

Medicine to Agriculture

Microfluidic-Produced N-Loaded Liposomes as Enhanced Efficiency Fertilizer

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PhD Candidate, University of Pittsburgh



University of
Pittsburgh



Before²



Toxic algae: Once a nuisance, now a severe nationwide threat

ENVIRONMENT

Severe **algae bloom** spells big trouble for Lake Erie

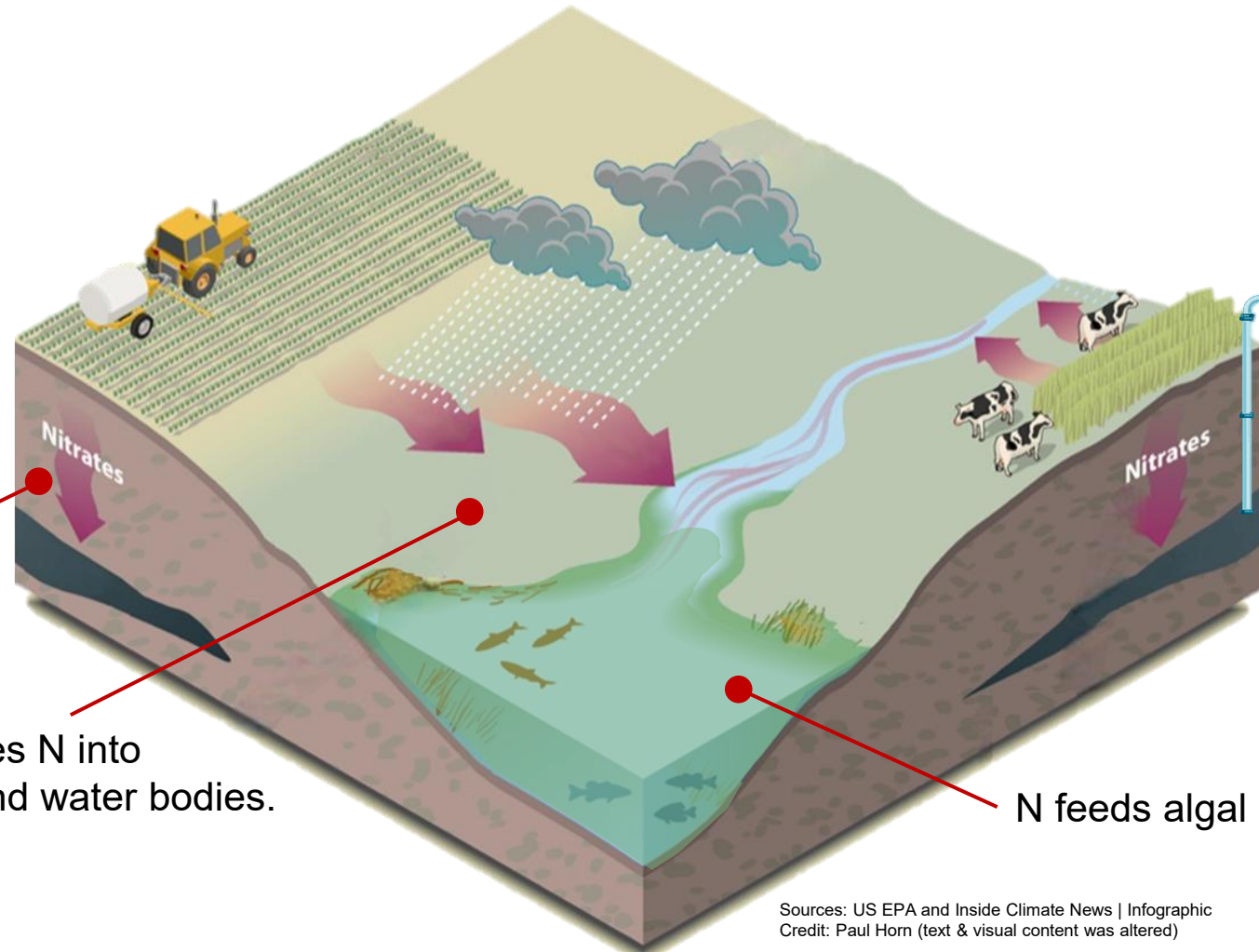
Toxic **algae bloom** causes Florida state of emergency

*Fertilizers, a Boon to Agriculture, Pose Growing **Threat** to U.S. Waterways*

Environmental Threats of Nitrogen (N) Fertilizer Waste in Agriculture



\$160B



Contaminating groundwater.

Runoff washes N into waterways and water bodies.

N feeds algal bloom.

Drinking water contamination.

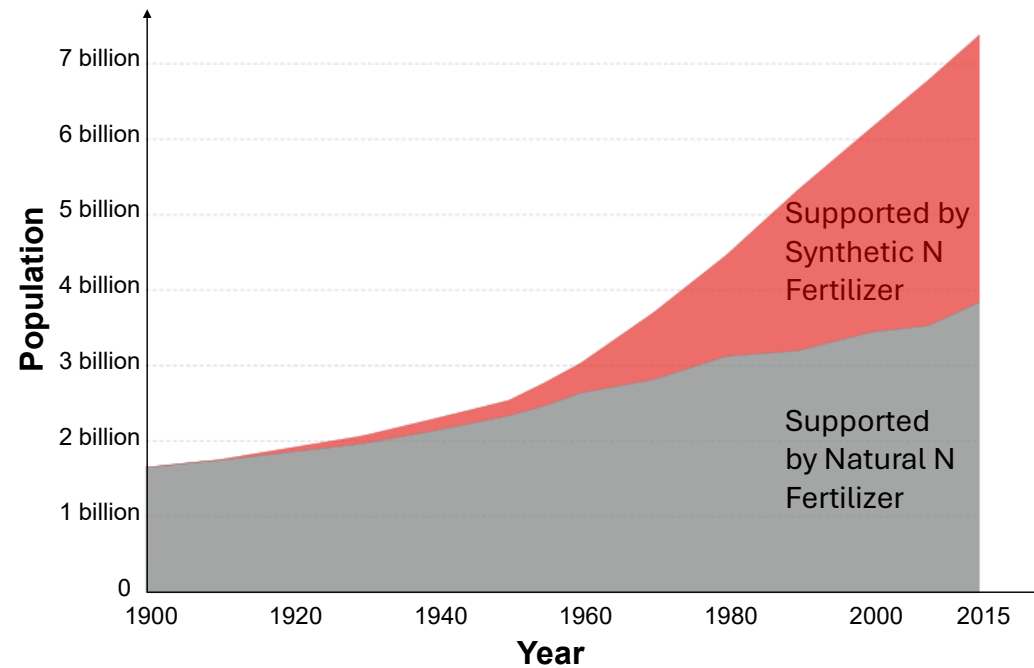


Glass of water from Lake Erie during 2014 Algae Bloom

Sources: TidesandCurrents.noaa.gov
Credit: Dave Zapotosky.

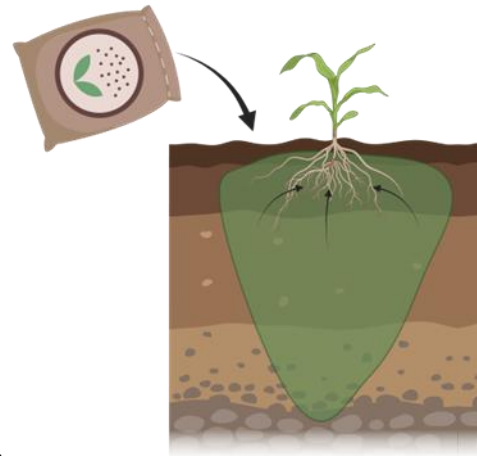
N Fertilizer in Agriculture: Feeding the world, yet Wasteful

2 out of every 5 people on Earth today owe their lives to the higher crop outputs that fertilizer has made possible. — *Bill Gates, 2013.*



Source: ourworldindata.org
Data from: Erisman, et al. *Nature geoscience* (2008), Stewart, et al *Agronomy journal* (2005), and Smil *AMBIO* (2002).

