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Tracking PFAS in Soil and Plants Following Short and Long-term Biosolids Land Application

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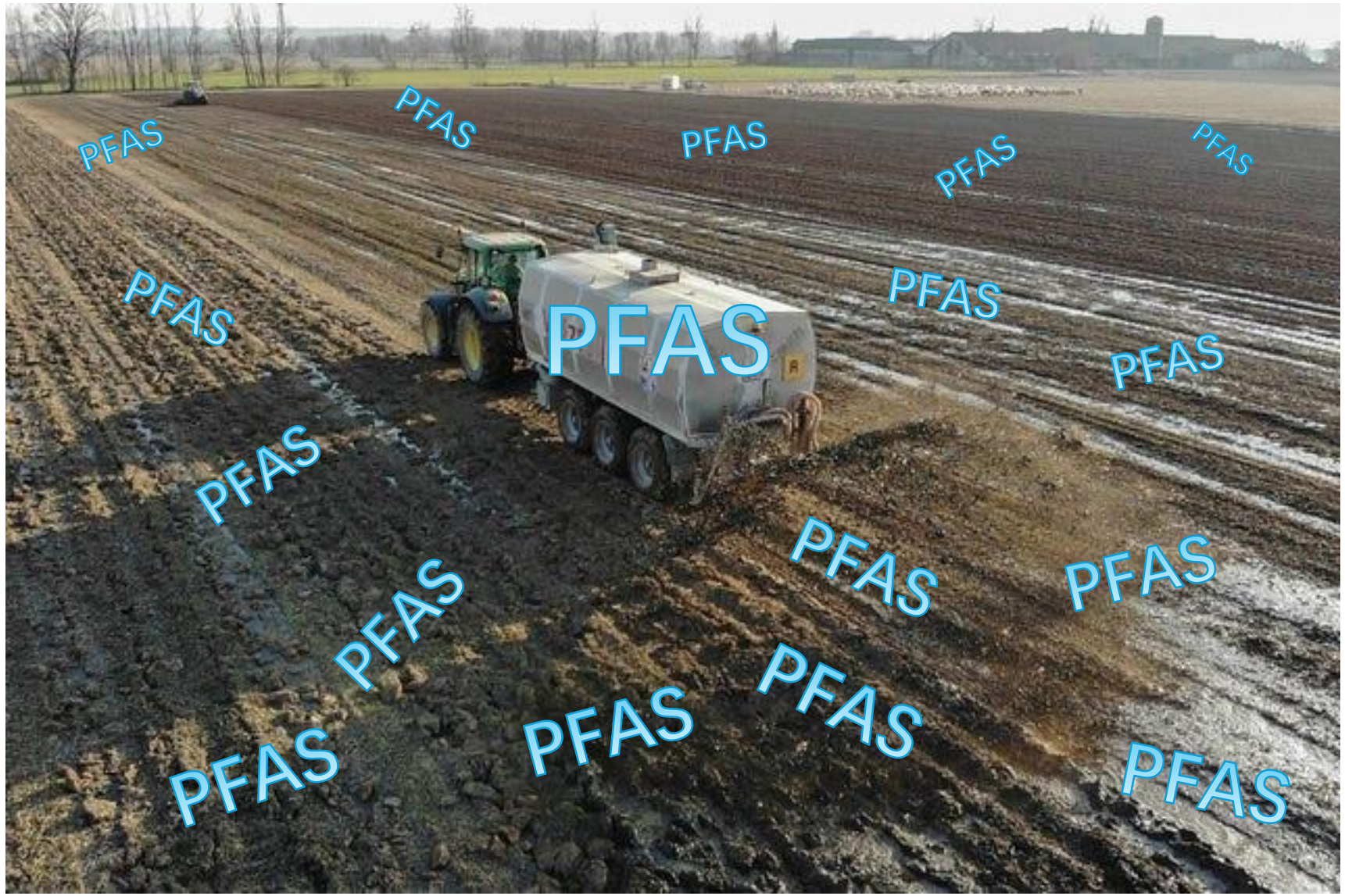
- 7.2 million dry tons of biosolids are generated in the US annually.
- ~55% are applied to soil for agronomic, sylviculture or land restoration purposes.
- ~45% are disposed of in municipal solid waste landfills.

