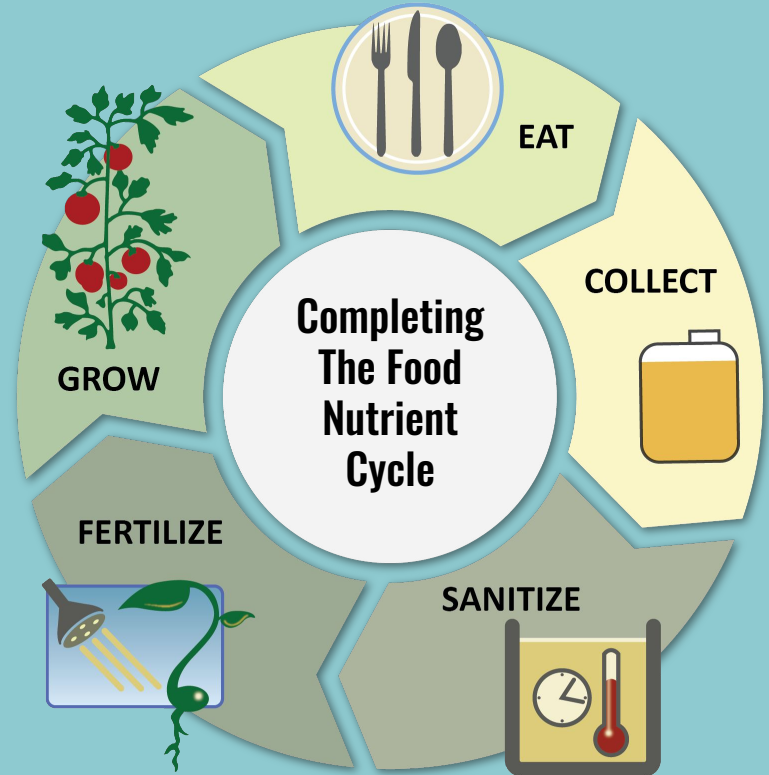
Acknowledgements:

*Research Assistants: Jennifer Mynard, Ella Ball,
Cole Teranes*

About us

Our Vision: A world with clean water and fertile soil achieved by reclaiming the nutrients from our bodies as elements in a life sustaining cycle.

Our Mission: Engage in research, education and technological innovation to advance the use of human waste as a resource.



