# Microplastic pollution in agricultural lands

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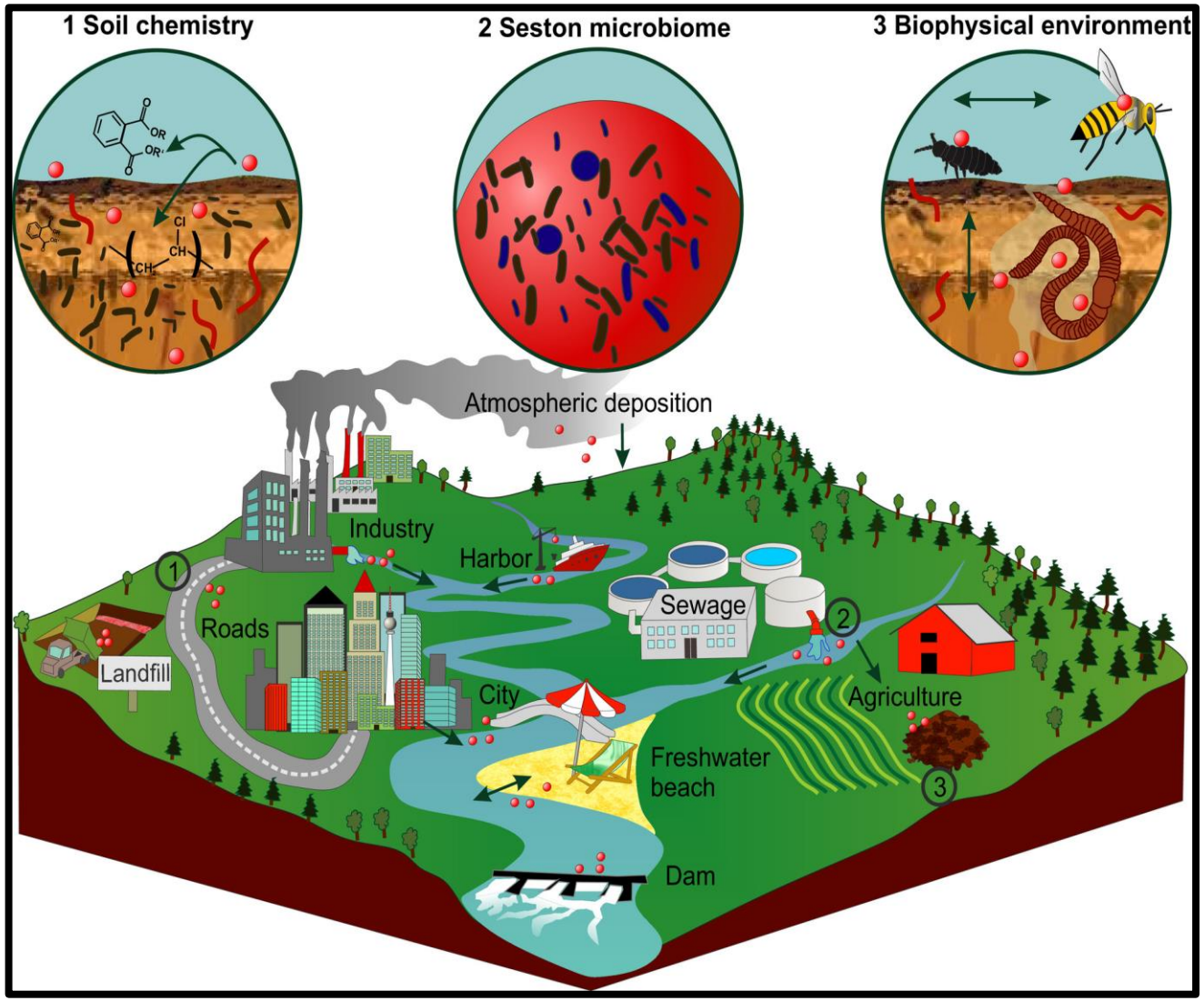
# Background:

