FYTOLUTIONS

WE CLEAN THE EARTH WITH PLANTS

CAMPUS VESTA:

PFAS Phytoremediation

Executive summary

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biotech

SGS

CAMPUS VESTA

BERTELS on perfect grounds

DEME

TESTIMONIALS

PIETER VAN TURNHOUT (VESTA)

“Testing innovative soil sanitation techniques to reach a scientific backed solution is in line with our vision of lifelong learning and being a lean organisation with an exemplory function.”
Director VESTA

DIRK PONNET

“The innovative PFAS remediation of Campus Vesta in Ranst will provide us with the indispensable knowledge to tackle many similar PFAS contaminated sites in Europe. Together with C-Biotech, DEME is committed to contribute to a cleaner world.”
Director Deme Environmental

LUC DE REN (SGS)

“Both CO2 capture and the positive effects of industrial hemp on different contaminated sites for different types of contamination must be seen as a game changer. We support C-Biotech by generating independent and high quality data.”
Business consult SGS Belgium

BRAM BERTELS (BERTELS B.V.)

“We are excited to synergistically apply our broad knowledge on hemp stimulation techniques with the passionate C-biotech team, hereby creating innovative solutions for urgent environmental and societal problems”
CEO Bertels B.V.

Campus Vesta

Context

Training site of Belgium firebrigade and police

Historical PFAS pollution in topsoil due to the historical use of firefighting foams during past fire drills and tests.

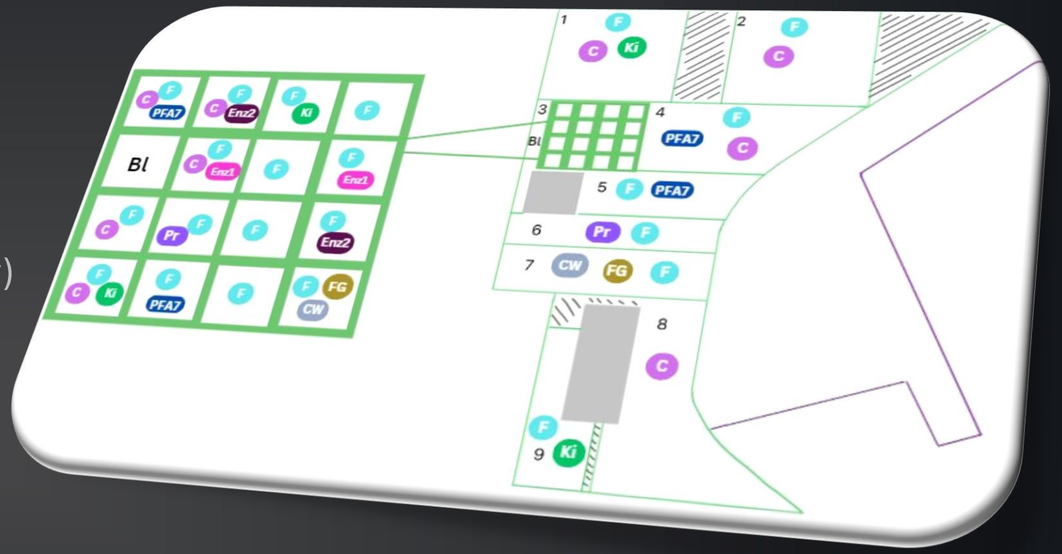
Objectives

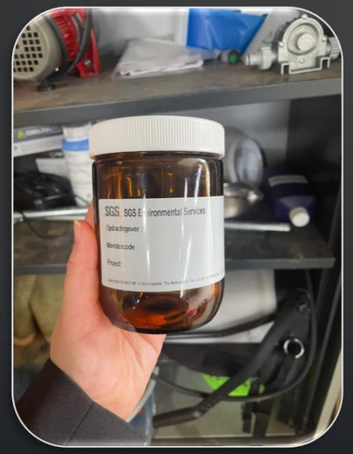
Demonstrate phytoremediation using industrial hemp

Speed up PFAS extraction by means of soil additives

Experimental design

- Plot was divided into
  - 9 large subplots
  - 16 small subplots: no influence of groundwater and leaching
- Different soil additives were applied
- Sampling of soil and leaves biomass at different time points (monthly)
- Analysis of PFAS concentrations
  - LCMS/MS CMA/3/D (36 compounds)