Urine Nutrient Reclamation

 CREATE FERTILIZER

 PREVENT POLLUTION

 SAVE WATER



230

urine donors

12,000

gallons of urine
collected annually

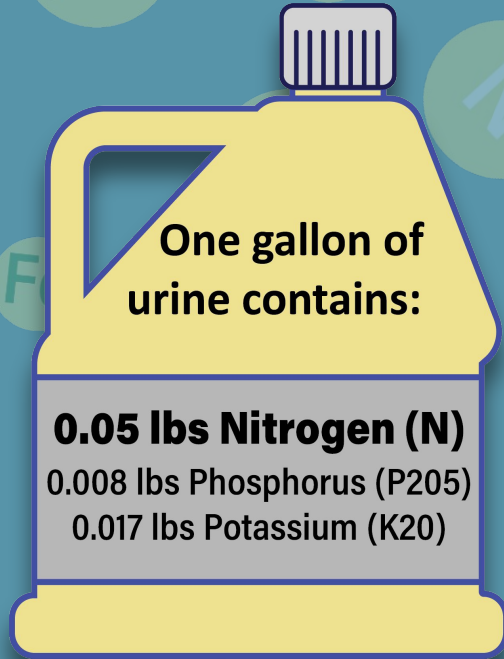
2.3 M

gallons of *clean* water
conserved since 2012

**RICH
EARTH
INSTITUTE**



Urine as a fertilizer

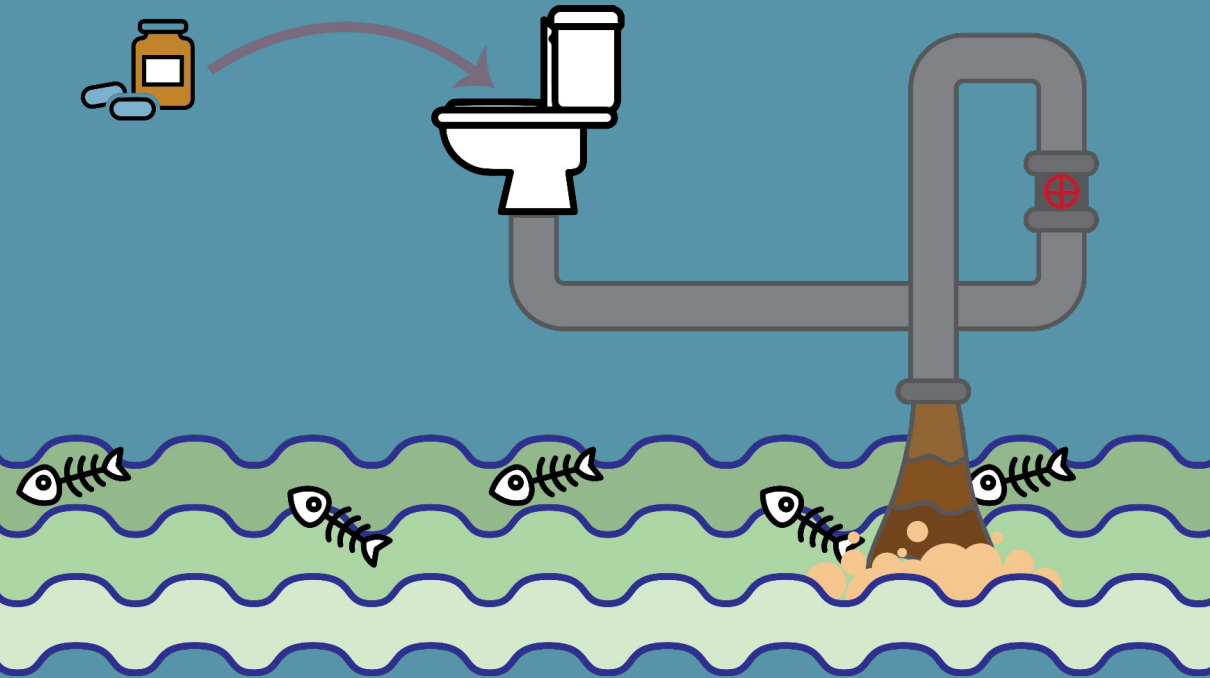


NPK analysis:

0.6 - 0.1 - 0.2

Element	lbs/gal	%
Nitrogen	0.048	0.57%
Potassium	0.013	0.16%
Sodium	0.012	0.15%
Phosphorus	0.003	0.04%
Sulfur	0.0037	0.04%
Calcium	0.0002	0.0024%
Magnesium	0.00006	0.0008%
Boron	0.000016	0.0002%
Zinc	0.000003	0.0001%
Iron	0.000002	0.0001%
Copper	0.000002	0.0001%

What happens to the pharmaceuticals in our urine?



When you take medicine or drink coffee and then flush your pee, what happens to it?

Pharmaceuticals in water bodies can be disrupting aquatic life...

When reclaimed as fertilizer...



By collecting urine and keeping it out of the wastewater stream, we can contain pharmaceuticals before they reach sensitive aquatic ecosystems and water supplies.

But that raises new questions:

Do these compounds end up in edible crops?
How do they affect long-term soil health?

What we found...

Rich Earth Institute has been studying this for six years in collaboration with our partners:



CROP

Eat one pound of urine-fertilized lettuce every day for 1,000 years to ingest the caffeine equivalent of one large cup of coffee.

The pharmaceuticals we detected were extremely small – in the nanogram per gram (or parts per billion range.)

SOIL

We found small levels of pharmaceuticals in the soil (parts per billion range).

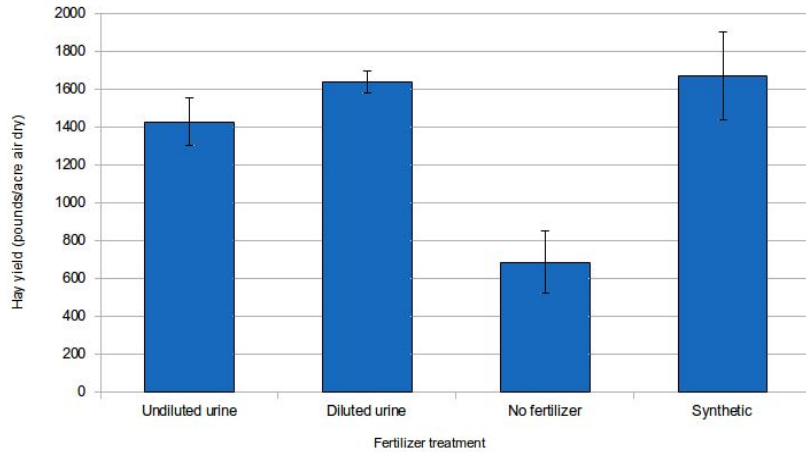
GROUNDWATER

Pharmaceuticals were detected in the groundwater in even lower levels (parts per trillion range.)