## Sources of microplastics (MPs) in soil

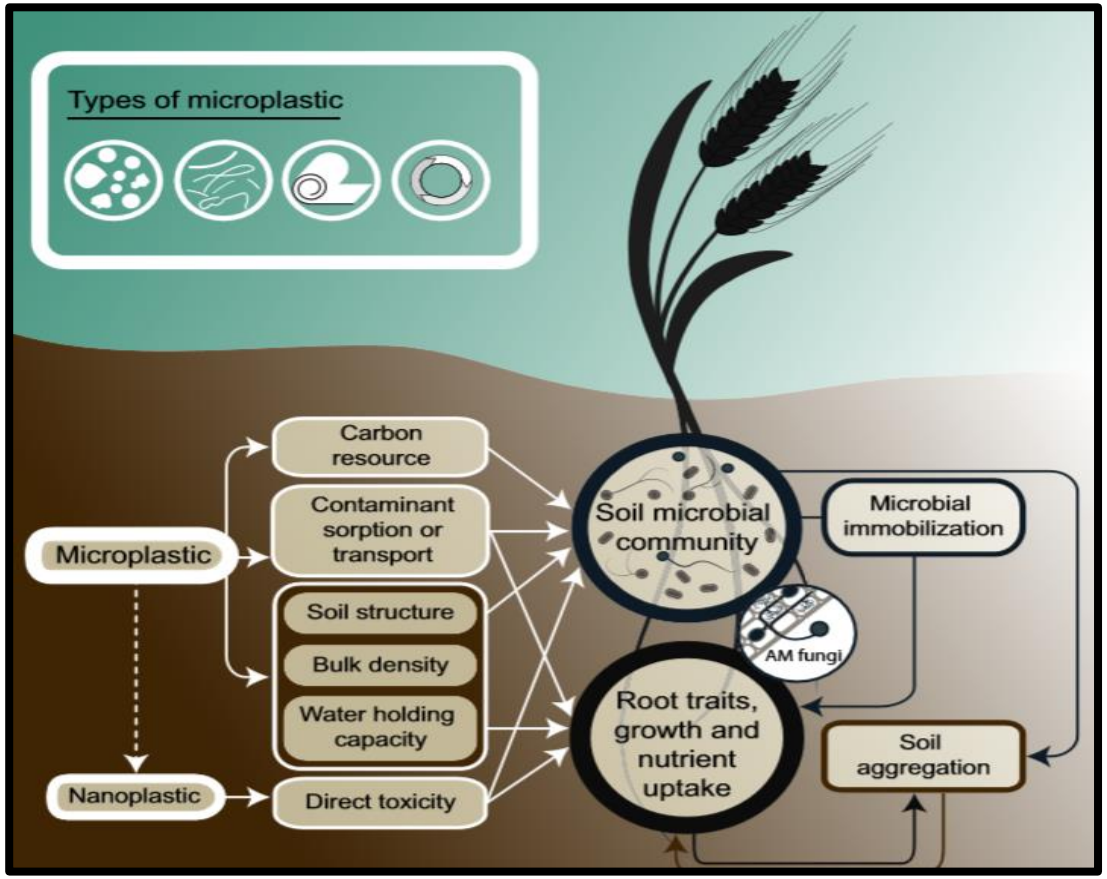
- ❖Atmospheric deposition
- ❖Transport from landfills (macroplastic breakdown)
- ❖Application of recycled organic waste to farming systems
- ❖Wastewater irrigation
- ❖Tillage with mulch plastic films

