# Depackaged Food Waste & Microplastics


*Presenter*:

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Assistant Professor, Rubenstein School of Environment & Natural Resources + Civil & Environmental Engineering

Fellow, Gund Institute for Environment

University of Vermont

*Graduate students doing the hard work*:

**Kate Porterfield** & **Sarah Hobson**

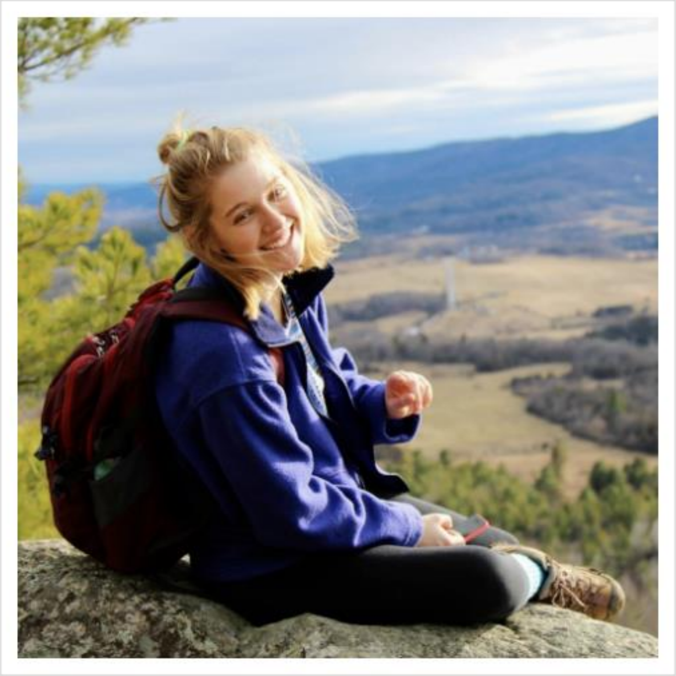

The University *of* Vermont

# Work at UVM in this area is being led by two fantastic graduate students working in my lab

**Sarah Hobson, M.S. Student in Natural Resources**

**Kate Porterfield,**

**Ph.D. Student in Civil & Environmental Engineering**



Funding provided by Casella

& the Gund Institute for Environment

# Depackaging systems separate organics from non-organics

South San Francisco Scavenger Company installs depackaging system (pre- dry AD)