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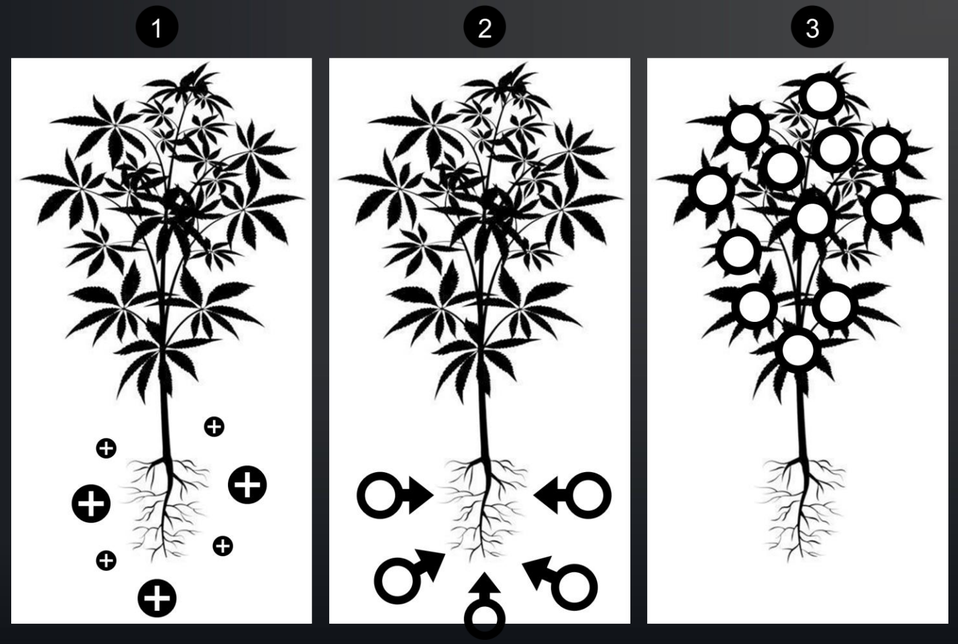
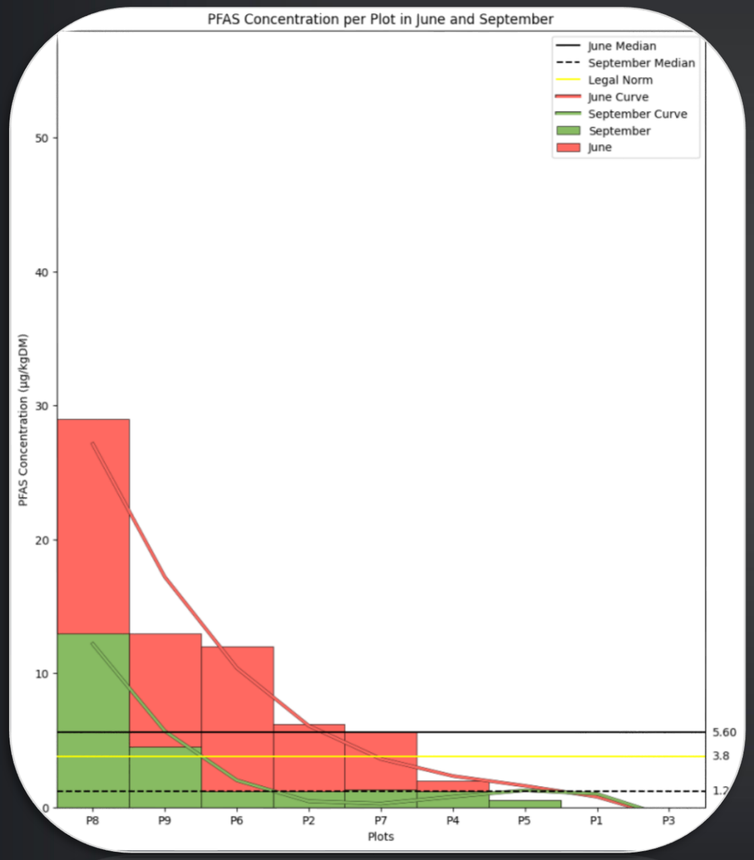
Intermezzo plot 9: Hempurizer+