Prior SARE-funded Research

Hay Yield

Effect of Urine Fertilizer on Hay Yield at Whetstone Valley Farm



Co-composting with urine + organic matter

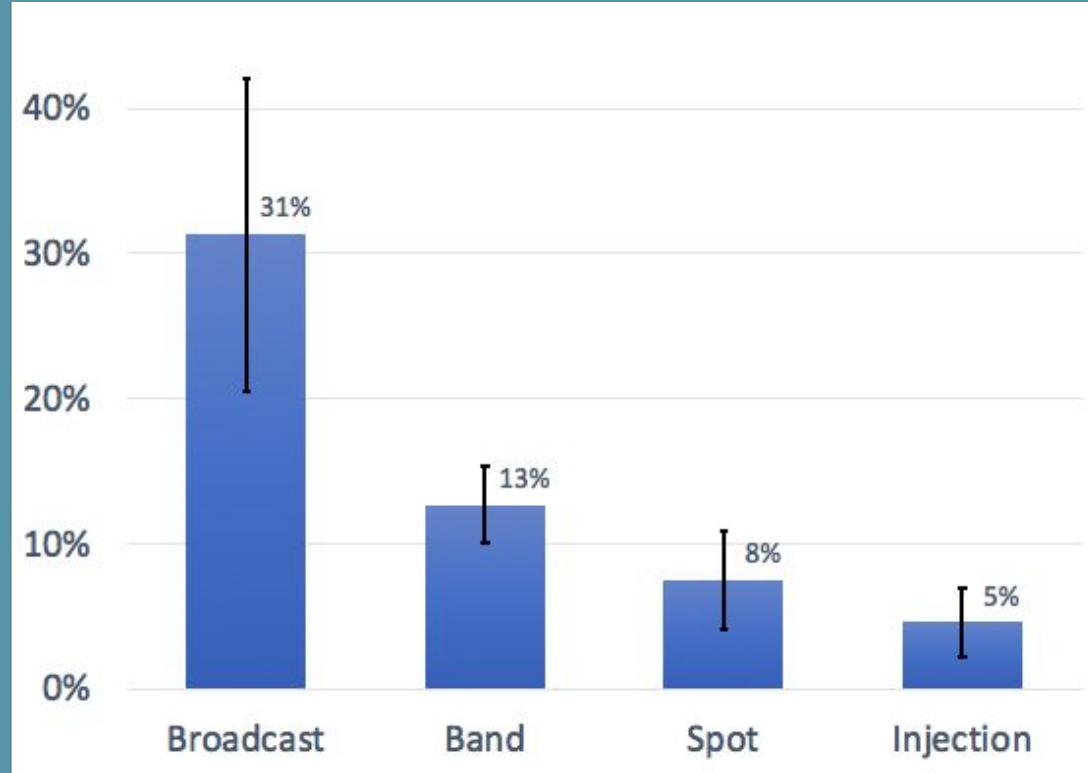
Co-composting of urine with leaves can produce a compost that:

- Retains the majority of the nitrogen and other nutrients found in urine
- Is a solid product
- Is aesthetically appealing
- Can be stored inexpensively
- Can be applied using conventional equipment.