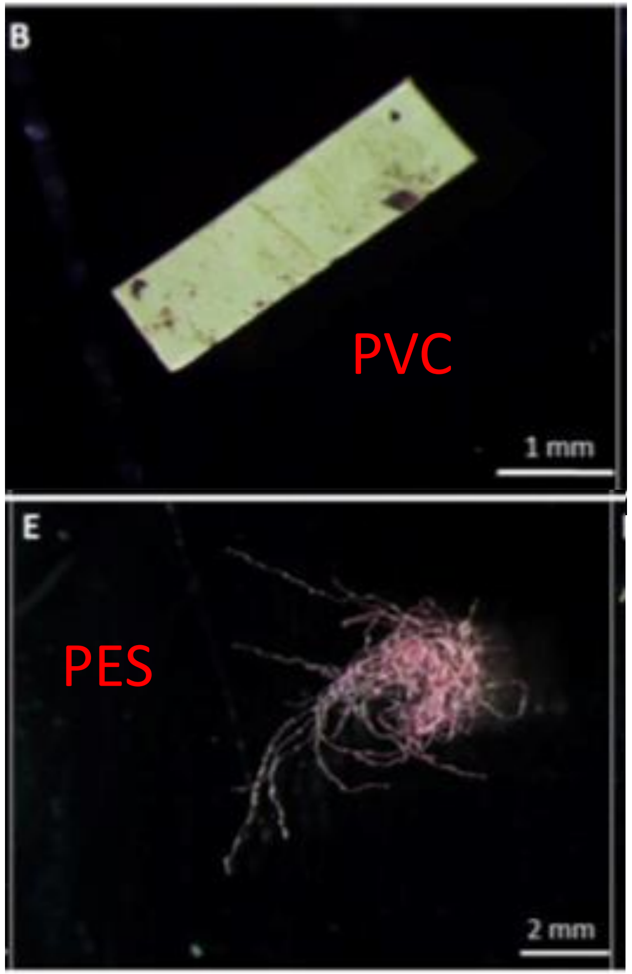

Packaged Food Waste

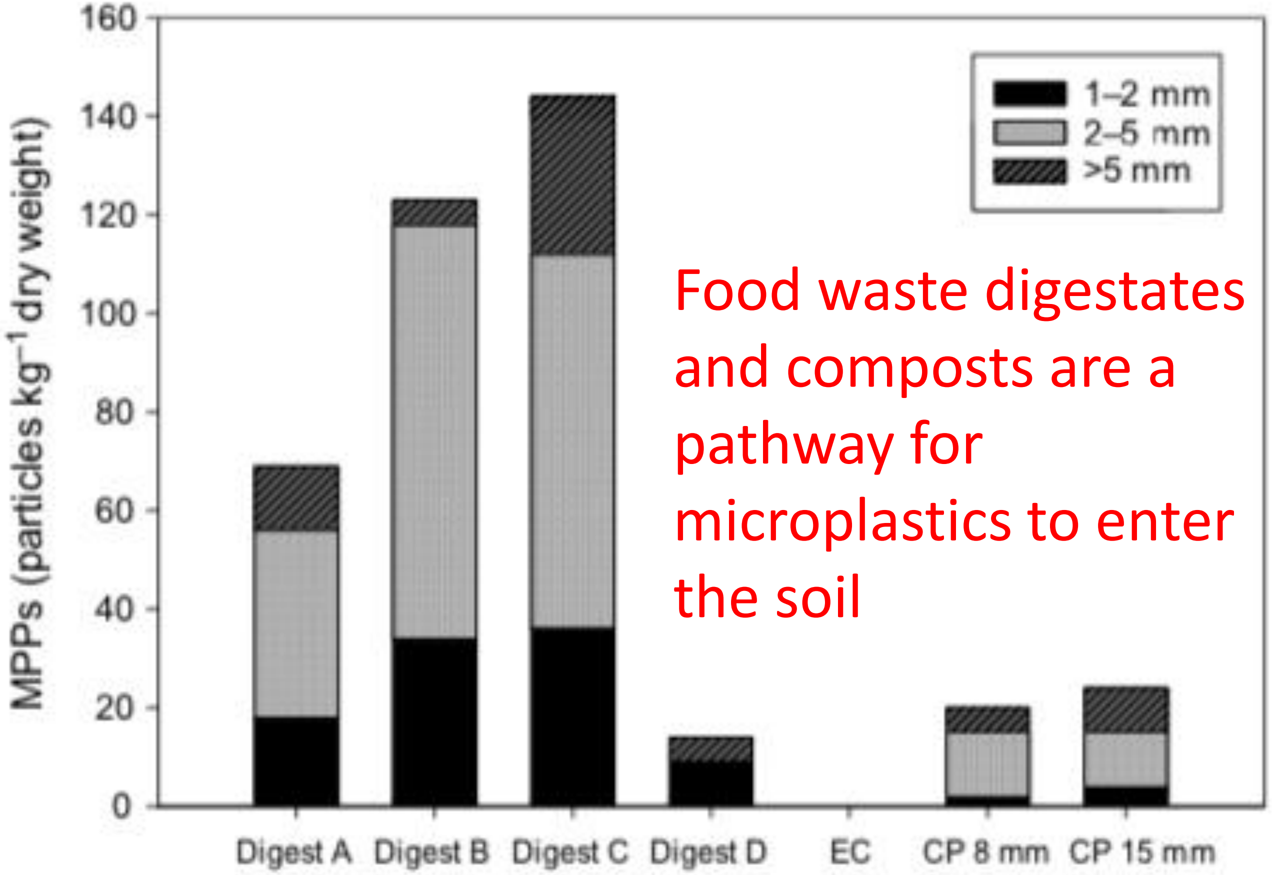

Organic “Mash”


Reject Contaminants

Nora Goldstein for Biocycle, May 2018

# Land application of organic residuals derived from food waste can introduce microplastics into soil




Food waste digestates and composts are a pathway for microplastics to enter the soil

**Fig. 1. Size fractions of MPPs in different fertilizers.** Digests A/B/C/D, biowaste digester; EC, energy crop digester; CP 8 mm/15 mm, biowaste composting plant.