**Low
Nutrient Use
Efficiency
(NUE):**

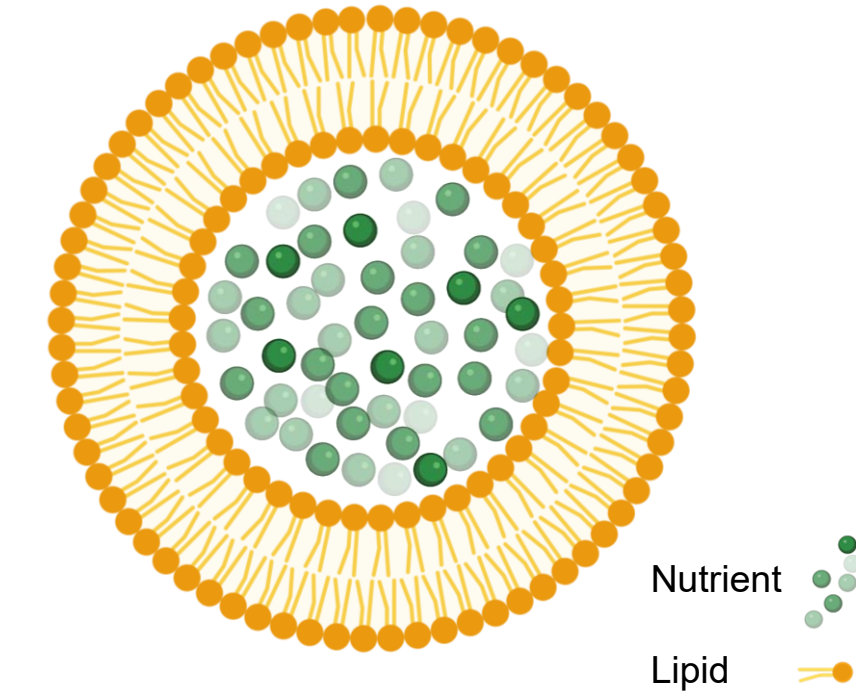
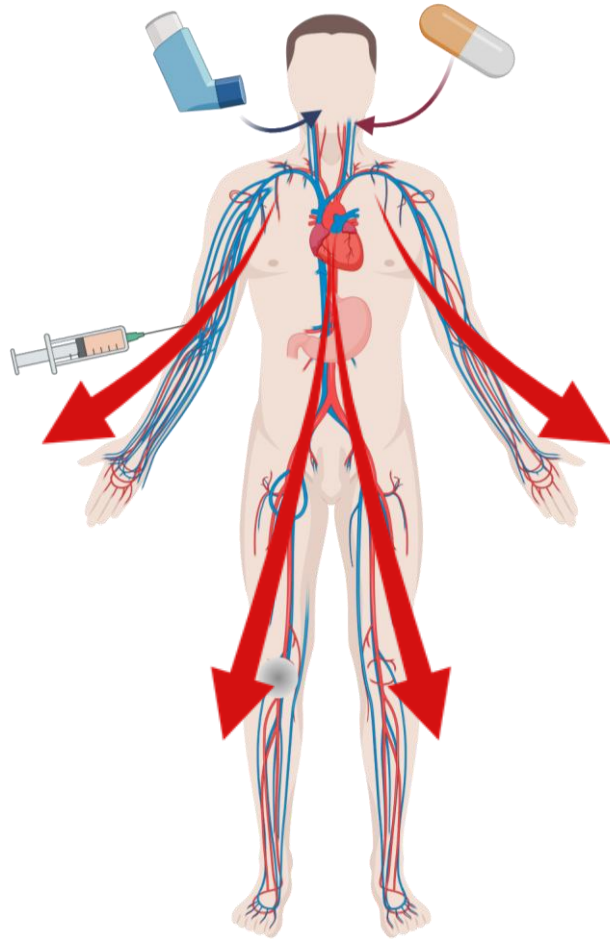


AGRINUE

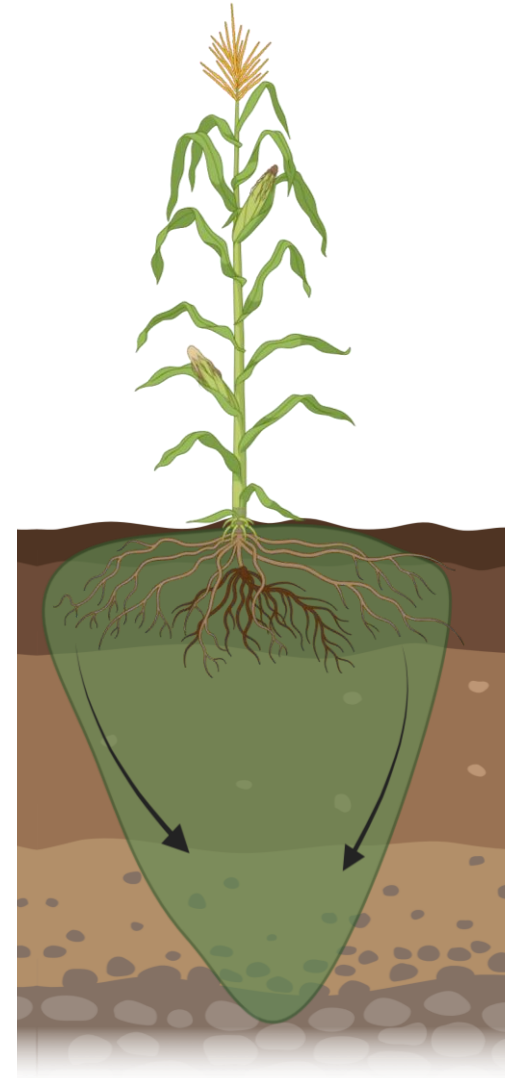
AGRIINUE

The logo for AGRIINUE is a green gear with a plant growing inside. The plant has two leaves and is growing out of a small mound of brown soil. Above the gear, there is a DNA double helix structure, symbolizing the intersection of agriculture, technology, and biology.

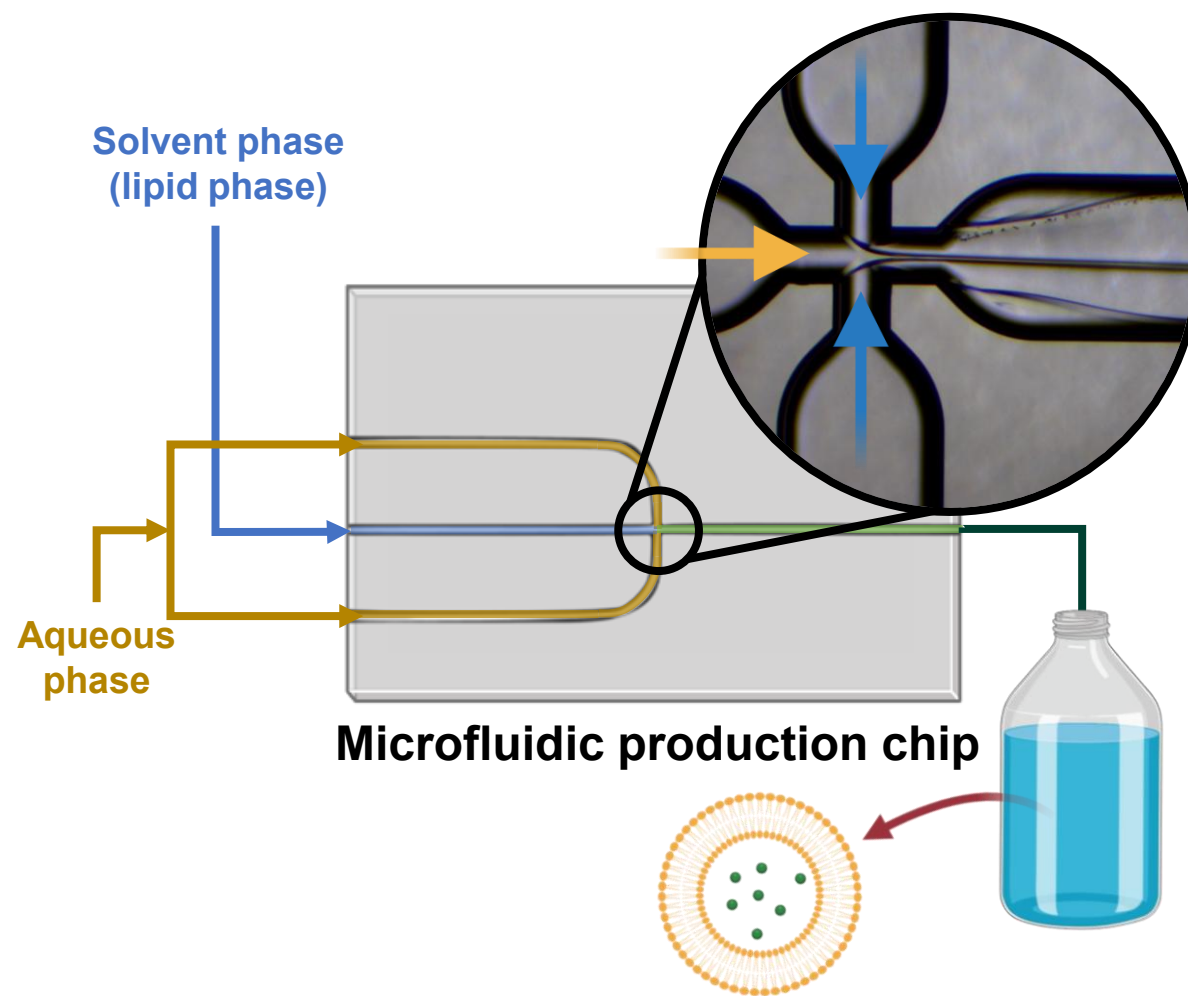
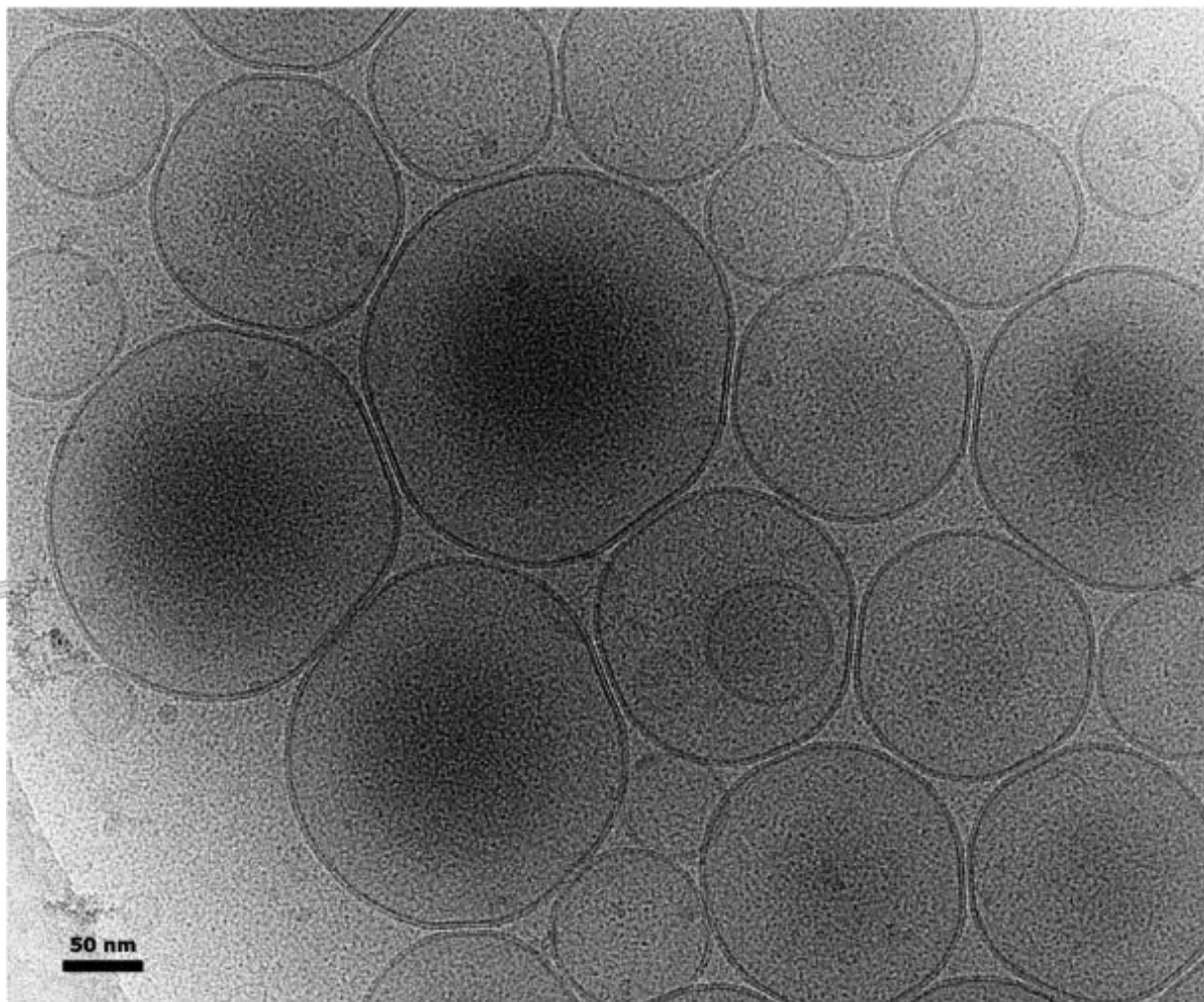
AgraNUE: From Medicine to Agriculture!