- Bertels has 30+ years expertise
  - Development and production of fertilizer and substrates, distribution in 54 countries
  - Specific research and solutions for professional cannabis and hemp cultivation

- Bertels and C-Biotech co-developed Hempurizer+ for mobilizing PFAS and promoting plant uptake



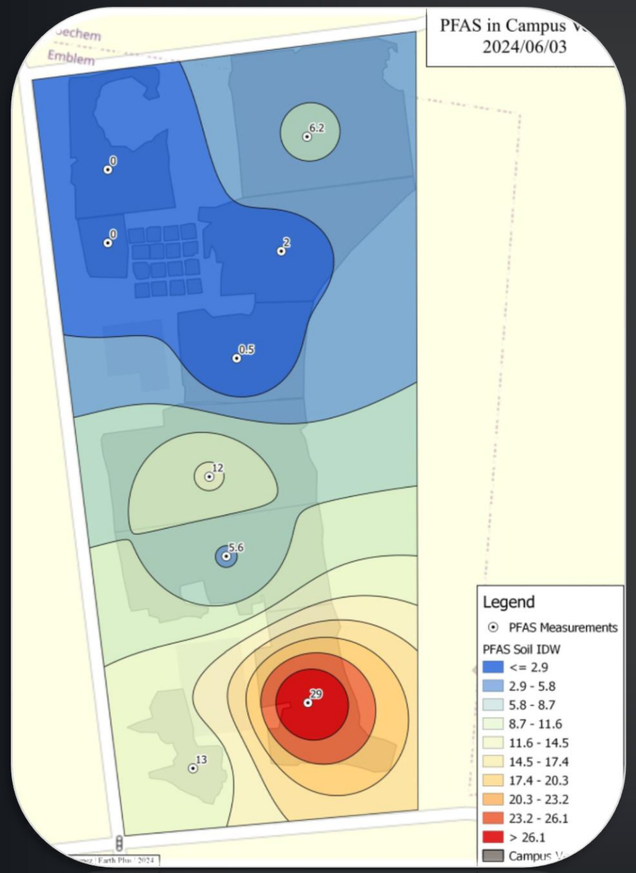
Results : Soil PFAS concentration (temporal)

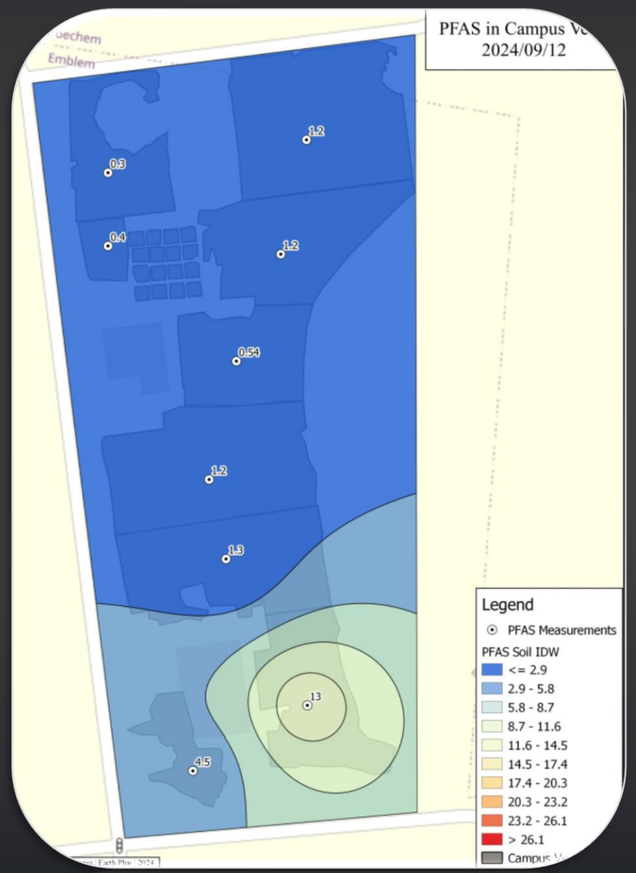


Findings

- PFAS levels were reduced in all subplots between June and September
- Different plots had different initial concentrations and different removal rates
- The majority of the subplots reached the legal norm (3.8 µg/kgDM) in 1 cultivation cycle