Weithmann et al. 2018

# Microplastics Literature Review
# Digestates and Composts derived from food waste

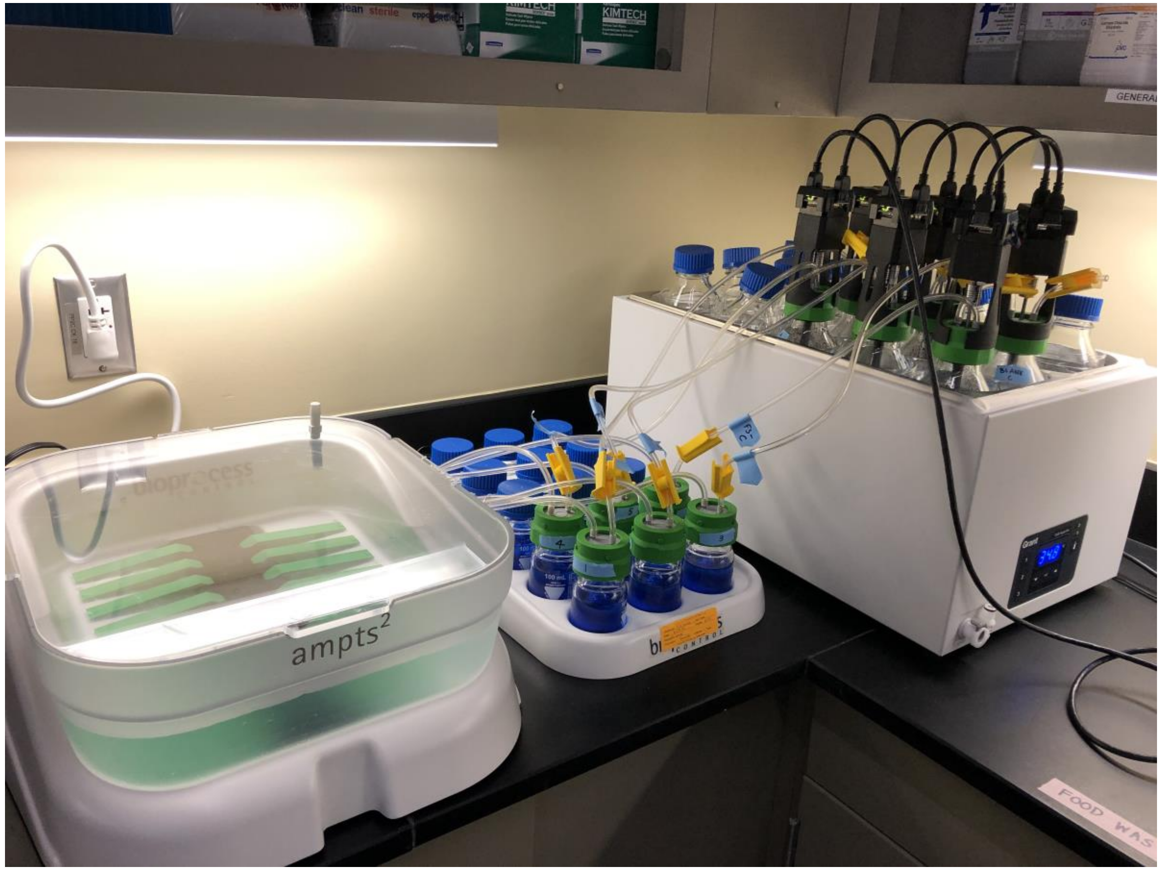
- 12 papers providing original data on microplastics in organic residuals were identified and reviewed
- Values for both composts and digestates typically ranged from ~20 particles to 2,800 particles per dry kilogram of material
- One study reports over 1,000,000 particles per dry kilogram of material for both composts and digestates
- Variability is likely driven by multiple factors, including feedstock, processing, and methods used to detect microplastics (e.g. size fractions included).
- **Note:** Our very early preliminary data suggest that our counts for digestate derived from feedstocks including depackaged food waste fall within typical range. More samples currently being analyzed.

# Depackaged Food Waste Characterization (our UVM study in progress)

- **Pre-consumer and post-consumer food waste**
  - Packaged ice cream pints, food scraps
- **Anaerobic Digestion Suitability**
  - Biochemical Methane Potential (BMP)
  - Chemical Oxygen Demand (COD)
  - Total Solids, Total Volatile Solids, pH, Carbon, Nitrogen, Phosphorus, Sulfur
- **Microplastics Content**
  - Organic matter digestion (chemical v. biological)
  - Size distribution (0.5 – 1 mm, 1 – 5 mm, > 5 mm)
  - Plastic type (FTIR Spectroscopy)

# Pre- and Post-Consumer Food Waste


# Measuring Biochemical Methane Potential (BMP)

BioCycle
THE ORGANICS RECYCLING AUTHORITY
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OCTOBER 19, 2021 | AD & BIOGAS, CONTAMINATION, FOOD WASTE