(USEPA, 2010)

https://www.epa.gov/biosolids



https://extension.psu.edu/an-overview-of-pfas-and-land-applied-biosolids

Objective

- Identify PFAS accumulation in soil and plant tissue for long-term biosolids application history.

- Evaluate the impact of repeated biosolids applications on PFAS accumulation in soil and plants.

Methodologies

BS1991

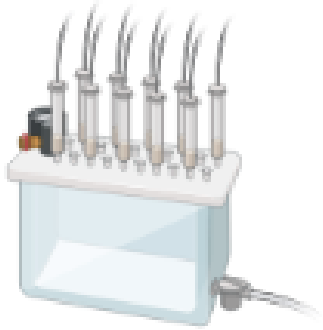
BS2002 (biosolids re-application)

BS2021

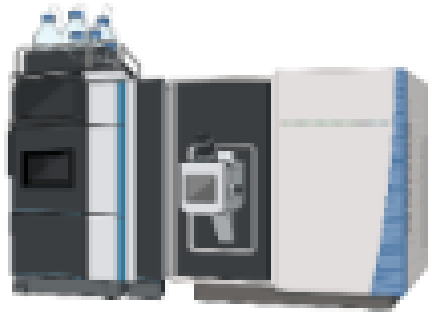
- Shortgrass steppe rangeland ecosystem
- Randomized complete block design
- 10 Mg ha^{-1}
- Soil and Plants were sampled

Modified EPA533 and 537 methods that detect 30 PFAS species

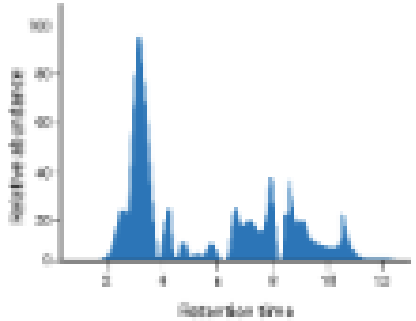
Soil and Plant Samples



Solid Phase Extraction



UPLC-MS/MS



Chromatogram/Mass Spectrum

Soil PFAS concentrations for the 10 Mg ha^{-1} biosolids application rate in the old plots (BS1991 and BS2002) and the new plots (BS2021)