Prior SARE-funded Research

Ammonia loss by different application methods

% of original ammonia lost



Prior SARE-funded research

Bio-acidification

1. Add carbon-rich waste materials to liquid manures
2. Fermentation generates organic acids
3. Lower manure pH mitigates ammonia loss



ACID WHEY & SWEET WHEY

Other Farm Partnerships



Cut flowers



High Tunnel Figs

Prior SARE funded Research



Drip Fertigation



Current Farm Partnership Project: Farm Scale Implementation

1. Drip fertigation experiments
2. On-farm experiments
3. Social Research:
 - a. Farmer partner site visit/interviews
 - b. Produce buyer interviews
 - c. Consumer / CSA member dialogue groups
4. Farm Guide



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Current Project - Farm Partners

Pete's Stand - John Janiszyn - application with sweet corn



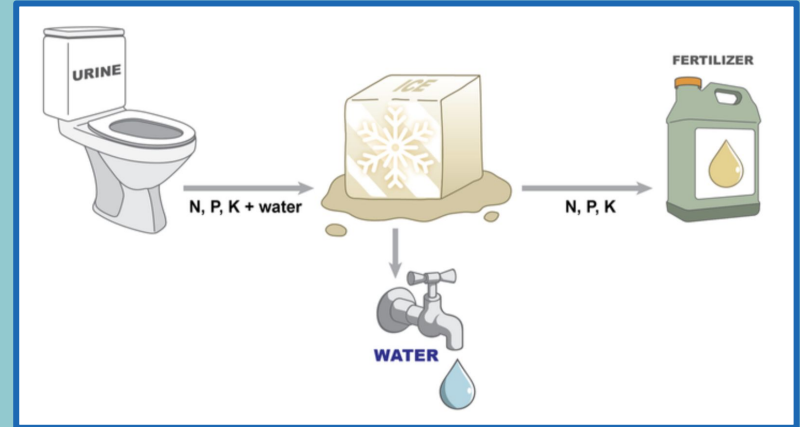
Current Project - Farm Partners

Pete's Stand

Concentrated Urine vs. Straight Urine

Concentrated Urine:

- Reduce greenhouse gas emissions through decreased transport needs
- Reduce tractor compaction/increase farm efficiency
- Produced with Brightwater Tools Freeze Concentrator



BRIGHTWATER TOOLS

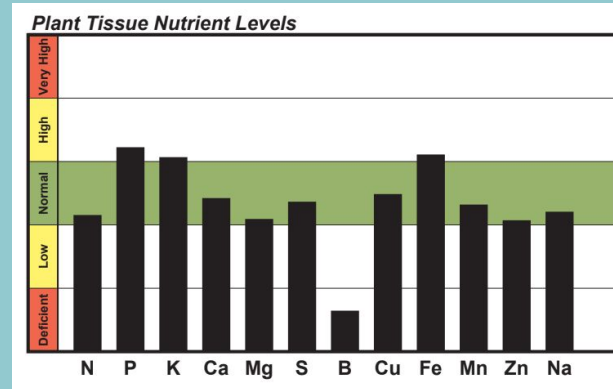
Technologies for Regenerative Sanitation

Current Project - Farm Partners

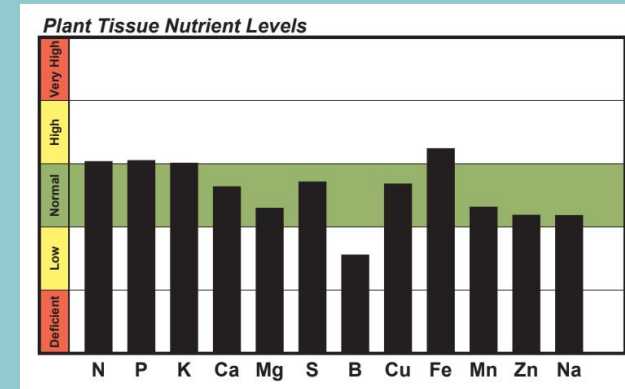
Pete's Stand

- Nitrogen results are similar between Urea, Urine Concentrate, and Urine - all had higher N than the control treatment.
- No apparent negative impact of Urine Concentrate compared to Urine.
- Mn appears to be higher in the Urine Concentrate and Urine treatments.