**Microplastic: plastic particles with 5 mm - 0.1 µm in diameter**



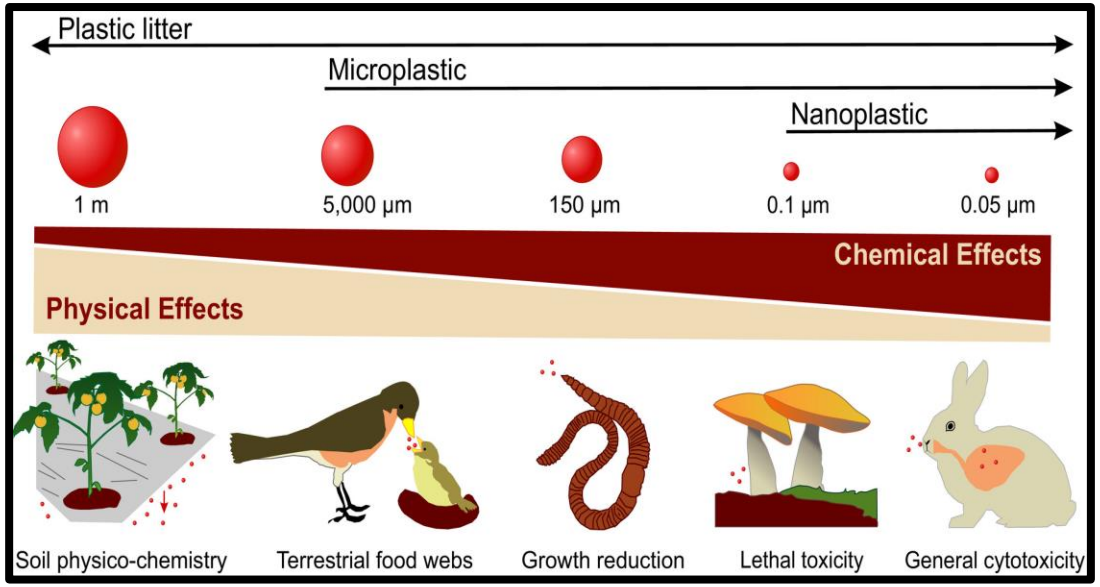
# Background:

- 79% of generated biosolid in Australia is applied to agricultural lands.
- Biosolid amendment as an organic fertilizer is one of the main sources of MPs in agroecosystems (2,800–19,000 tonnes MPs per year in Australia).
- Microplastics are small enough to be taken up by soil biota and consequently accumulate in the food chain.
- Earthworms contribute significantly to uptake, breakdown, and distribution of plastic particles in soil profile.



# Experimental design:

- We determined MPs concentration, size distribution, and chemical composition in 3 biosolids and 6 biosolid-amended agricultural soils.

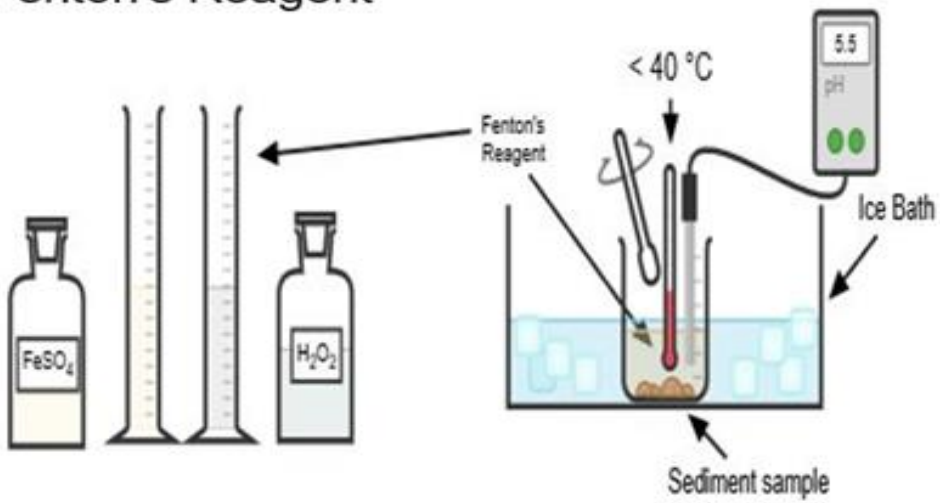



- We assessed the potential short-term risks of MPs to earthworms' (*Amynthas Gracilis* and *Eisenia Fetida*) survival rate and fitness in an environmentally relevant exposure study (28 days).