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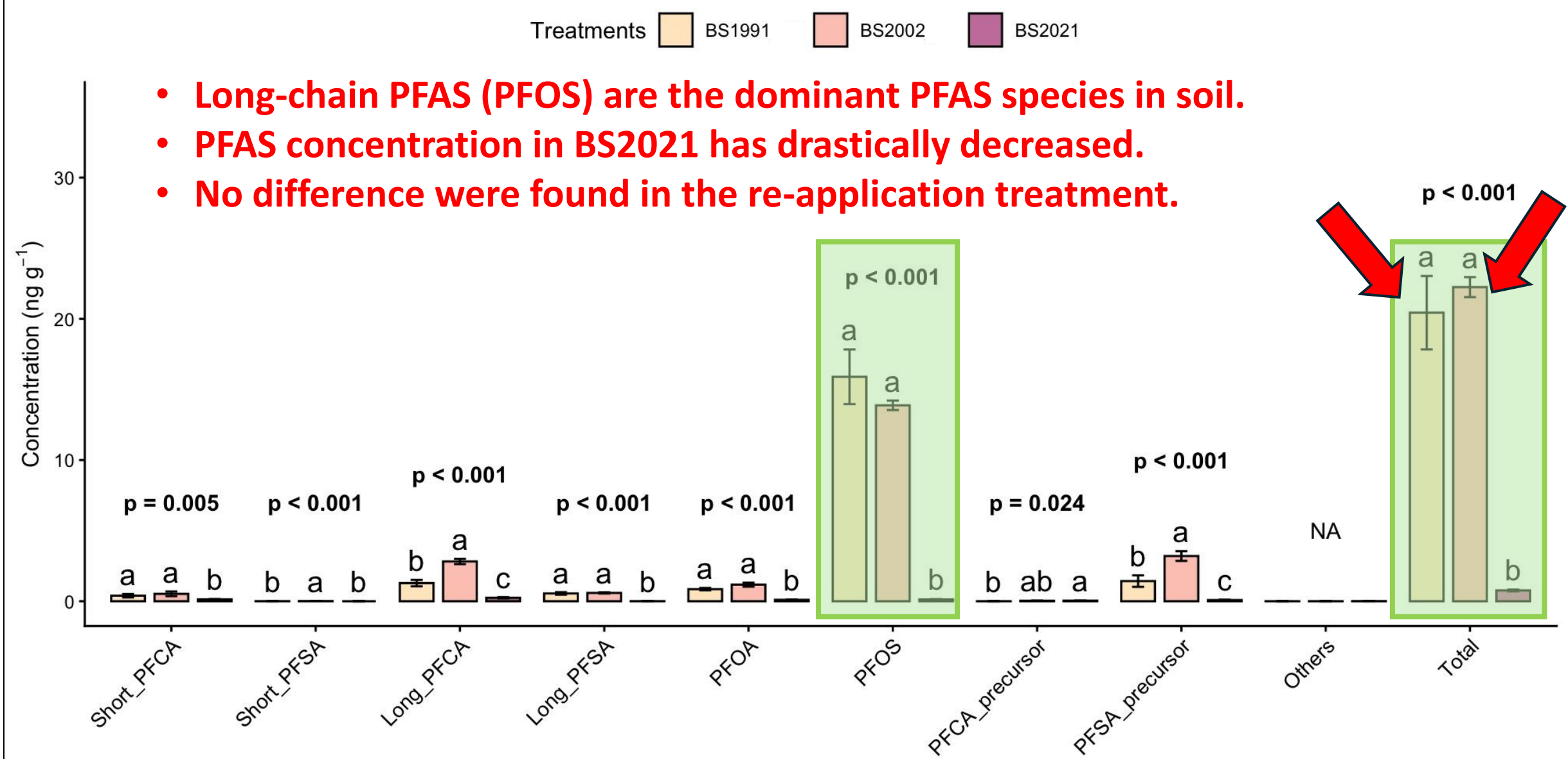
- **Long-chain PFAS (PFOS) are the dominant PFAS species in soil.**
- **PFAS concentration in BS2021 has drastically decreased.**
- **No difference were found in the re-application treatment.**



Plant PFAS concentrations with 10 Mg ha^{-1} biosolids application rate in the old plots (BS1991 and BS 2002) and BS10 in the new plot.