# Measuring Microplastics

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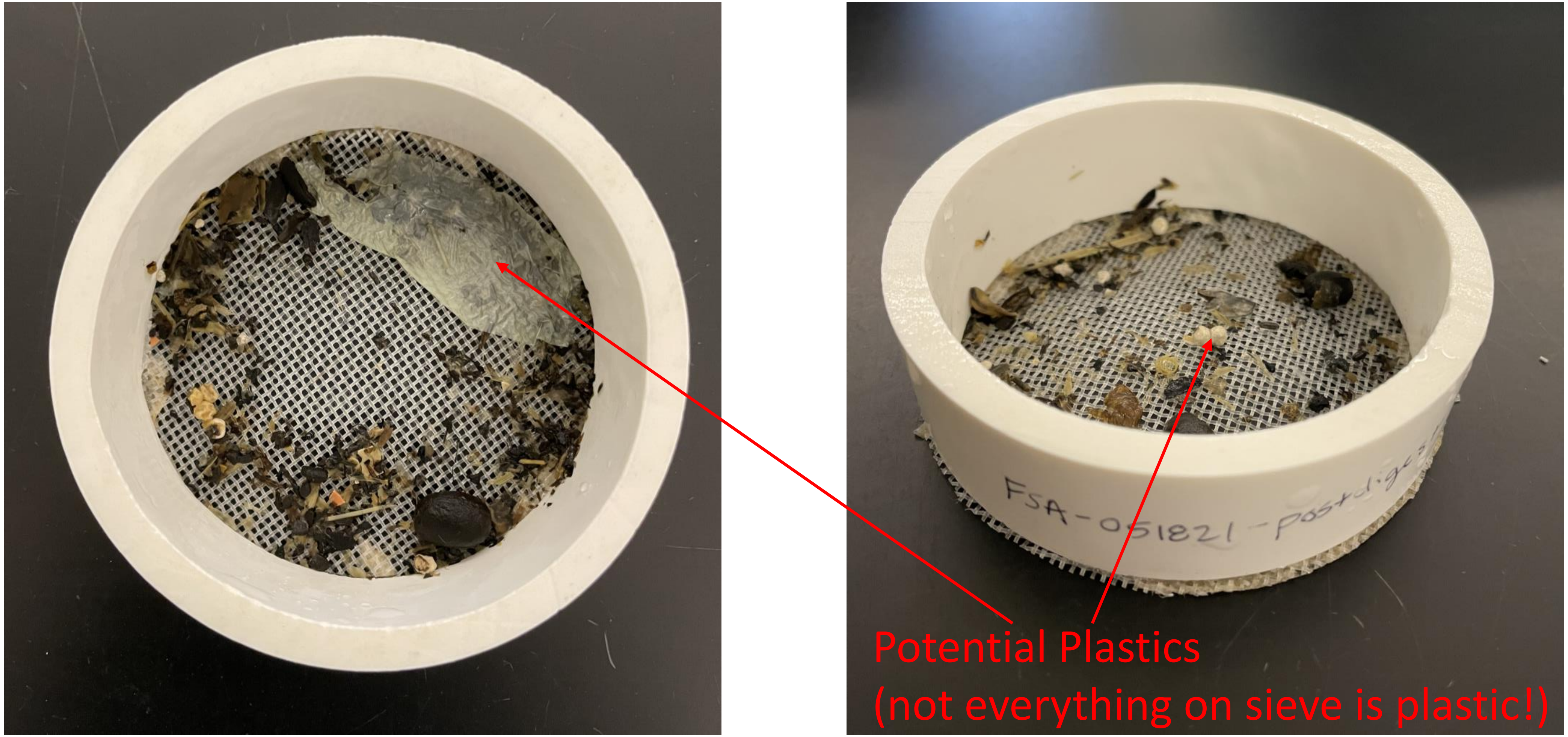