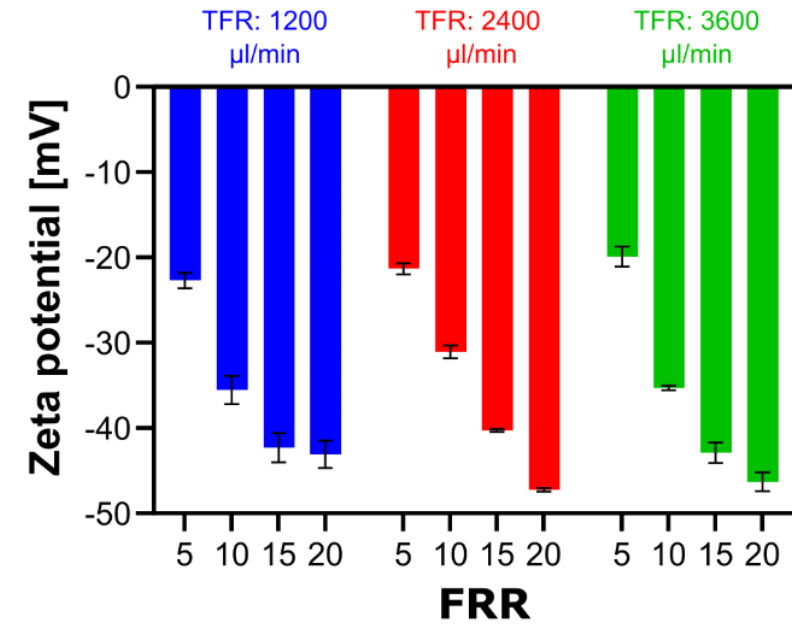
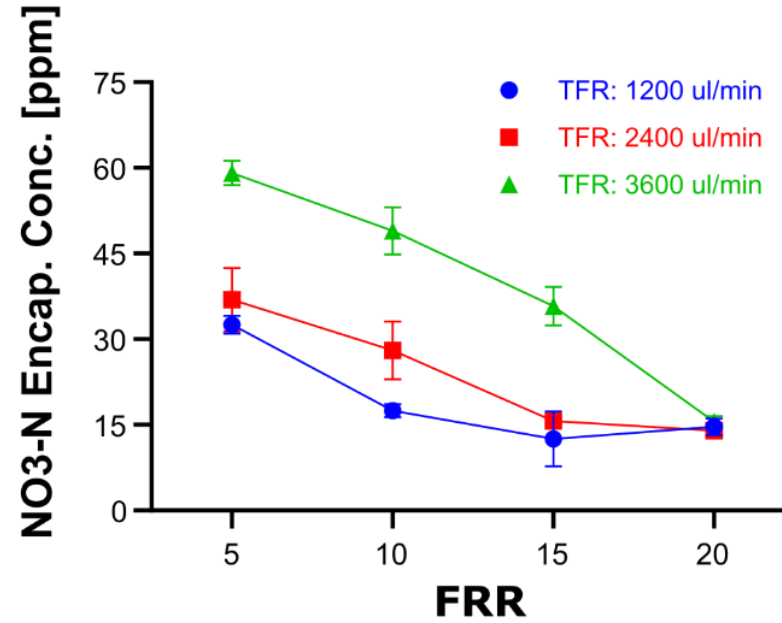
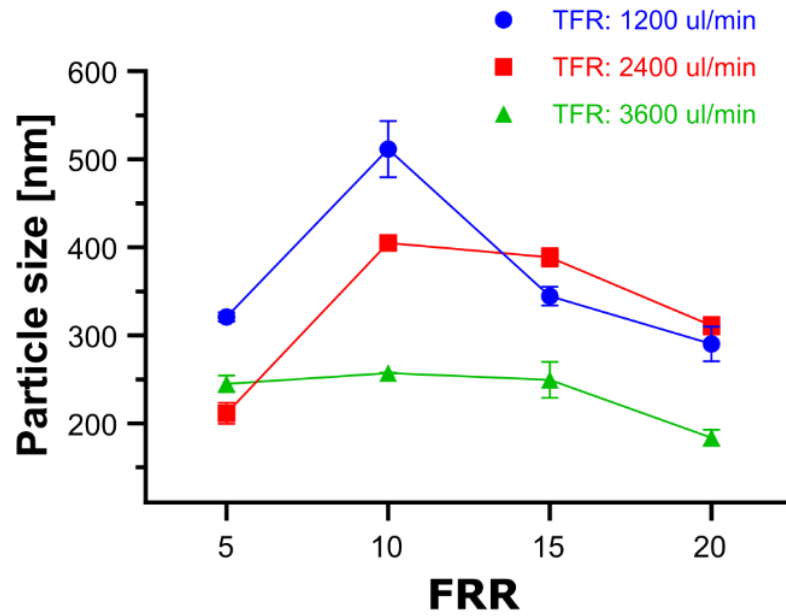
**Liposomal
delivery system**