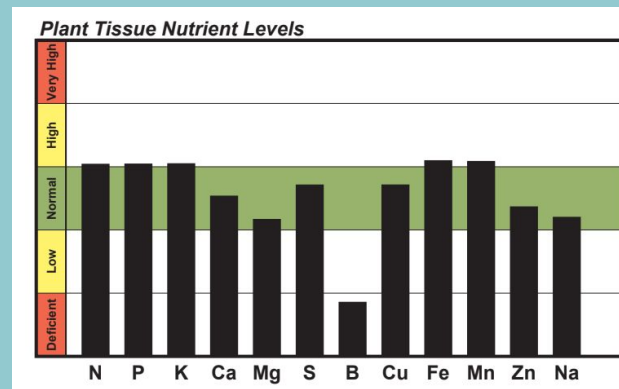
Control Treatment Row



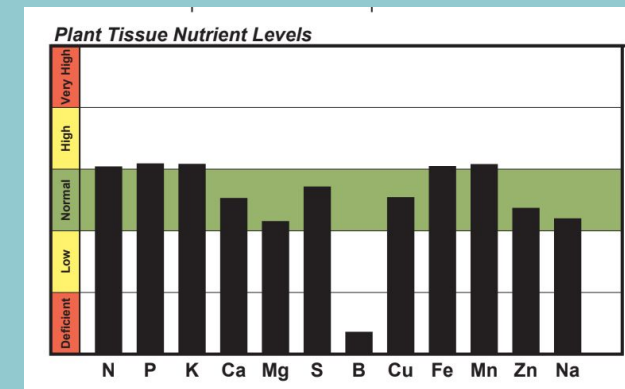
Urea Treatment Rows



Urine Concentrate Treatment Rows



Urine Treatment Rows



Current Project - Farm Partners

John Janiszyn - observations from site visit (prior to full development of the corn)

****control leaves were yellower, ears less filled out at the tips than urine treated, or "regular"***

****urine treated corn was greener, and the plants were taller - possibly due to more sunlight in these rows***

****concentrated urine treated plants were not as tall, on average, as the unconcentrated urine, and also a little behind the "regular" urea treated corn***

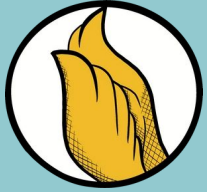


Current Project - Farm Partners

Some of John's additional thoughts from site visit:

- *I'd be curious to see what that would look like if I even went 50% more, or even doubled it, just to see how the plants would react to that in the short term "*
- Would like to try urine under plastic with different crops
- Noted less pest pressure in the urine-treated plants; suspects not due to any deterrence from the urine, but rather that the conventionally treated corn grew faster, and so attracted the pests (moths of corn earworm) sooner.
- Sees human urine fertilizer as equivalent to any other source of nitrogen: *"You know it's pretty clean stuff it's not being taken out of ...a sewage treatment plant or something like that where there's a chance of other things [mixing in]."*
- Some concern about customers potentially hearing about this and confusing diverted urine with biosolids, or something coming from a treatment plant, and reacting negatively

Current Project - Farm Partners



Yellowbud Farm -
Chestnut Seedling
Fertilization at a
wholesale tree nursery

Jesse Marksohn and
Eric Cornell

Chestnut seedlings at
Yellowbud Farm, 2023



Current Project - Farm Partners

Yellowbud Farm application to the in-ground nursery seedlings



Current Project - Farm Partners

Yellowbud Farm - Observations from Site Visit

Motivation - Jesse: *"For me, it's incredibly intuitive and something that is really important ...to figure out how humans can better interface and interact with the landscape as co-creators, not aliens on a foreign land.... We can literally use our own biological processes to create fertility...and reevaluate what we consider waste"*

Planning process with Rich Earth - Jesse: *"We kind of co-created a [plan, with] different trial plots and then Abe obviously advocating for more replication plots to have a better understanding that what we think we might observe is useful."*

Use in the nursery trees - Eric: *"We didn't have a control, but it is quite apparent that the trees did really, really well even with the high seeding density. So I'm very curious to get more rigorous with that. But I believe we've really proven the concept that it is a viable use for the material."*

Comments from others: Jesse *"Often a piece of feedback I get [is] like 'that's great with trees. I wouldn't put it on my like, you know, spinach.' ...Generally the feedback is positive. ..My experience has been people are very intrigued and excited about about the concept"*