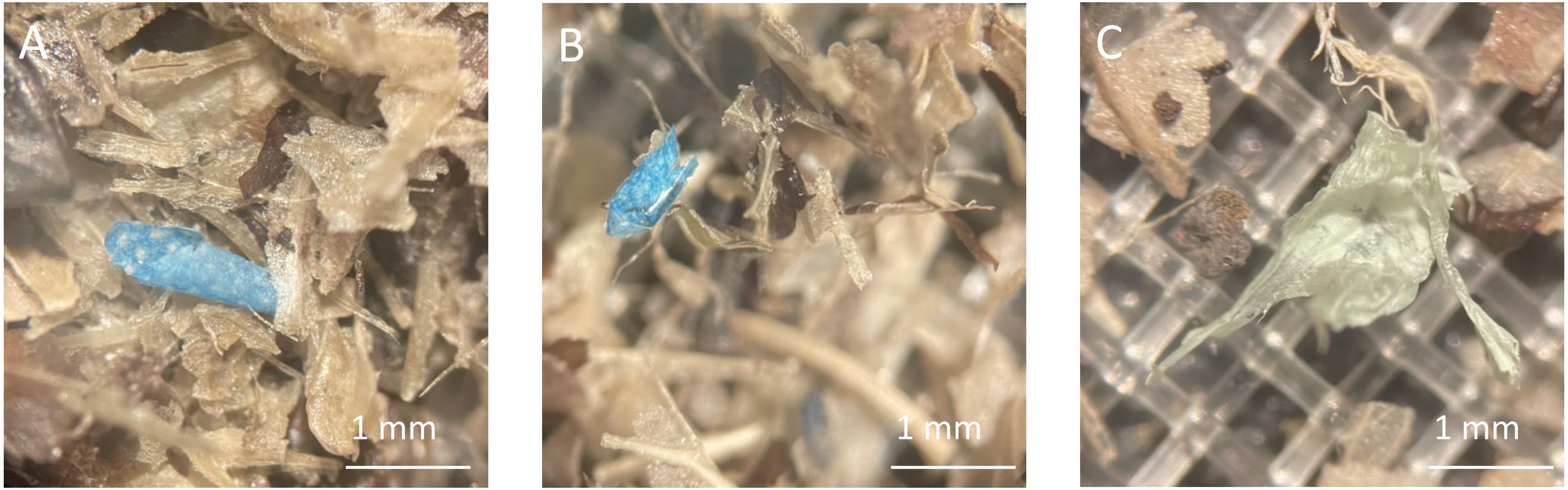
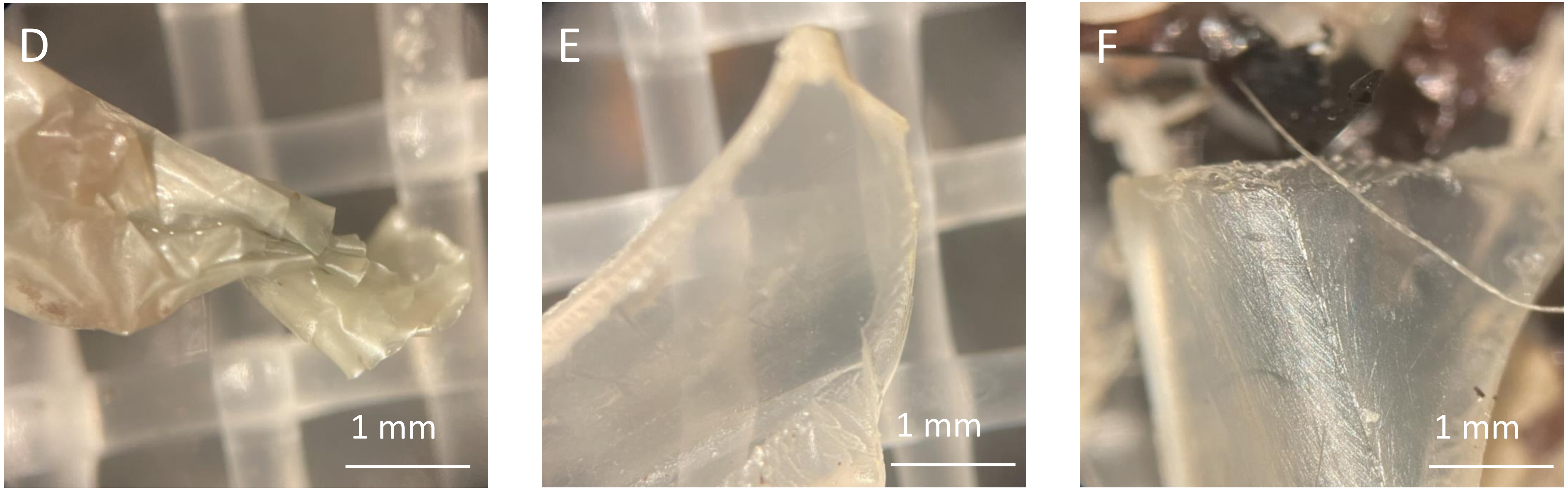
# Measuring Microplastics Content