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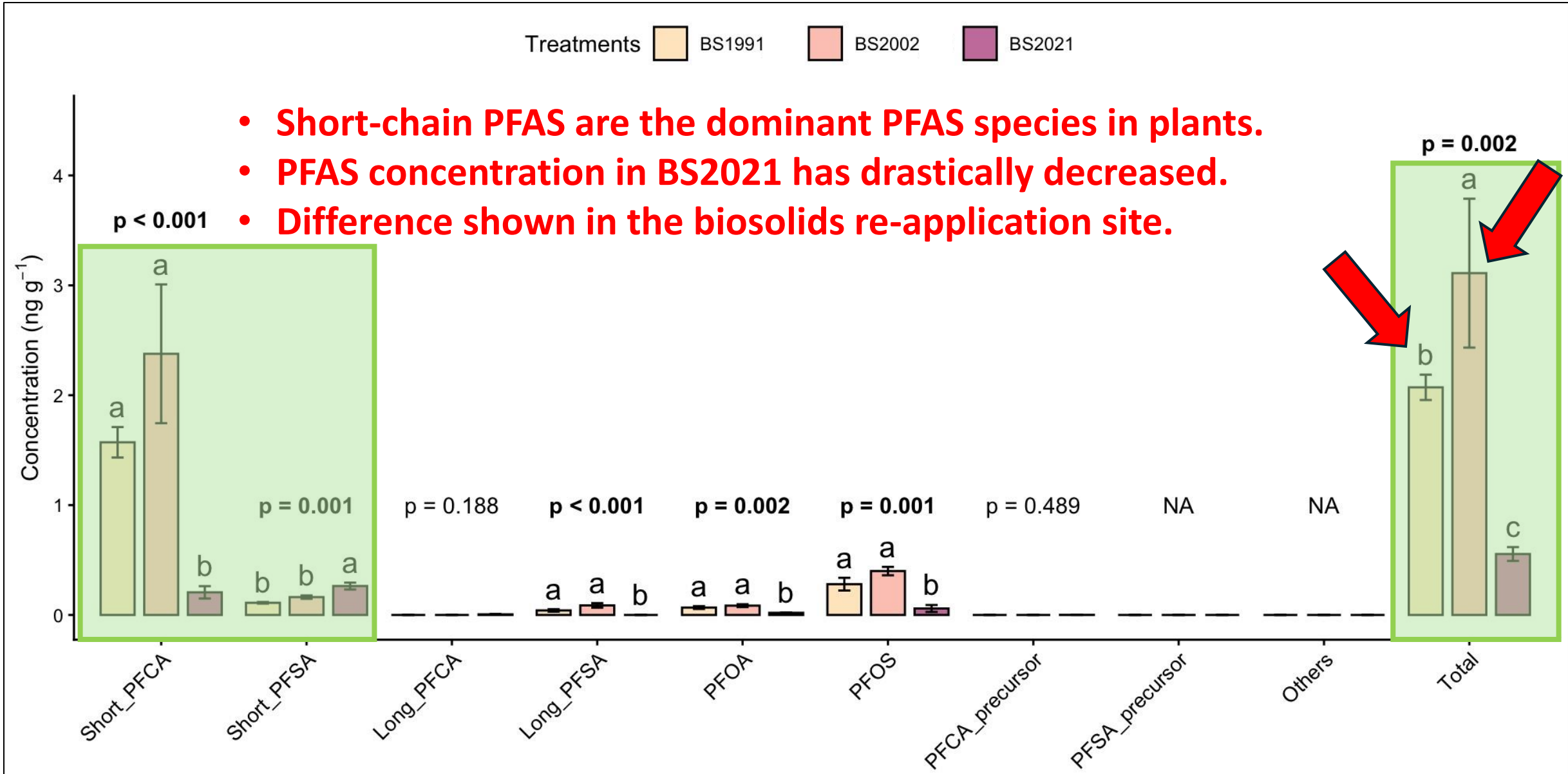

- **Short-chain PFAS are the dominant PFAS species in plants.**
- **PFAS concentration in BS2021 has drastically decreased.**
- **Difference shown in the biosolids re-application site.**

Plant Bioaccumulation Factors (BAF) across different biosolids treatments

Treatments	Short_PFCA	Short_PFSA	Long_PFCA	Long_PFSA	PFOA	PFOS	Total
BS1991	3.99	28.76	0.00	0.07	0.08	0.02	0.10
BS2002	4.49	16.83	0.00	0.15	0.07	0.03	0.14
BS2021	1.48	253.40	0.02	0.00	0.19	0.44	0.72

Conclusion

- PFAS species distribution differences existed between soil and plant.
- The phase out of the long-chain PFAS products had decreased the PFAS concentration in the current biosolids.
- Biosolids reapplication elevated PFAS in the plant rather than in the soil.
- Plant BAFs were greater in the sort-chain PFAS compared to the long-chain compounds.