PFAS in recycled fertilisers:

Potential issues, identified uncertainties, and need for monitoring

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Identification of contaminants/impurities of potential concern → **Longlist of contaminants/ impurities** → **Prioritised shortlist of contaminants/impurities*** → **Risk assessment** → **Pre-RMOA (Regulatory Management Options Analysis)** → **AoA (Analysis of Alternatives)**

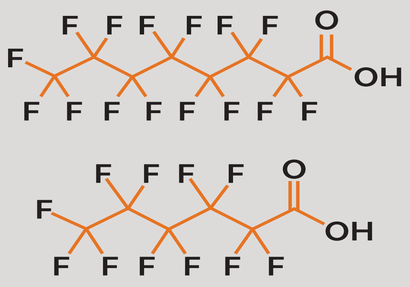
** Taking into account intrinsic hazards, existing regulations, occurrence in fertilisers, exceedances of existing limits in fertilisers, concentrations in environment, existing risk assessments, etc.*

Methods

Q: Which compound to assess?

A: Reference compounds:

PFOA
(for longer-chain PFAS)
+
PFHxA
(for shorter-chain PFAS)



Q: Which fertiliser to assess?

A: Comparison of concentrations of contaminant expressed based on P_2O_5 content

Q: Background concentrations?

A: Statistic analysis based on data obtained via IPCHEM platform

Q: Exposure calculations?

A: Freshwater, sediment and soil → FEE tool Fertilizers Europe (for tool selection see our our other **POSTER***)

Secondary poisoning + humans via the environment → output of FEE tool + equations EUSES

Q: Which scenario to assess?

A:
- Single annual application of 100 kg P_2O_5/ha
- spERC1 Fertilizers Europe (outdoor use – direct application of solid fertilisers to soil, surface spreading)
- Generic crop, application to bare soil
- No crop offtake
- No specific risk management measures

Q: Risk assessment PFAS?

A: 'Non-threshold' effects → no actual risk assessment can be performed, instead comparison against 'benchmark' concentrations/doses as an indication

Results

Fertiliser type assessed

– Fertilisers based on/containing thermal oxidation materials derived from sewage sludge, containing a maximum of 100 µg/kg dw of PFAS reference compound and with an average P content of 7.2%.

General findings

– **No exceedances** of 'benchmark' concentrations/doses calculated for **PFHxA**
– **Exceedances for PFOA** are mainly for **secondary poisoning** and **humans exposed via the environment**
– **Contribution through fertiliser use to total concentration in soil (and groundwater) increases over time** for both short- and long-chained PFAS
– **Source contribution analysis** is difficult due to limited available data, but important other sources of PFAS to agricultural land are likely raw/digested sewage sludge, compost, irrigation water, and atmospheric deposition (all highly variable depending on location)

Results PFOA (reference compound for long-chain PFAS)

Assessment Endpoint	'Benchmark' concentration/dose	'Risk Characterisation Ratio' after 1 yr of application	'Risk Characterisation Ratio' after 10 yrs of application
Freshwater [A]	0.1 (most critical EQS) 30 (EQS pelagic org.) (*µg/L*)	0.24 8.1E-04	0.24 8.1E-04
Soil [B]	0.645 194 (*µg/kg dw*)	**1.21** 4.0E-03	**1.33** 4.4E-03
Sediment [B]	3.52 1060 (*µg/kg dw*)	0.61 2.0E-03	0.61 2.0E-03
Secondary poisoning [A] – Aquatic pathway – Terrestrial pathway	0.9 (*µg/kg*)		**45** **3.6**
Humans exposed via the environment	8.6E-04 [C] 1.5 [D] (*µg/kg bw/day*)		**22.7** 2.3E-02

[A] EQS / PNECoral derived by Valsecchi et al. (2017)
[B] Calculated using equilibrium partitioning
[C] Based on TWI of 6 ng/kg bw/wk (EFSA, 2018)
[D] TDI set for PFOA by CONTAM-panel EFSA (2008)

Near-Future-Needs

Further research and/or measurement campaigns would be needed with regard to:

– PFAS **removal efficiency** of different **recycling techniques** resulting in material that may be used in/as fertilisers
– PFAS in different **environmental compartments** → especially poor data availability for soil and sediment
– PFAS in **organic waste streams that may be used directly or indirectly (after treatment) in agriculture** → this would increase reliability of source contribution analysis and would allow to identify the most efficient regulatory measures
– **Atmospheric deposition** of PFAS in relation to surrounding activities
– Emission of **PFAS precursors** and their contribution to PFAS in the environment

Take home message

It is of utmost importance to guarantee high removal efficiency of PFAS during recycling of organic wastes for re-use as/in fertilisers in order to avoid further accumulation of PFAS in the environment and consequent issues with contamination of food and drinking water.

Acknowledgement

The results presented were generated in view of the project "Contaminants in fertilisers: Assessment of the risks from their presence and socio-economic impacts of a possible restriction under REACH" (European Commission – DG Environment). The project team was composed of Arcadis, DHI, Arcadia International and Vander Straeten Consulting Services. Presented work was performed by Arcadis.

The report can be found here (QR)

* Deleebeeck N, Lefèvre L (2022). Exposure and risk assessment of contaminants in fertilisers - Comparison of exposure tools and establishment of a strategy for meaningful 'screening' assessment. Poster presented at SETAC Europe 32nd Annual Meeting, Copenhagen, Denmark.