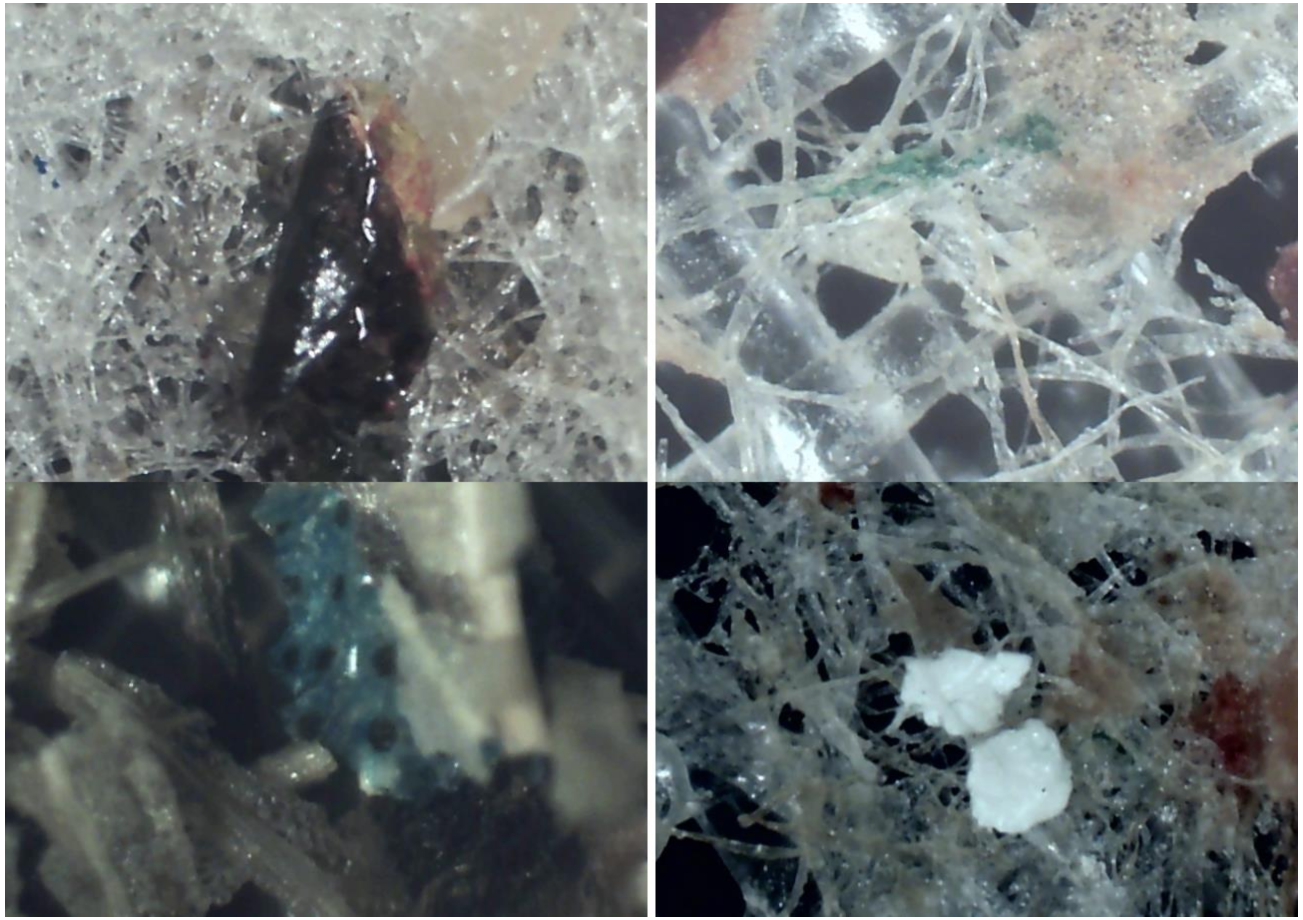





Putative microplastics in depackaged food waste isolated using our biological method



# Traditional chemical method for soils/sediments (Fenton's reagent)
# Putative microplastics in depackaged food waste



# Microplastics in Soils: Sources and Abundance

**Range of MPs in agricultural soil:**

- Plastic mulched soils: 2.5 to 18,760 average particles/kg soil
- Non-plastic mulched soils: 0.34 to 880 average particles/kg soil