# Methodology:

## 1. Removal of organic matter

Fenton's Reagent

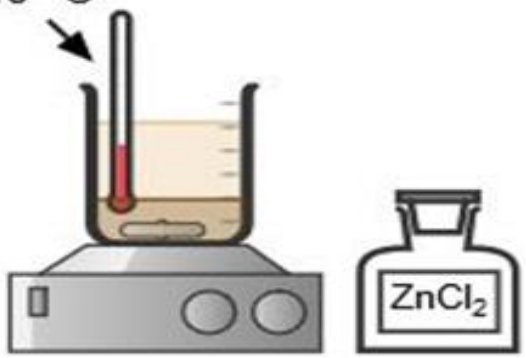


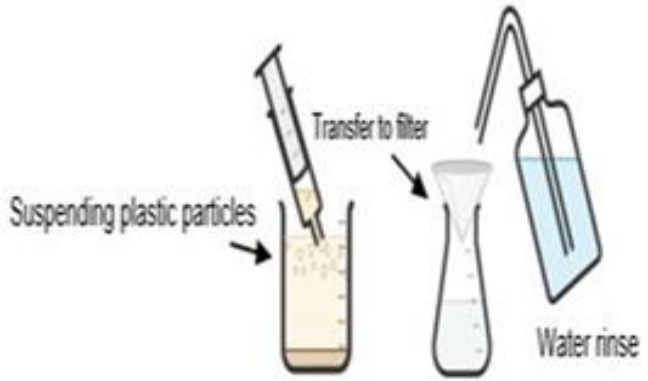

## 2. Density Separation & Extraction

Zinc Chloride Solution (1.6 g $cm^{-3}$)