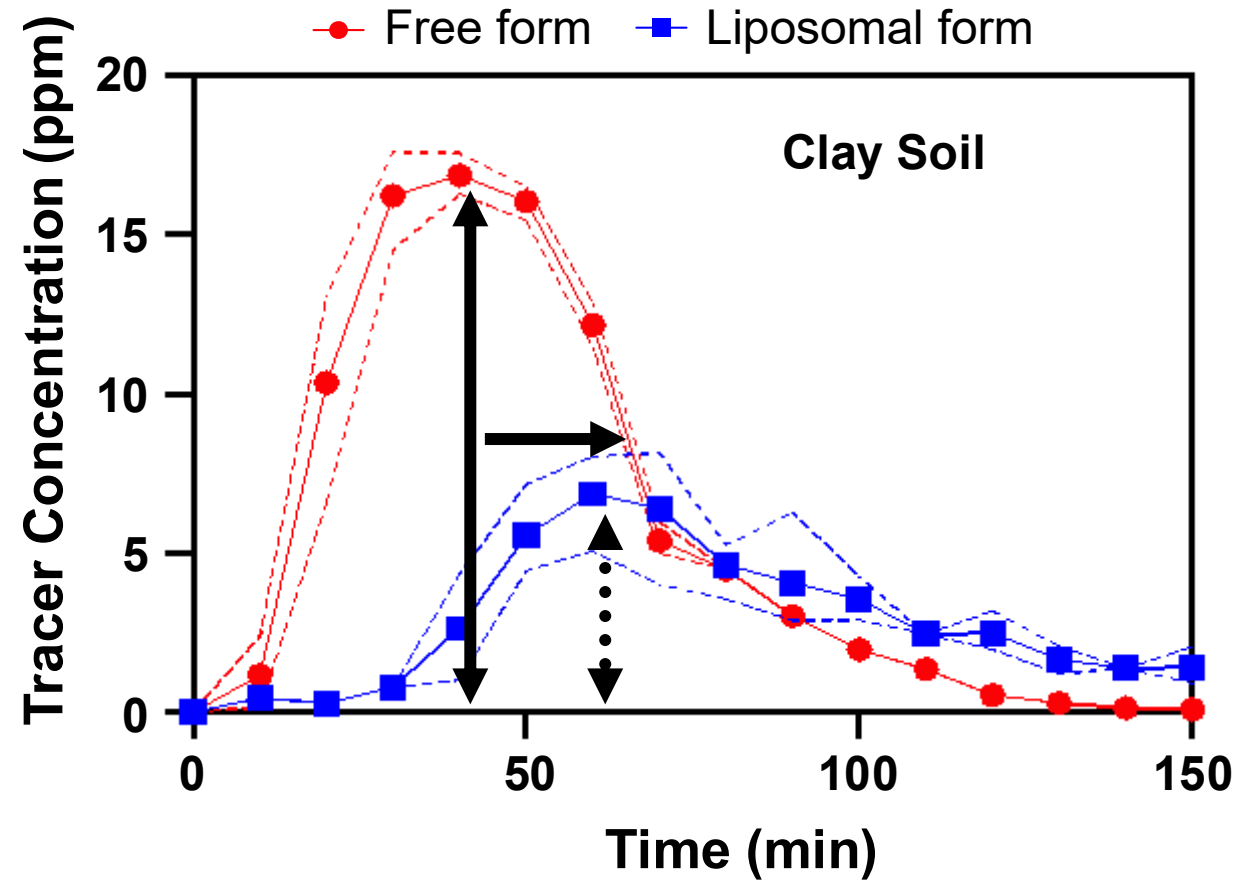
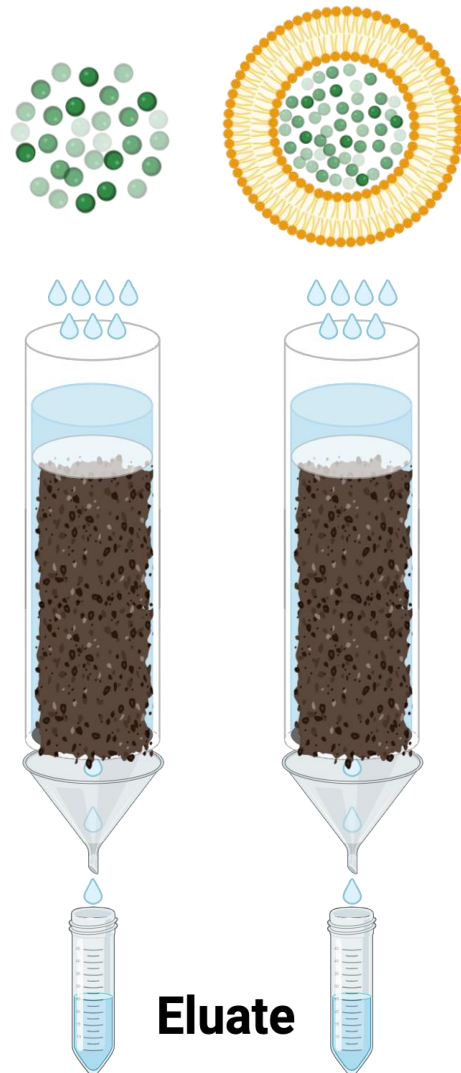
Lab to Land: Meeting Agricultural Demands