**Sources:**

- Plastic mulching
- Soil amendments (sludge, compost, fertilizer)
- Farm equipment
- Irrigation
- Atmospheric deposition
- Roads
- Litter

**Knowledge gaps:**

- Relative contribution of plastic by source
- Background level in soils
- Bioplastics behavior in soils
- Abundance of sub-micro plastics (nano and smaller)

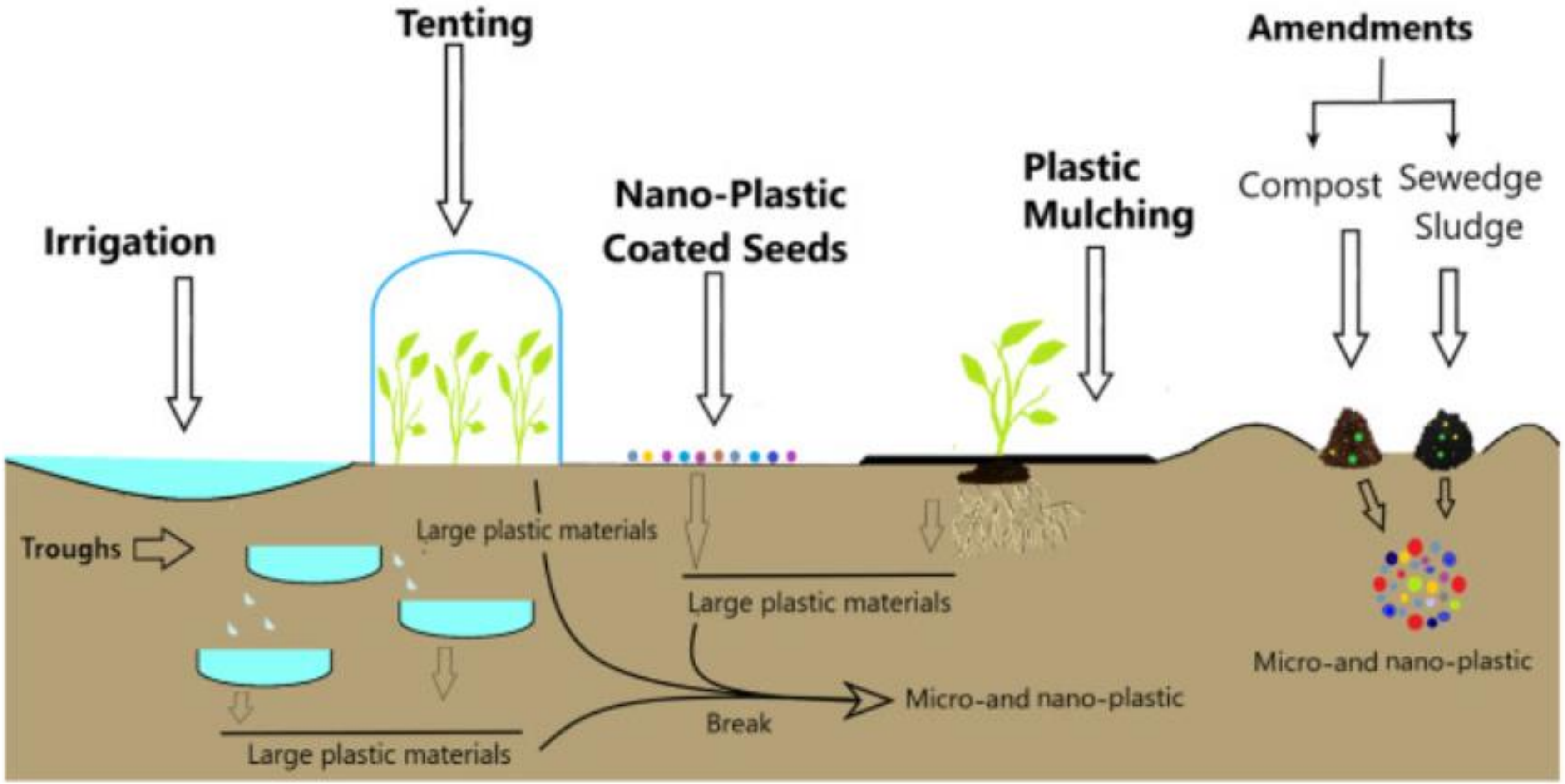
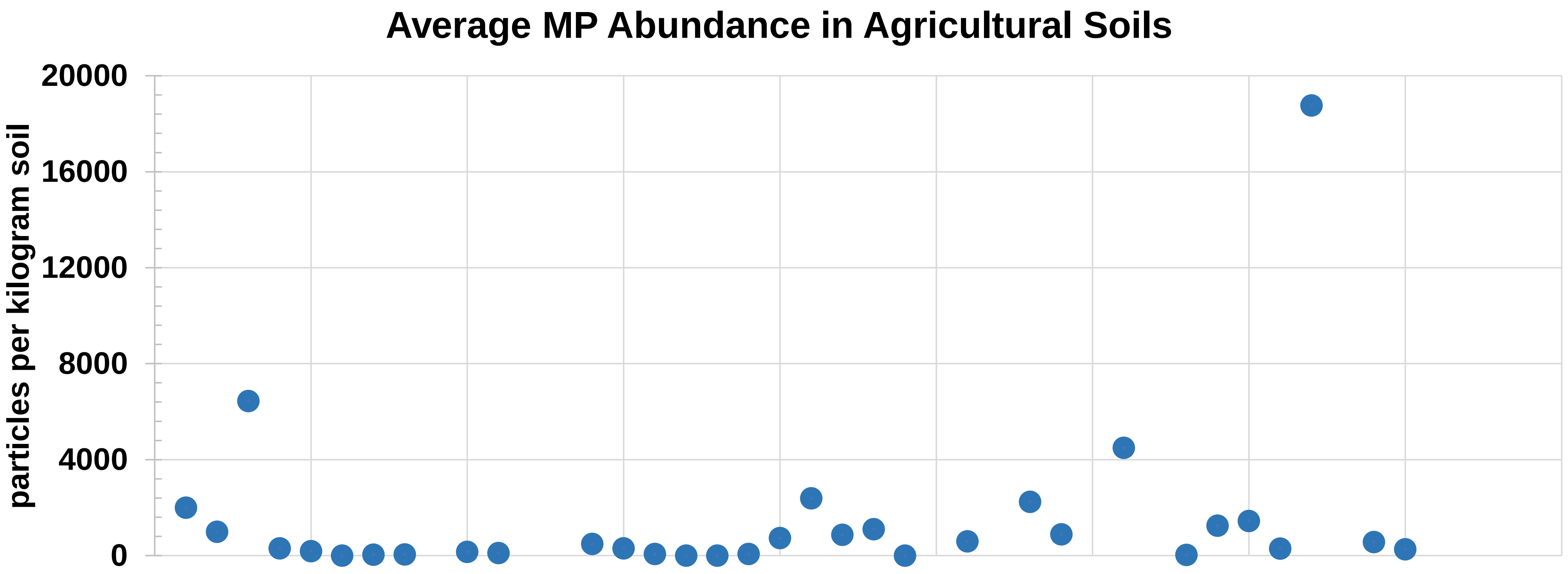