Current Project

Yellowbud Farm - Hickory Seedling Fertilization in Air-Pruned Beds



Jesse Marksohn takes hickory seedling measurements

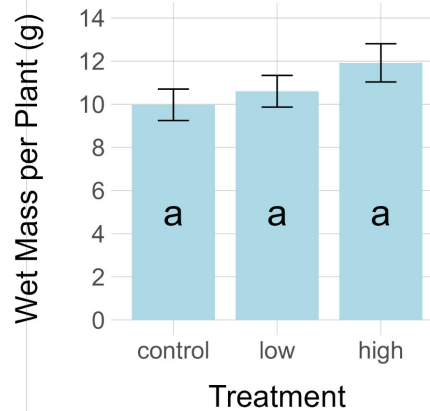
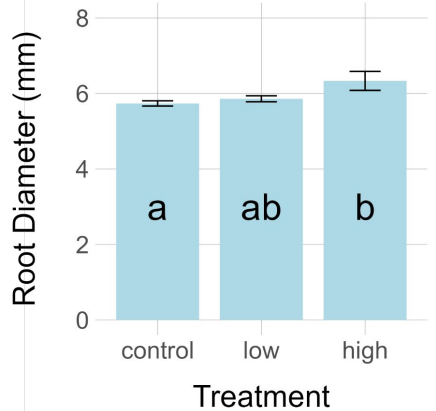
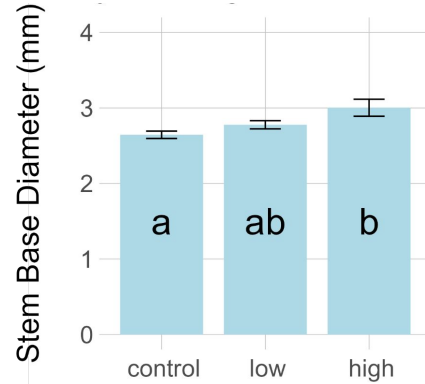
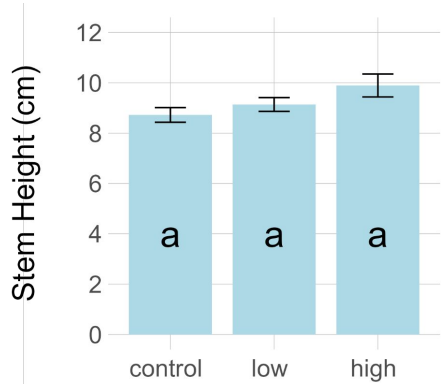
Urine was applied to seedlings at three rates:

1. **High** - .13L per ft sq
2. **Low** - .07L per ft sq
3. **Control** - no urine

Roughly 50% of the high treatment group seedlings were sellable, compared to only a handful from low and control groups

Current Project

Urine Treatment Effects on Hickory Seedling Growth



*Bars marked by the same letter are not significantly different from each other

Current Project - Dialogue Groups

Social research dialogue groups - two completed, one more to do

Initial Reactions: *"It was exciting when I first heard about it... in terms of sustainability." "Learning of urine separation, and it's being decoupled from industrial processes and industrial fertilizer, that seemed amazing that we weren't we already doing it on a much larger scale!" [laughing]*

Concerns: *"I wonder how they manage to ensure it's safe and clean?"
"I wonder if that pasteurization process takes away the pharmaceuticals that run through our societal systems?"*

"Are we doing the right thing, in order to do the right thing?"

Current Project - Dialogue Groups

Social Research - two dialogue groups completed, one more to do

Familiarity with other fertilizers: there was awareness of not really knowing all that much about the composts, manures, and other fertilizers farmers use, but *"What I know about the world of synthetic fertilizer is just that it's like... one of the most energy intensive processes you could find... it's a big part of our carbon footprint."*

Labeling: *"I like 'peecycling' because, like recycling, it puts it in the 'going green' category."*

"'Urine derived fertilizer' speaks to a process of a raw material that creates an inherent trust....it talks about the pathway through which it becomes something that can be applied...that seems easier to accept."

Current Project - Buyer Interviews

Social research buyer interviews - one completed, three more to do

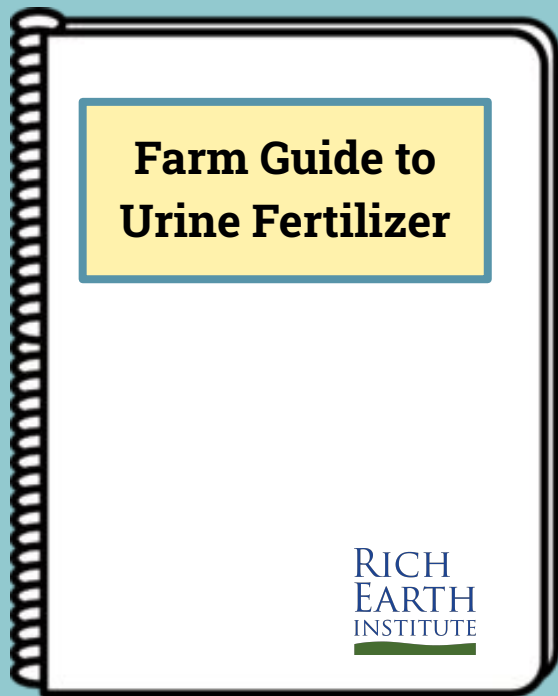
Interest: *"To me it would almost be a better alternative than just chemically derived nitrogen... man-made synthetic stuff... to me [that] is just worse.... Now I'm a little more comfortable with it...[after learning about sanitization methods]"*