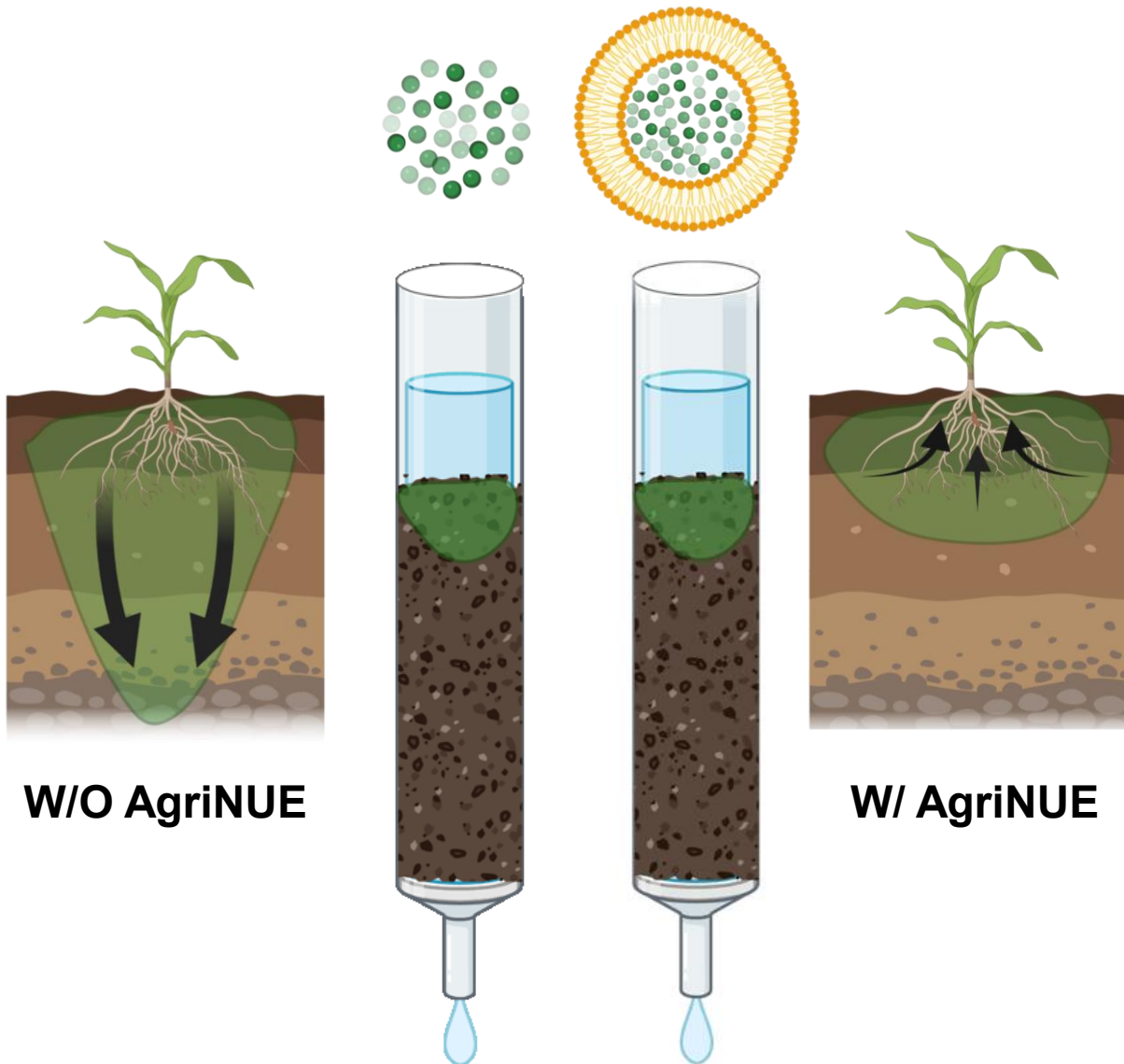
AgriNUE possess Tunable Properties



AgrINUE Slows Nutrient Transport in Soil

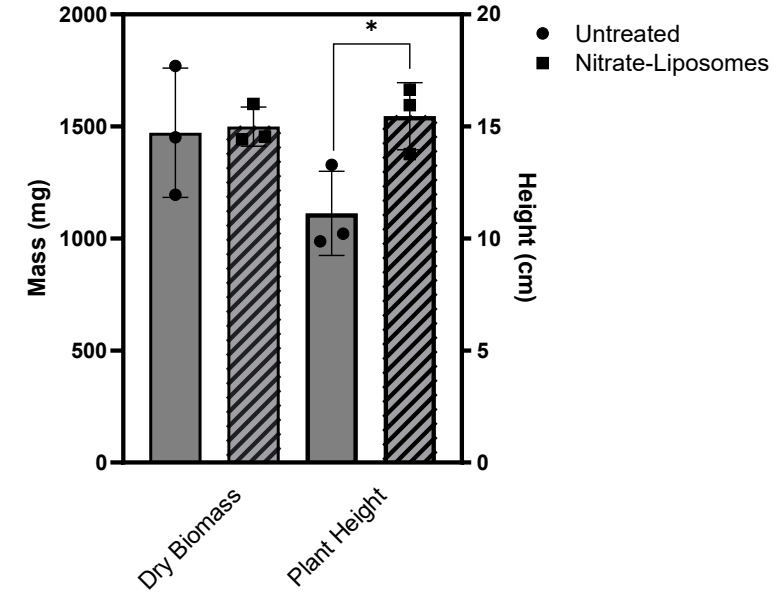
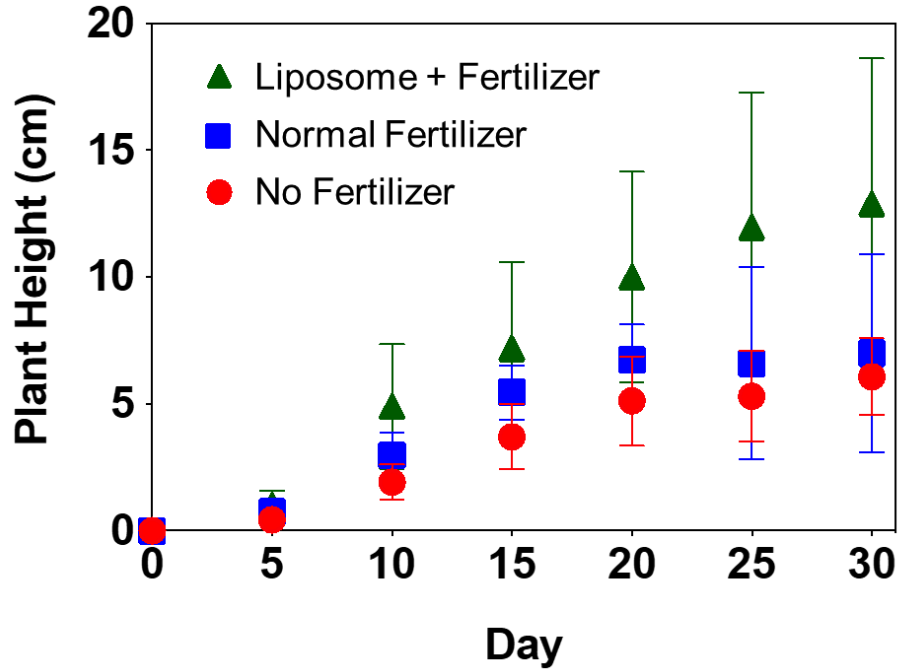


AgriNUE Slows Nutrient Transport in Soil



60%
**Less
Waste**

AgrINUE is non Toxic to Plant Growth



Corn images do not represent data in the growth figure.





**Keep This an
ALWAYS-Image, Not a Before-Image!**



Prof. Steven Little



Prof. Leanne Gilbertson



Prof. Emily Elliott



Sai Pamuru, PhD



Patrick Dunn, PhD



Camille Butkus, MSc



Nihan Yonet-Tanyeri, PhD



Julie Weitzman, PhD



Pratirupa Bardhan, PhD



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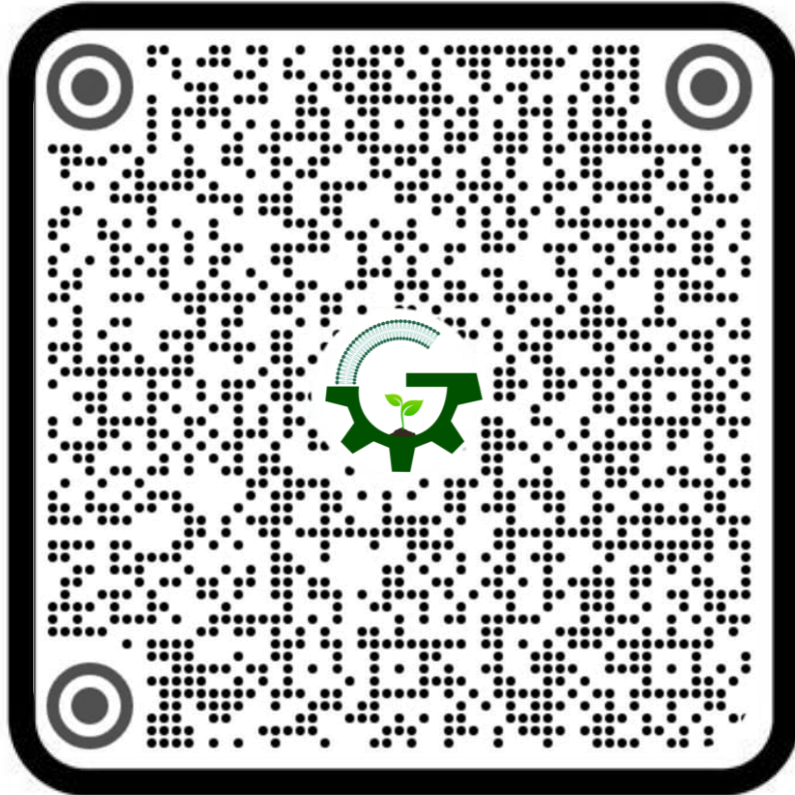


Mia Van Heerden

Let's Connect!

alm462@pitt.edu

SCAN
ME!