*Figure 1:Image from (Iqbal et al., 2020). Inflows of plastic to agricultural soils*

# MP Abundance in Ag Soils: Previous Studies



# Physical Effects: Fate and Transport

| **Increase Soil:** | **Decrease soil:** |
|---|---|
| Aeration | Bulk density |
| Water repellence | Aggregate sizes |
| Porosity | Water holding capacity |

**Microplastics movement:**

- Concentrate at surface
- Transport other chemicals

**Knowledge gaps:**

- MP fragmentation extent and conditions
- MP effects across soil types and other environmental variables
- Sub-micro sized particles fate and transport

# Ecotoxicity of Microplastics

→Many studies found no effect, or no effect at real world application rates

→Environmental conditions matter (soil type, compaction, moisture, chemical make-up)

**Observed effects:**

- Root growth decrease (but 1 study found root growth increase)
- Transport other chemicals
- Change metabolic pathways
- Decreased biomass growth
- Smaller plastics= bigger effect
- Lower seed germination
- Oxidative stress
- Increase in biomass phytochemicals
- Earthworm oxidative stress, neurodegeneration, and inflammation
- Decreased microbial community diversity and functioning

**Knowledge gaps:**

- Transport of sub-micro plastics in organisms
- Timeline of MP biodegradation, assimilation, and mineralization
- Toxicity of real-world doses (most studies have very high doses)
- Overall need for more ecotoxicity studies (species and food chain transport)

# Information in this presentation is based on a large # of peer-reviewed papers

- Our review & research findings are preliminary at this stage
- We hope to have a review paper ready to share by early 2022
- Full results from our study of depackaged food waste in Spring 2022
- In the meantime, please feel free to reach out to us for papers on any topics included in this presentation

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