Results: Soil PFAS concentration (spatial)





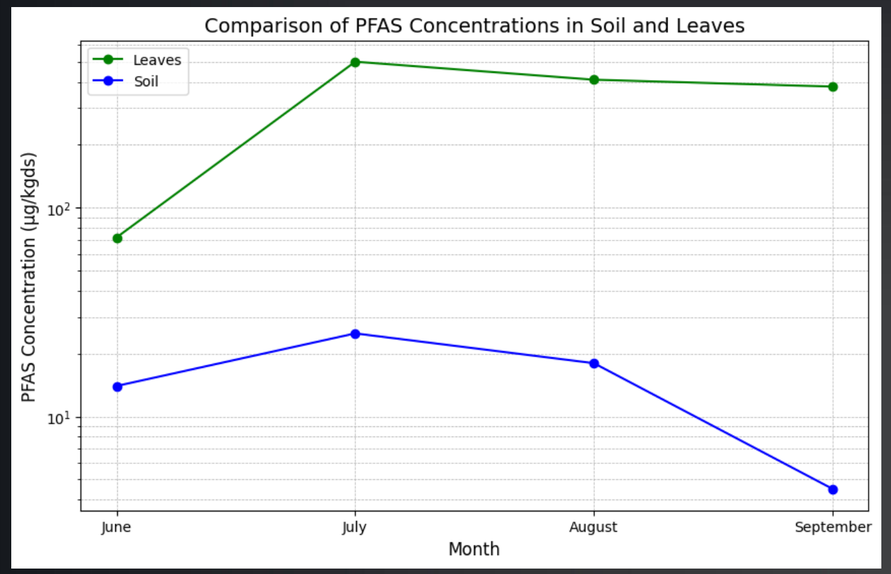
Findings

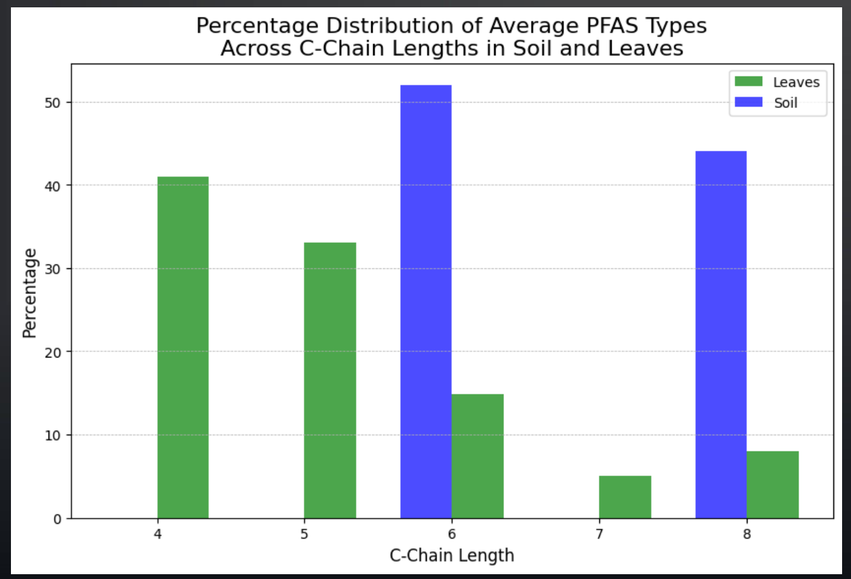
- Heterogeneous pollution, not known from 2 preliminary soil samples, taken mid and south of the plot

- Overall reduction of PFAS of 67% was achieved

- 2/3 of the plot area is now below the Flemish remediation norm of 3.8µg/kgDM

Results : Leaf PFAS concentration (temporal)





Findings

- Accumulation in the leaves observed
- Best performing plot achieved an amplification factor of 27 (vs 7.8 for others)
  - 14 µg/kgDM in soil
  - 380 µg/kgDM in leaf
- Shorter chains present to a larger extent in the leaves
- Remaining PFAS in soil are those with a longer chain length

