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Is There Really a Threat? The Sampling Campaign and Its Results

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Abstract

The agricultural reuse of treated sewage sludge recovers nutrients and organic matter, but it may also transfer potentially harmful constituents, heavy metals, pathogens and contaminants of emerging concern such as pesticides, pharmaceuticals and personal-care products (PPCPs) and per- and polyfluoroalkyl substances (PFAS) to soils and crops, raising questions over its long-term safety (Mejías et al., 2021; Ghisi et al., 2019). Within the Sludge2Energy project, which develops pyrolysis of dried sewage sludge as an alternative to direct land application, this study addresses a central question: is there really a measurable threat in fields that receive sludge? To answer it, a monitoring database was assembled combining the characterisation of the applied sludge, of receiving soils sampled before and after application, and of the crops grown on them. The sludge was characterised over successive production batches for its agronomic properties (pH, dry-solids and organic-matter content, nitrogen and phosphorus), for regulated heavy metals (cadmium, copper, nickel, lead, zinc, mercury and chromium) and for microbiological quality. Sludge-amended and control soils were analysed for a broad suite of physicochemical parameters, pH, electrical conductivity, texture, organic matter, macro- and micronutrients, together with the same heavy metals and, in a dedicated screening campaign, with pesticides, PPCPs and PFAS in both soil and plant tissue. Across the dataset, the heavy-metal content of the sludge remained comfortably within the applicable regulatory limits for agricultural use, and its microbiological indicators were consistently low. Receiving soils, whether sampled before or after sludge application, showed heavy-metal concentrations well below regulatory thresholds and physicochemical properties typical of the local agricultural land, with no systematic deterioration attributable to sludge. In the organic-micropollutant screening, PFAS were consistently below detection in both soil and plant

matrices, PPCPs were largely absent, and pesticide residues were sparse and confined mainly to plant tissue, the detected compounds being current-use crop-protection products rather than sludge-specific markers. Taken together, these results provide a reassuring baseline: under the management practices observed, the sludge applied and the fields receiving it show heavy-metal, pathogen and organic-micropollutant levels that remain within safe ranges, with no evidence of accumulation in soils or crops. While continued multi-season monitoring is needed to confirm these findings and to capture cumulative effects, the evidence suggests that the contaminant threat from sludge reuse is limited, and reinforces the value of upgrading residual sludge through pyrolysis within Sludge2Energy.

Keywords: sewage sludge, biosolids, heavy metals, soil quality, contaminants of emerging concern, soil and crop monitoring

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