Concerns: Organic certification would be very helpful. Without that, would want assurance of when it was applied, how it was applied, no residue on plants, etc. Would have fewer concerns for non-edible crops like flowers or animal feed.

Labeling: Mixed feelings about this - since most produce is not labeled with regard to fertilizer use, *"Do we even need a label? Would it matter?...but, at the same time, it would be kind of groundbreaking...in time it would be accepted."*

Education: Having pamphlets would be helpful. *"[To be] armed with the knowledge so I could pass it on to the customer... that would be awesome – minds would change."*

Current Project - Farm Guide



Contents:

Safety

- Sanitization
- Heavy metals
- Pharmaceuticals
- Antibiotics
- PFAS

Characteristics of urine fertilizer

- Nutrient content
- Ammonia volatilization
- Salt accumulation
- Effect on soil pH

Application Methods

- Calculating application rates
- Application Timing
- Dilution
- Application equipment
- Combining with Other Amendments

Experiences with Specific Crops

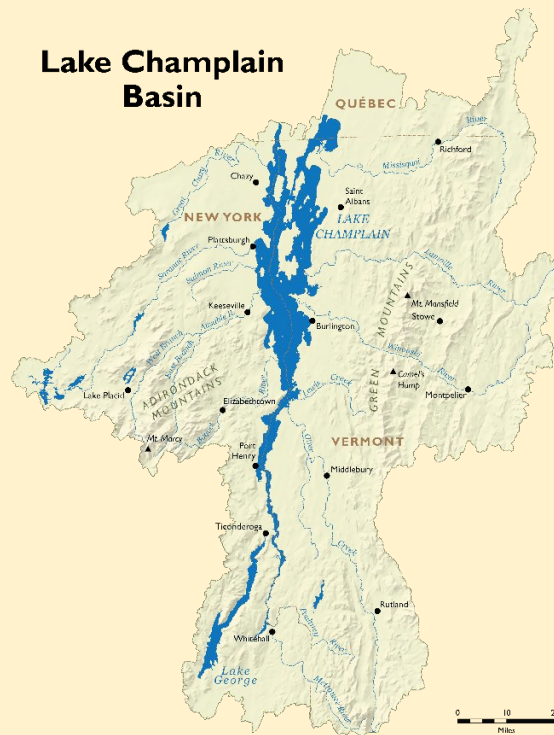
Talking with Consumers & Buyers

Future Urine Fertilizer Availability

Vermont

Lake Champlain Watershed

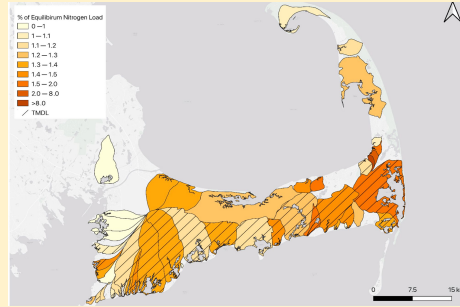
Mitigating nutrient pollution: Urine fertilizer can provide sufficient nitrogen on lands with extensive phosphorus build-up from historic manure/compost applications.



wasted 

Future Urine Fertilizer Availability

Cape Cod



The Enterprise
FALMOUTH

Falmouth Water Quality Committee
Endorses Urine-Diversion Pilot

By GILDA GEIST Feb 9, 2024 0

Falmouth Pond Coalition



The Green Center



Massachusetts Alternative
Septic System Test Center



Questions for Discussion

- *Farmers in Audience - further questions if you were interested in using urine fertilizer?*
- *What would be most important to you to have in the farm guide?*
- *What new research questions emerge for you?*
- *Other questions???*