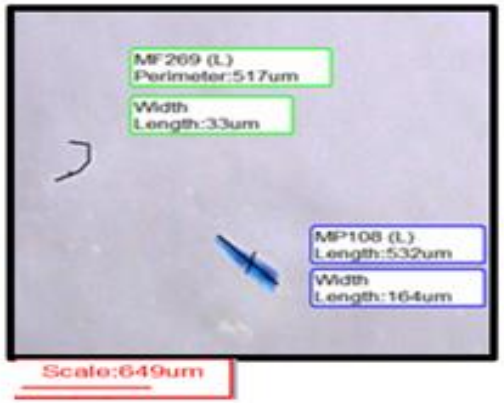
Extraction with Whatman 42 filter paper

< 40 °C



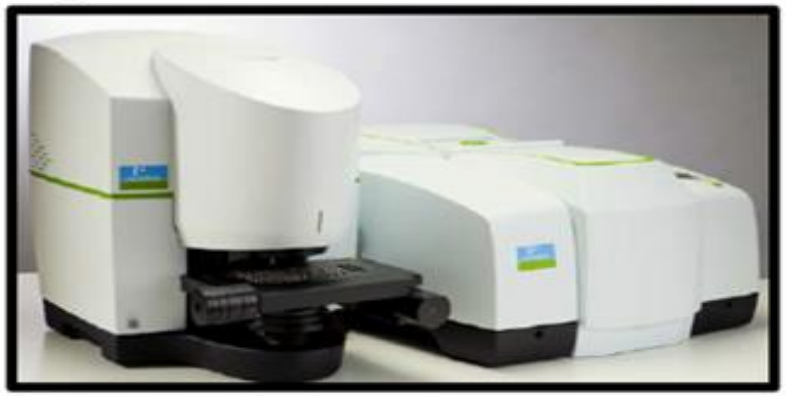




## 3. Visual microscopic selection




## 4. Identification

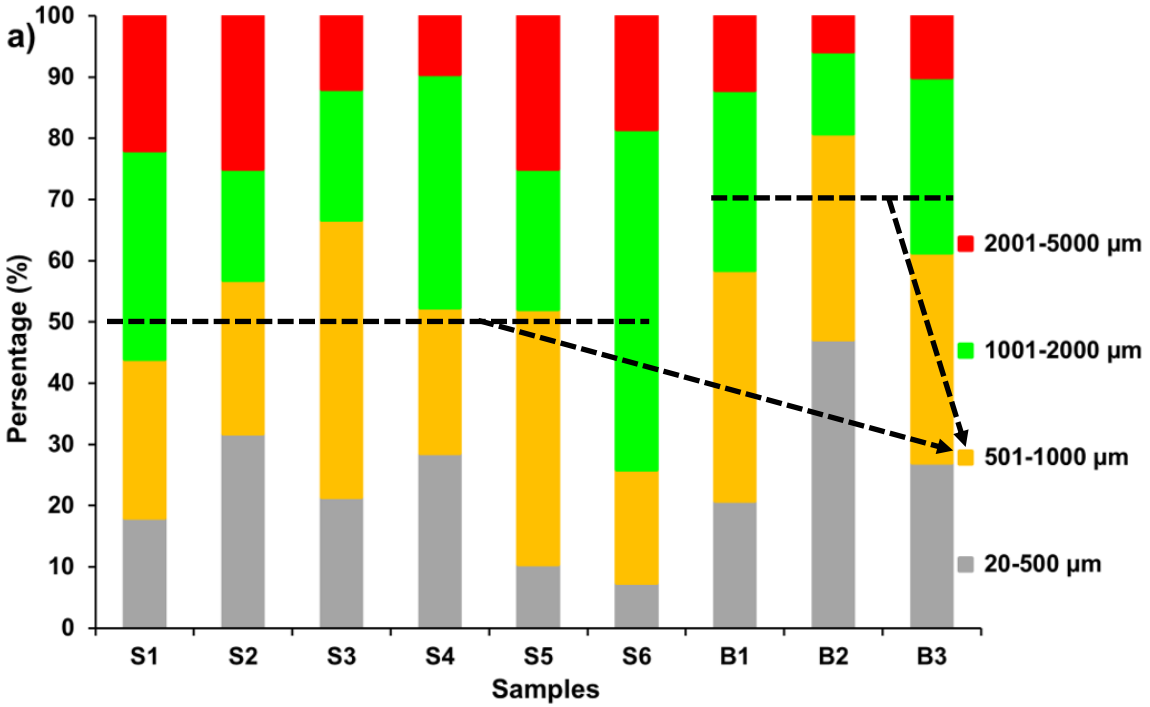
Fourier-transform infrared spectroscopy (FTIR) with spotlight 400