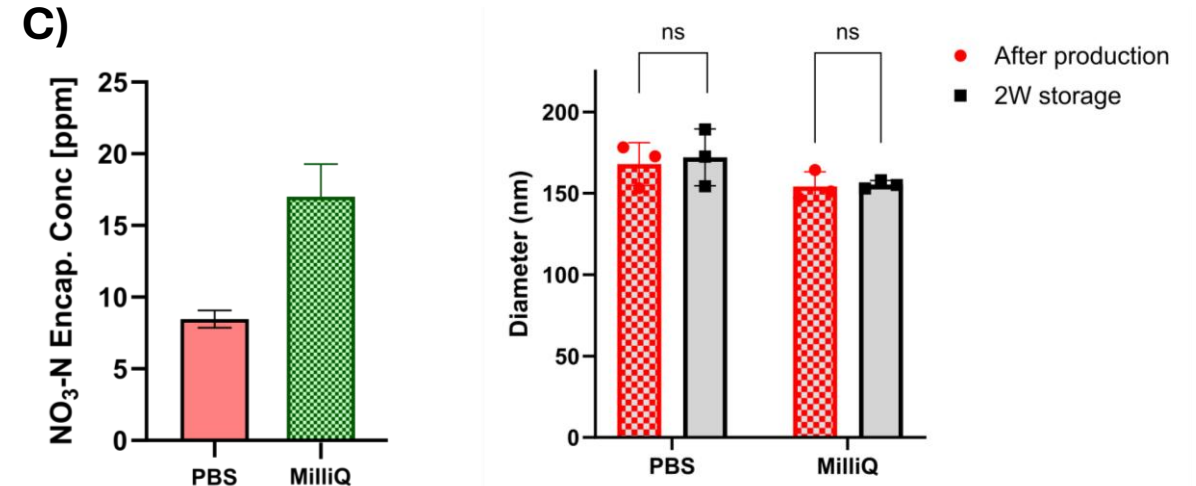
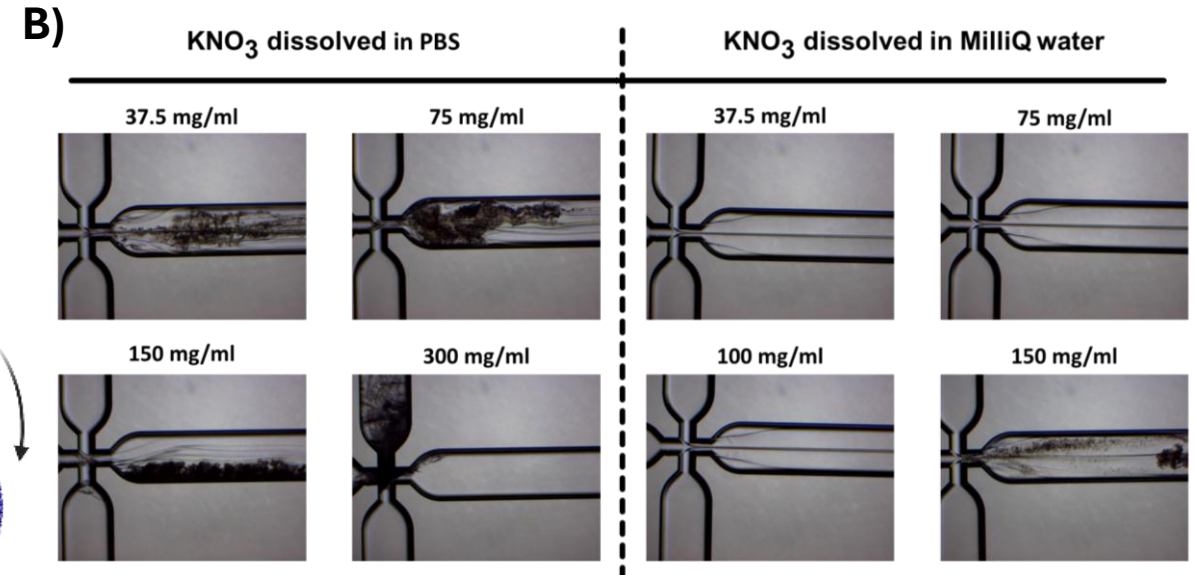
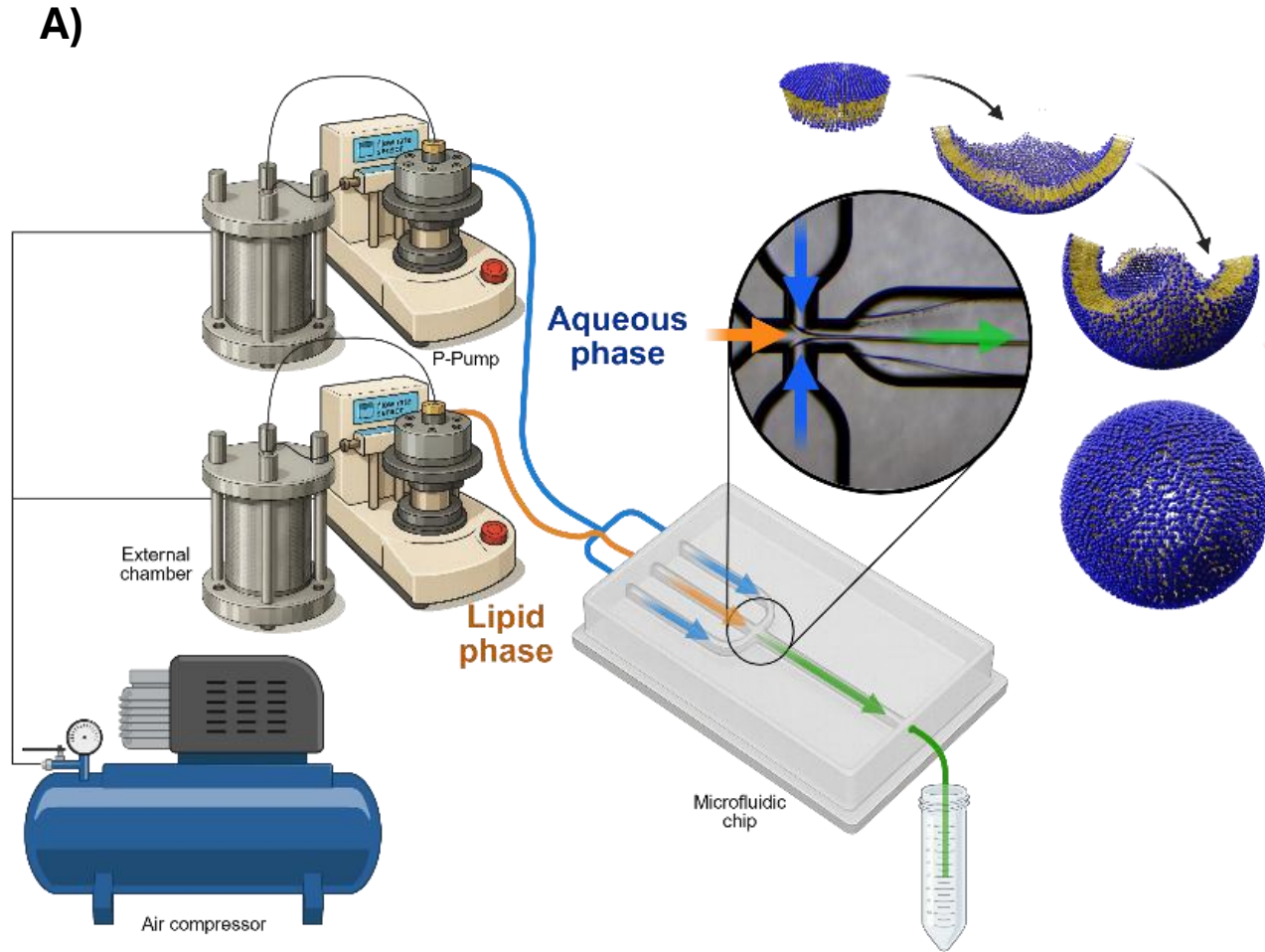
Medicine to Agriculture: Microfluidic-Produced N-Loaded Liposomes as Enhanced Efficiency Fertilizer

Alireza Mohammadzadeh¹, Patrick Dunn², Sai Thejaswini Pamuru³, Max Miller¹,
Amaechi Ijoma⁴, Mia Van Heerden¹, Nihan Yonet Tanyeri⁴, Julie Weitzman⁵,
Camille Butkus⁵, Emily Elliott^{4,5}, Leanne Gilbertson³, Steven Little^{1,4}

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³ Department of Civil and Environmental Engineering, Duke University

AgriNUE produced via scalable method



AgriNUE: from Safe, Biodegradable, and Eco-Friendly Materials

Plant-derived lipid:

- Soybean Lecithin
- Sunflower Lecithin

Other ingredients:

- KNO_3 in water
- Isopropyl Alcohol (IPA)

**Lipid-Packaged
Fertilizer**



Non-Toxic



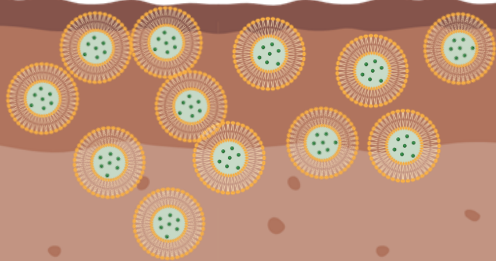
Biodegradable



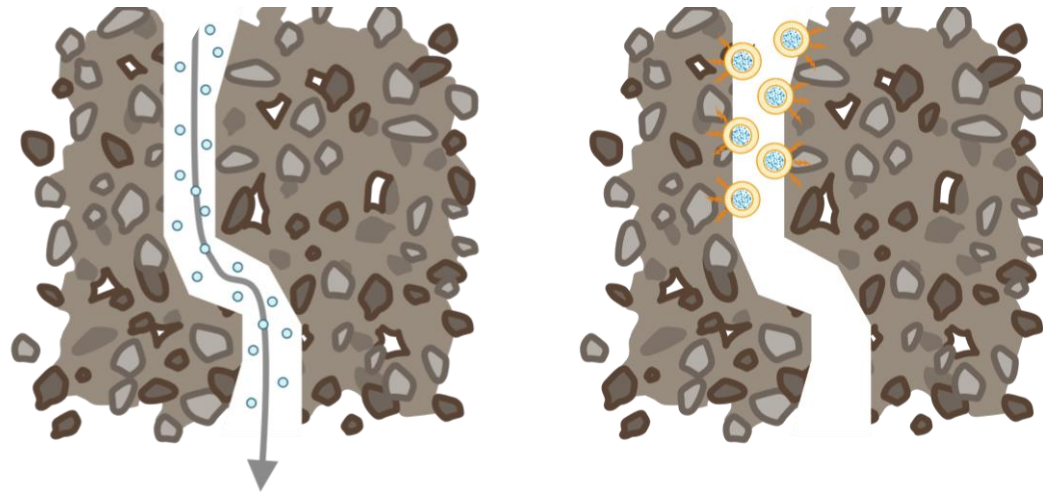
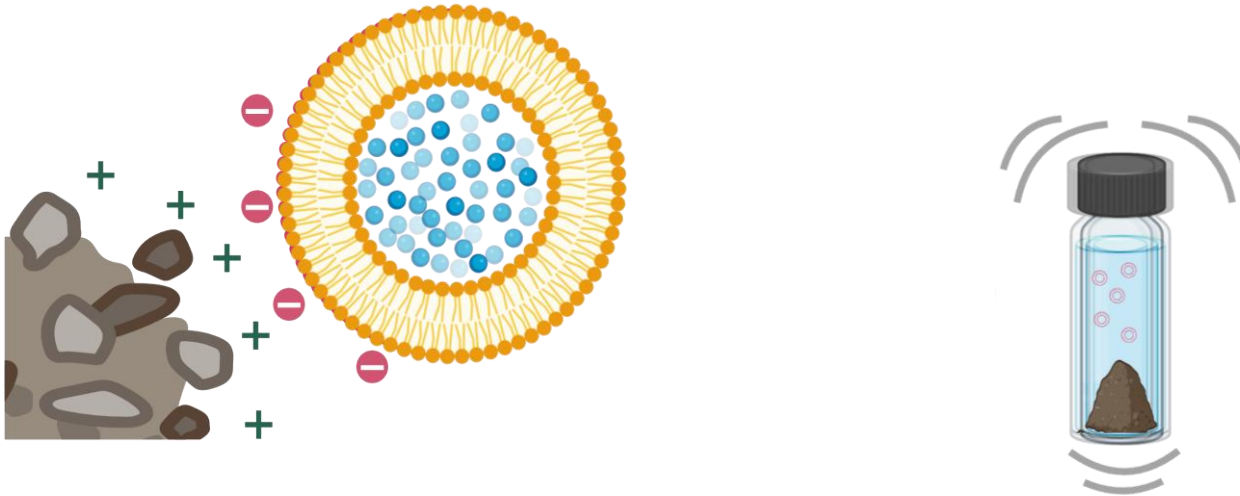
Green Solvent