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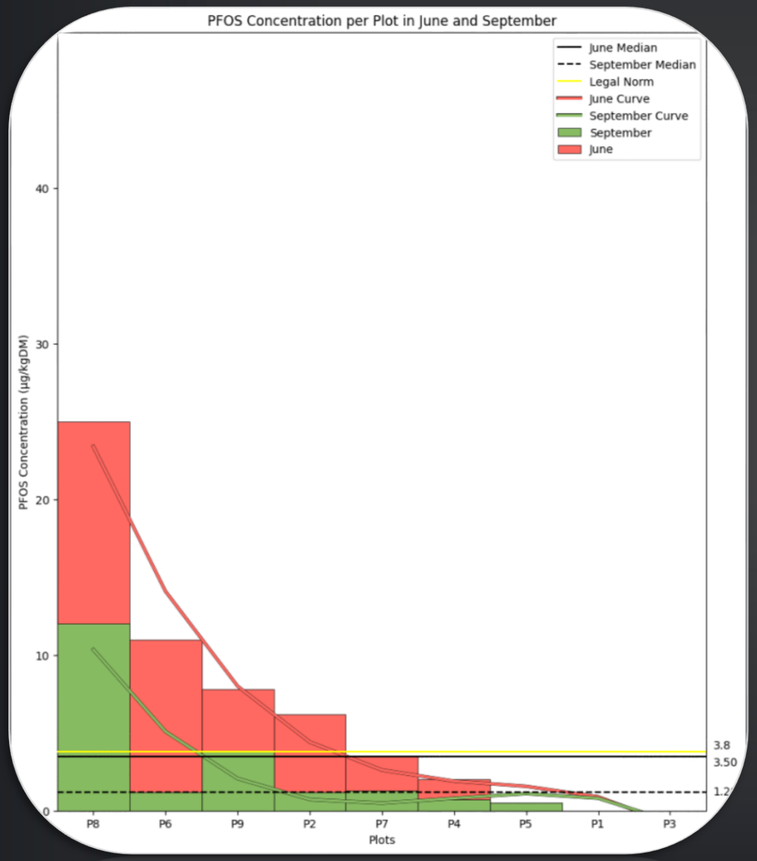
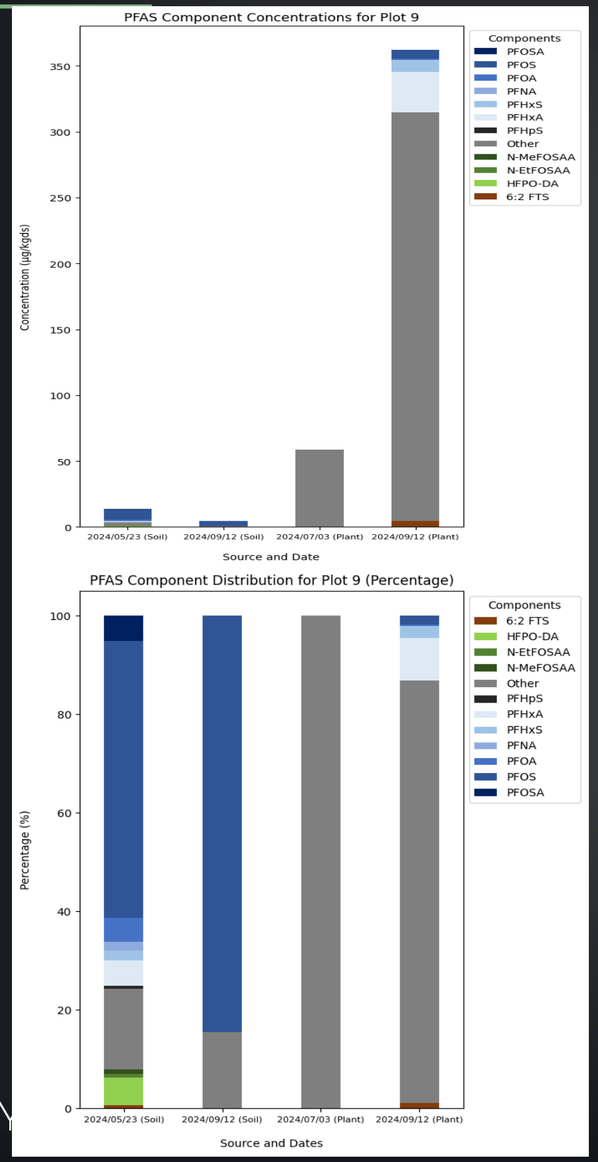
Results : Soil PFOS concentration (temporal)