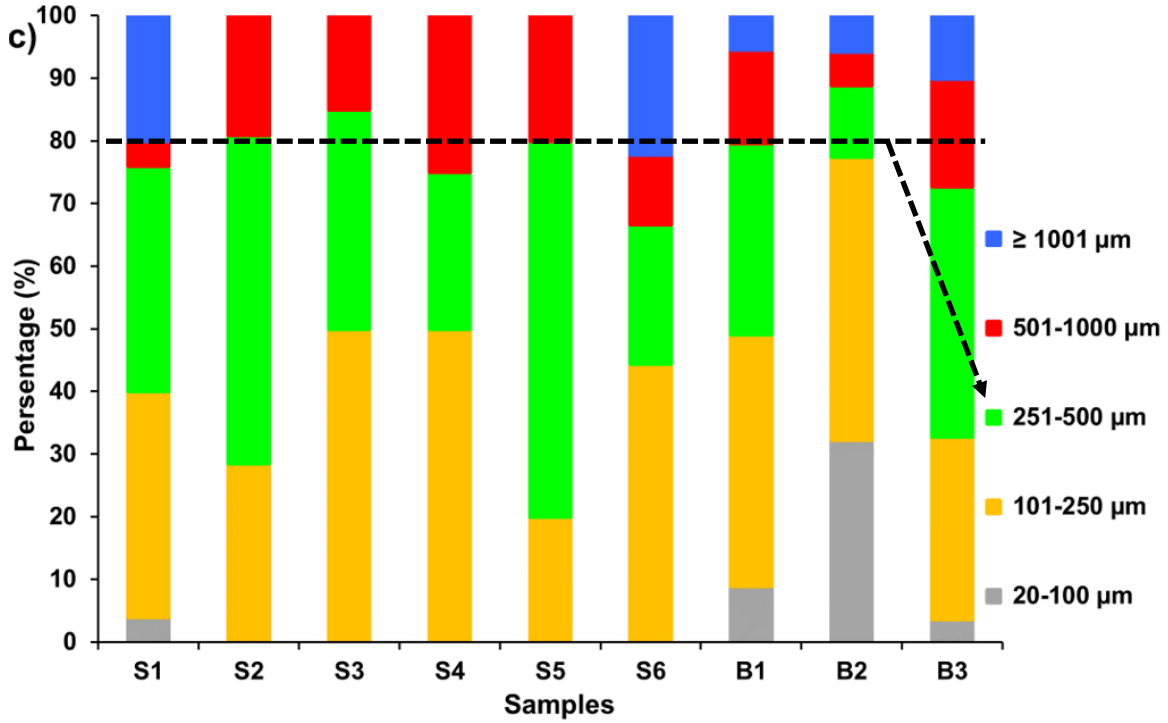


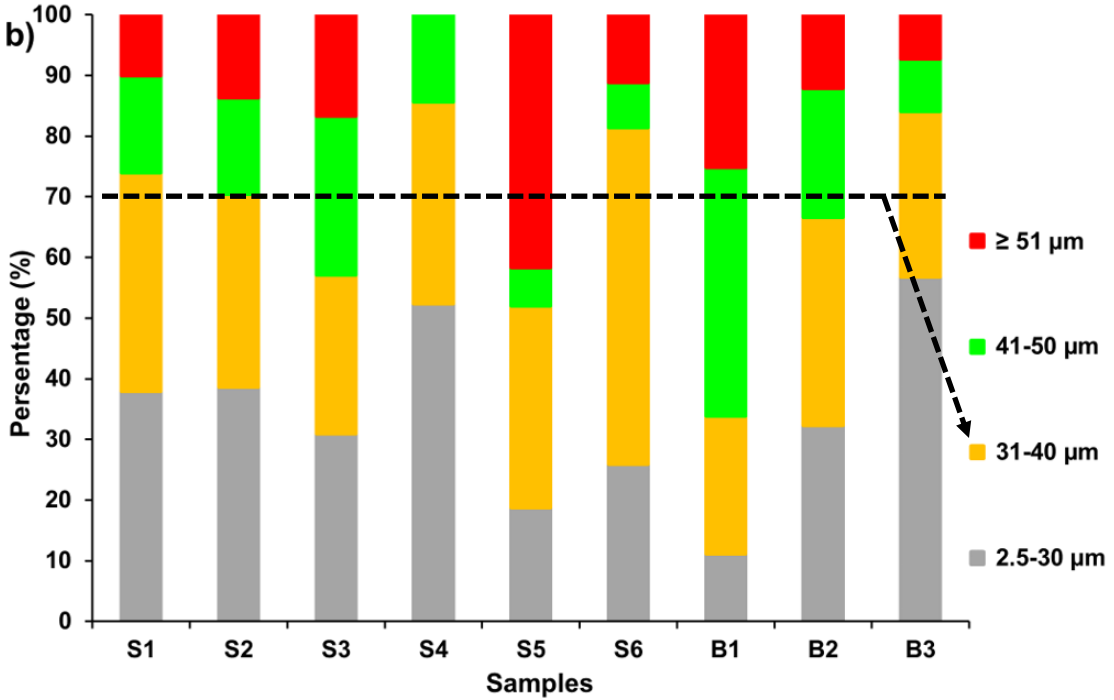
# Characteristics of microplastics in soil and biosolid samples:

| Sample ID | Total MPs (No. $kg^{-1}$ dry mass) | MPs fragments (No. $kg^{-1}$ dry mass) | MPs fibres (No. $kg^{-1}$ dry mass) | MPs fragment/fibre ratio | MPs weight (mg $kg^{-1}$ dry mass) |
|---|---|---|---|---|---|
| S1 | 3100 | 1100 | 2000 | 0.6 | 20 |
| S2 | 2600 | 900 | 1700 | 0.5 | 21 |
| S3 | 2500 | 800 | 1700 | 0.5 | 18 |
| S4 | 1000 | 200 | 800 | 0.3 | 12 |
| S5 | 2200 | 300 | 1900 | 0.2 | 22 |
| S6 | 1500 | 400 | 1100 | 0.4 | 26 |
| B1 | 55400 | 16200 | 39200 | 0.4 | 328 |
| B2 | 73800 | 18000 | 55800 | 0.3 | 352 |
| B3 | 62200 | 15600 | 46600 | 0.3 | 440 |

The (S) and (B) represent Soil and Biosolid samples, respectively. The soil samples were collected from top 5 cm of agricultural lands amended with biosolid. The reported data are means of three replicates. MPs = microplastics.