Scalable

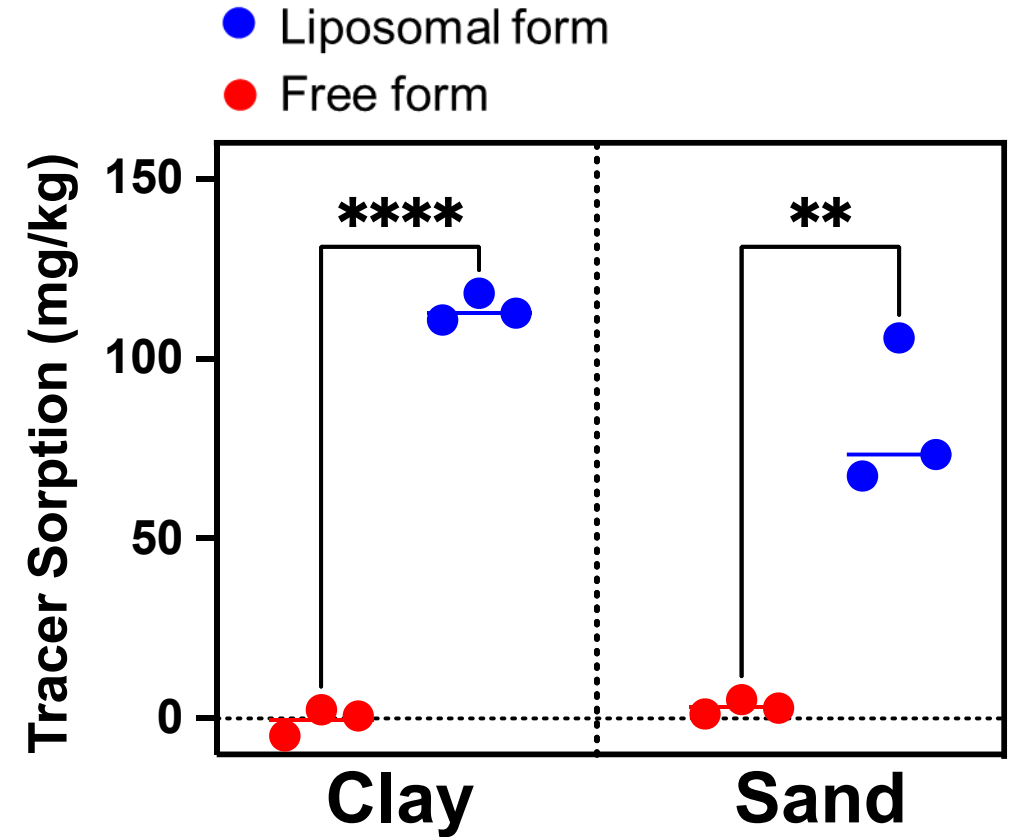


AgriNUE Carriers Stick to Soil Particles.

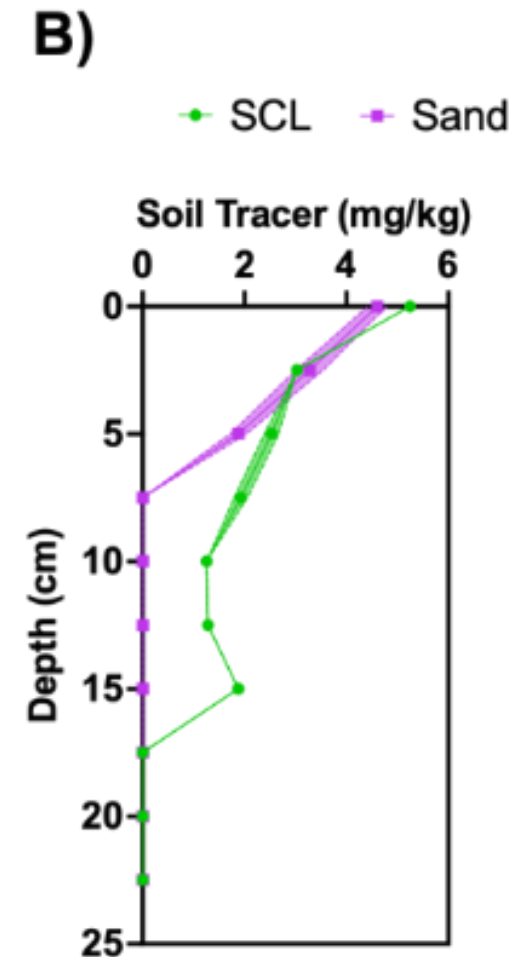
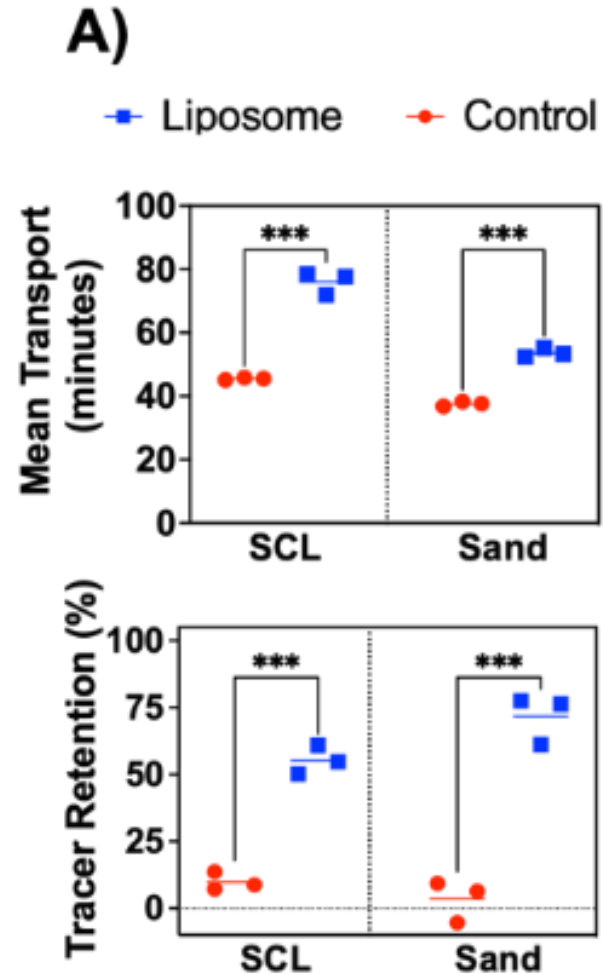
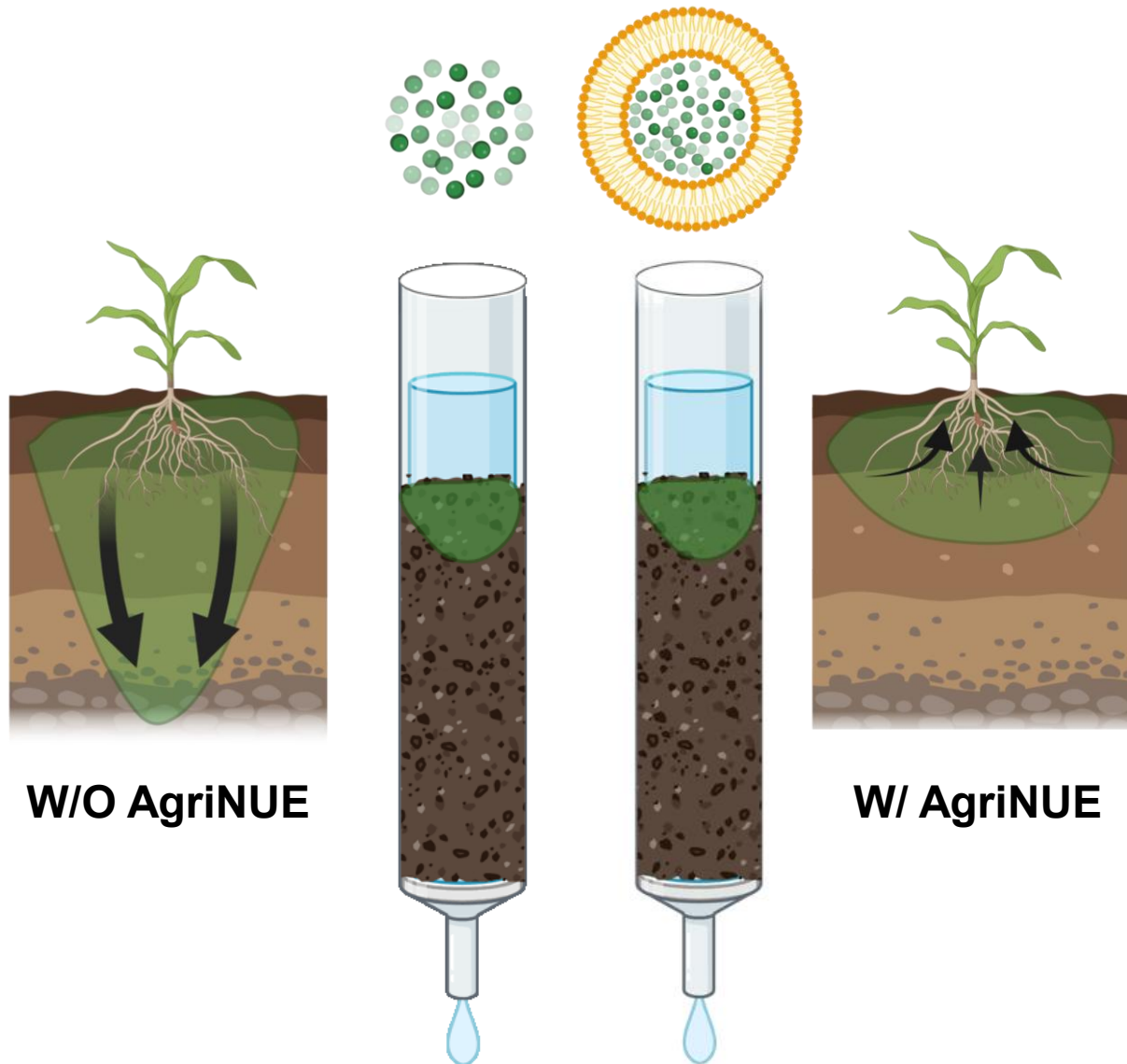