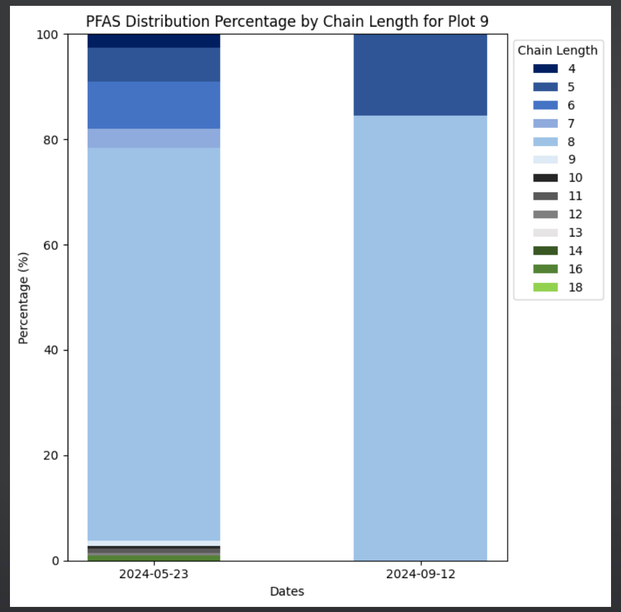


Findings

- PFOS levels reduced in all subplots
- Different plots had different initial concentrations and different removal rates
- The majority of the subplots reached the legal norm in 1 cultivation cycle
- PFOS was only found in small concentrations in leaves, with BAF of 0.14
- Direct uptake of PFOS by the plant was highest in plot 9 (Hempurizer+): BAF of 0.83