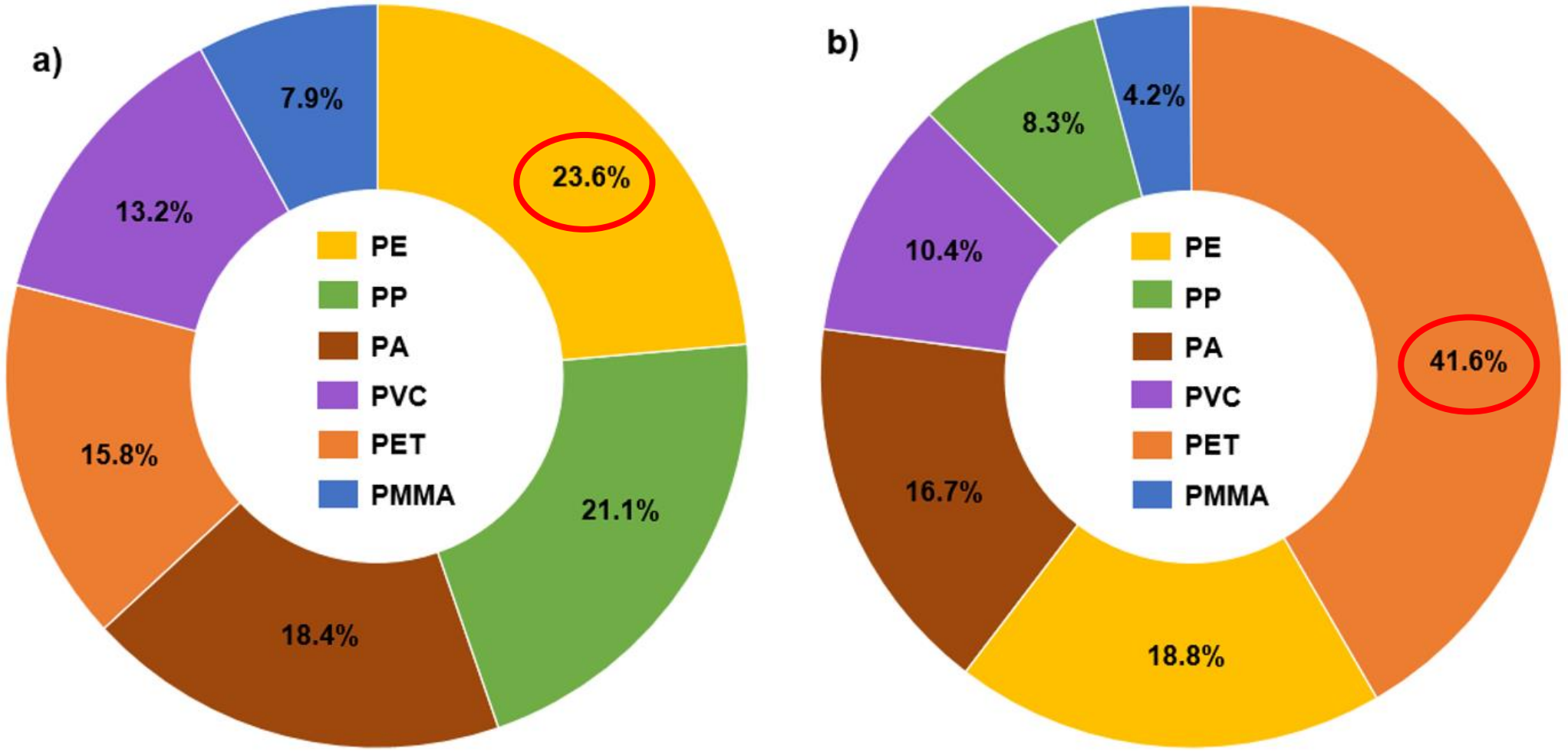



Size distribution of microplastic fibres length (a) and width (b), and fragments diameter (c) in soil and biosolid samples.