W/O AgriNUE

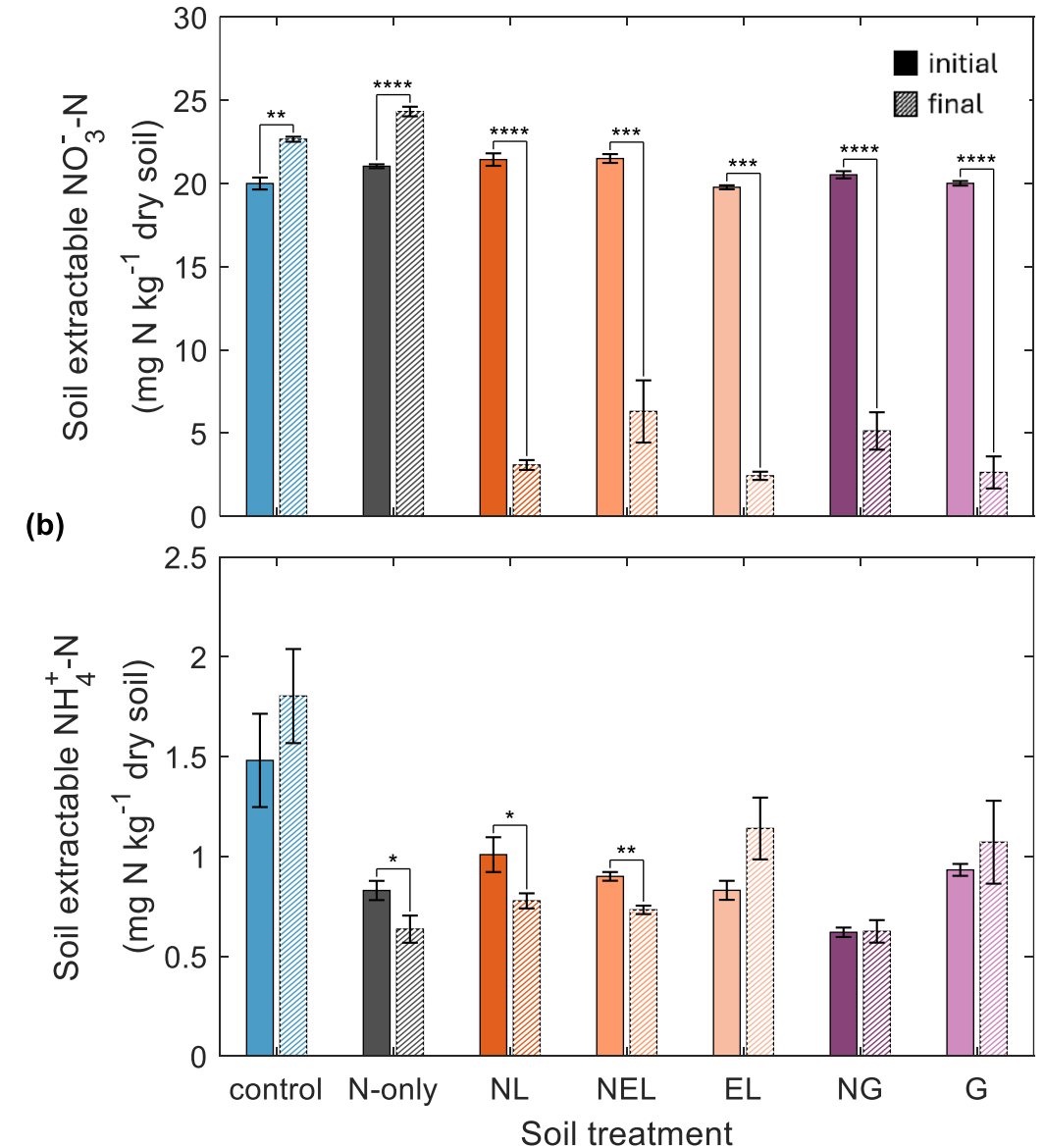
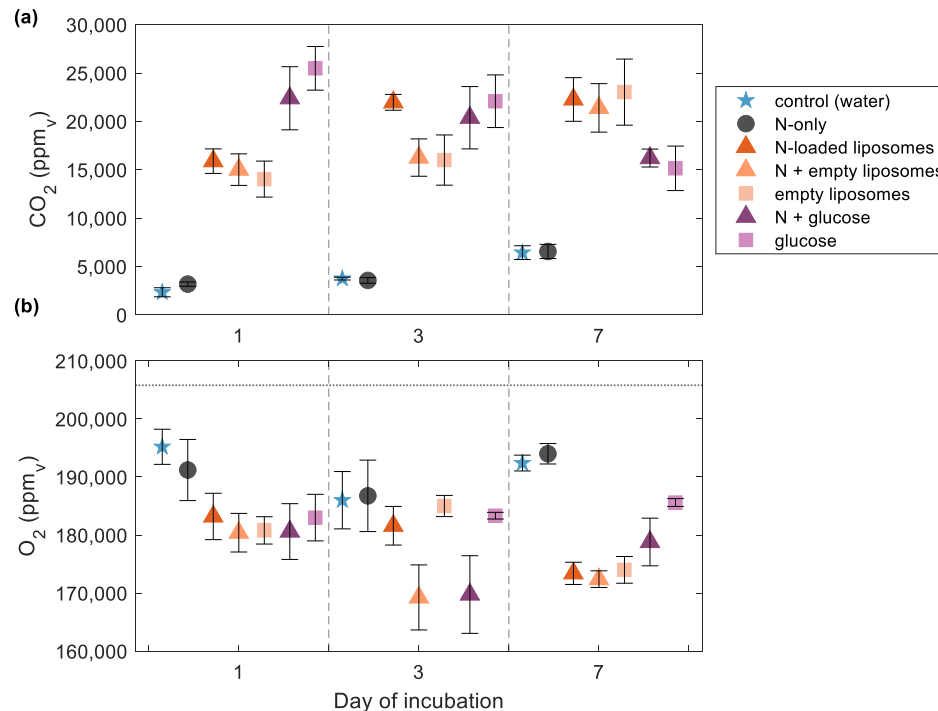
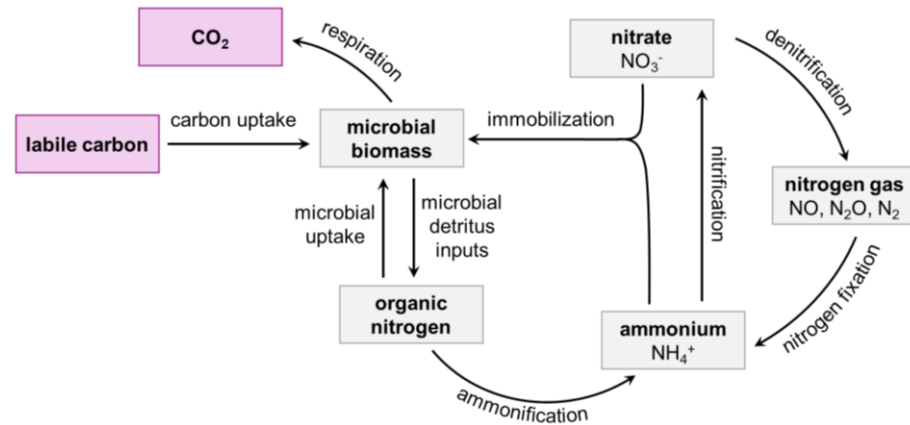
W/ AgriNUE



AgriNUE Keeps the Nutrient at the top of the Soil



AgrINUE Increases Microbial Activity Leading to N Immobilization.



Release of N from AgriNUE: Cholesterol reduces the release but