Results: qualitative composition plot 9 - temporal

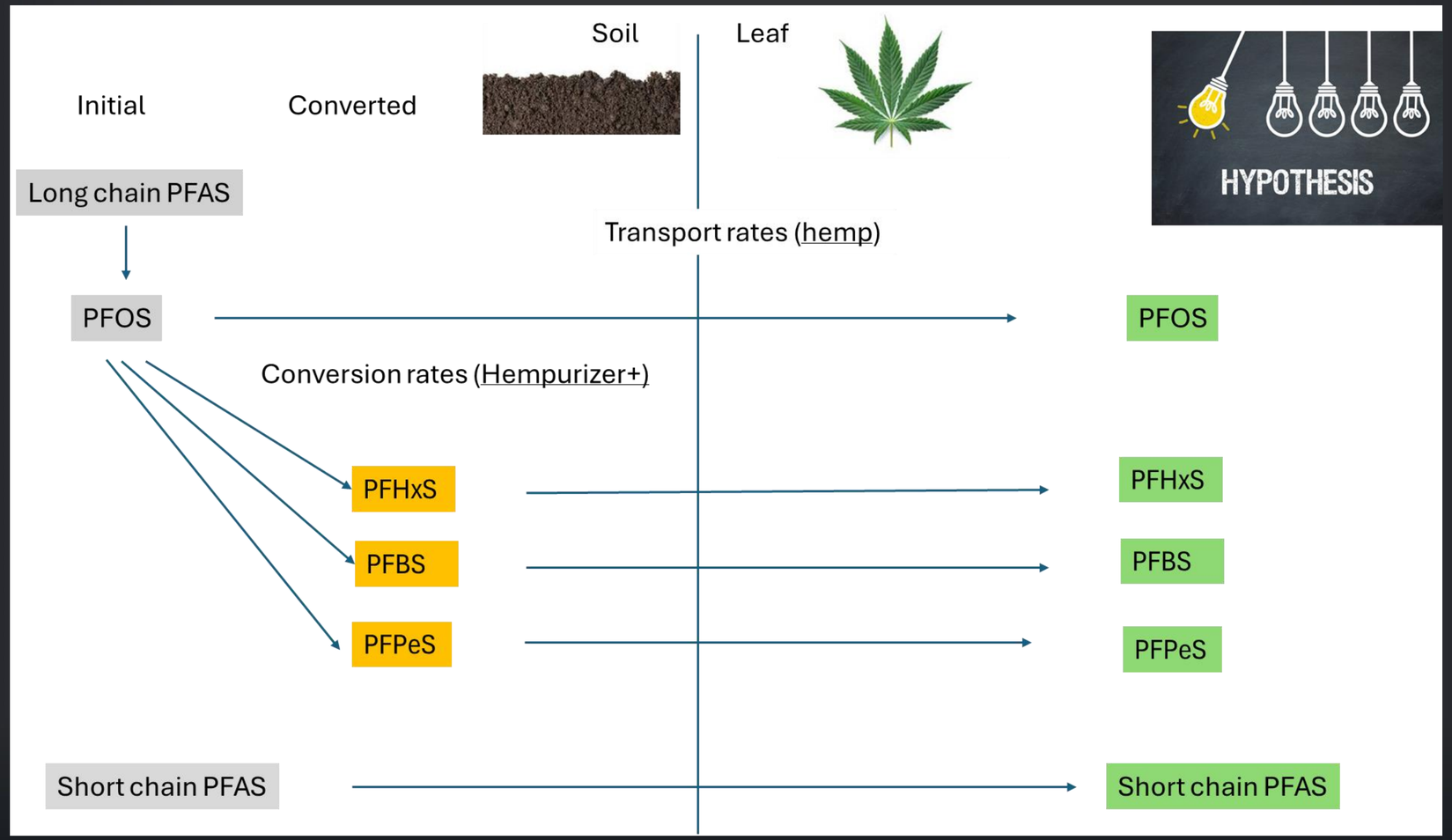




Findings

- PFAS in leaves majority short chain, though 10% longer chain present too
- Some of the shorter chain PFAS were initially (almost) not present in soil (PFHxS, PFBS and PFPeS)
- 9+ chain lengths disappeared from soil, but not in plant
- Same observation made for other plots using Hempurizer+, not in other plots
- Strong indication that PFOS partially degraded into PFHxS, PFBS, PFPeS and was subsequently taken up
- Summing up PFOS, PFHxS, PFBS, PFPeS in the leaves results in a PFOS BAF of 2-3, a factor 20-30 compared to currently reported values

Hypothesis : Partial conversion of PFOS and subsequent uptake in the plant



Financials for 0.3ha starting at 30µg/kg DM

- Traditional excavation

Top soil removed: 0.5m
Volume soil: 1,500m³
Density: 1.8 ton/m³
Disposed volume: 2,700 ton
Soil loading cost: €0.75/ton
Soil transporting: €5.5/ton
Gate fee PFAS washing: €75/ton
Total: €81.25/ton

Cost: €219,375
CO2 ⬆

- Phytoremediation

Biomass production: 10 ton/ha

Cultivation cost: €10,000/ha
Biomass treatment: €2,500/ton
Lab testing: €10,000/ha
Project management: €12,500

Number of cultivations: 2-3

Cost: €39,500 – €53,000
CO2 negative

Conclusion

- Heterogeneity was more pronounced than expected from preliminary soil sampling
- Soil PFOS and PFAS concentrations decreased in all the large subplots
- One cultivation was sufficient to bring 67% of the subplots below the legal norm in 1 cultivation
- PFAS concentration increased in the leaves proving that components were taken up by the plants
- Hempurizer+ resulted in highest PFAS BAF (27) and highest PFOS BAF (0.87)
- Hempurizer+ treated plots revealed a PFOS conversion into shorter chain length PFAS occurring in the leaves
- Accounting for this hypothesis, a PFOS BAF of 2 to 3 was obtained, which is a factor 20-30 higher than currently reported
- We now have a solution for 85% of the PFAS-polluted sites since they are mildly polluted (<100µg/kg DM)

Perspectives

- Treatment of south part of the plot
- Further testing and improvement of Hempurizer+ together with Bertels to further increase PFOS BAF
- Test treatment on PFAS-polluted plots with different type of PFAS (e.g. PFOA) in Europe and USA
- Investigate polluted biomass destruction
- Develop method to detect heterogeneity of PFAS pollution (Hempscan) to allow for more precise treatment

GET IN TOUCH

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