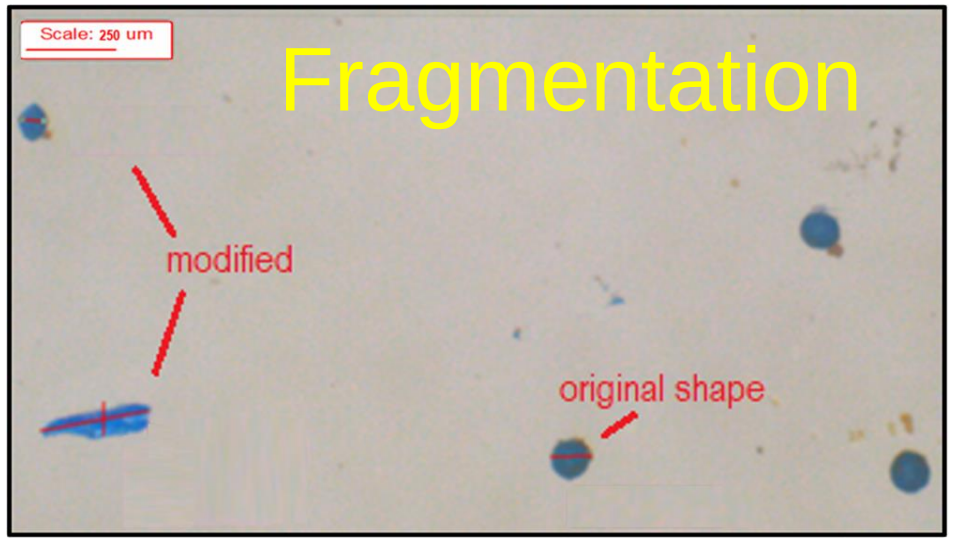
The (S) and (B) represent Soil and Biosolid samples, respectively.




Relative proportions of microplastic polymers identified in soil (a) and biosolid (b) samples. PE = Polyethylene; PP = Polypropylene; PA = Polyamide; PVC = Polyvinyl Chloride; PET = Polyethylene Terephthalate; PMMA = Polymethyl Methacrylate.

# General characteristics of the earthworms :

| Earthworm Species | Average length (mm) | Average body mass (g worm$^{-1}$) | Target body mass per pot (g) | No. of earthworms per pot |
|---|---|---|---|---|
| Amynthas Gracilis | 145 | 1.32 | ≈ 4.0 | 3 |
| Eisenia Fetida | 60 | 0.28 | ≈ 4.0 | 14 |





# Characteristics of earthworms during incubation study (28 days):

| Earthworm Species | Treatment | Change of biomass (mg worm$^{-1}$ day$^{-1}$) | Growth rate (%) | Survival rate (%) |
|---|---|---|---|---|
| Amynthas Gracilis | Control | 25.2 a* | 39.8 a | 100 a |
| | Spiked microplastics | 24.8 a | 37.7 a | 93.3 a |
| | Spiked biosolid | 10.5 b | 17.3 c | 93.3 a |
| Eisenia Fetida | Control | 2.9 c | 24.0 b | 100 a |
| | Spiked microplastics | 2.9 c | 21.4 b | 98.6 a |
| | Spiked biosolid | -7.6 d | -45.7 d | 81.4 b |

* Means followed by different letters within a column indicate significant differences between the treatments at $P < 0.05$. The reported data are means of five replicates.

**494 PE fibres and 156 PE microbeads in 250 g soil**

# Microplastic in earthworm casts:

| Earthworm Species | Treatment | Total MPs (No. $kg^{-1}$ dry cast) | MPs fragments (No. $kg^{-1}$ dry cast) | MPs fibres (No. $kg^{-1}$ dry cast) | MPs fragment/fibre ratio |
|---|---|---|---|---|---|
| Amynthas Gracilis | Control | ----- | ----- | ----- | ----- |
| | Spiked microplastics | 1090 a* | 640 a | 450 c | 1.4 a |
| | Spiked biosolid | 1280 a | 180 c | 1100 a | 0.2 b |
| Eisenia Fetida | Control | ----- | ----- | ----- | ----- |
| | Spiked microplastics | 910 b | 539 b | 371 c | 1.5 a |
| | Spiked biosolid | 1012 a | 210 c | 802 b | 0.3 b |

* Means followed by different letters within a column indicate significant differences between the treatments at $P < 0.05$. The reported data are means of five replicates (extracted from 5 g collected casts). MPs = microplastics.

# Conclusions:

- Biosolid-amended soils showed lower MPs content (≈30 times) and dry mass (≈19 times ) than biosolids.
- Polyethylene and polyethylene terephthalate were the major source of MPs contamination in biosolid-amended soils, biosolids respectively.
- Biosolid application decreased survival rate of Eisenia Fetida but showed no effect on Amynthas Gracilis.
- Investigated earthworm species did not bioaccumulate microplastics during the exposure experiment.

# Thank You

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