Transport and Distribution of Per- and polyfluoroalkyl Substances in Soil Profiles from Land Application of Biosolids

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ABSTRACT

A large portion of biosolids generated from wastewater treatment plants are applied to agricultural land for their plant nutrient values and as amendment to improve soil health. Many biosolids contain the elevated levels of emerging pollutants, especially per- and polyfluoroalkyl substances (PFAS). The repeated applications could lead to increasing PFAS accumulation in soils and leaching down to groundwater. In this study, we received soil samples collected at the multiple depth down to 180 cm at the sites receiving biosolids annually for eighteen years, as well as the corresponding wheat and corn grains produced at the sites. We applied EPA 1633 analysis method with target 43 PFAS to both soil and grain samples collected every six years. None of PFAS was detected in either wheat or corn grains. In the surface soil (0-5 cm), more than 20 targeted PFAS out of 43 compounds were identified and quantified at the levels of micrograms per kilogram of soil, which included legacy PFAS (e.g., perfluoroalkyl carboxylic acids and perfluoroalkyl sulfonic acids) and PFAS precursors (e.g., polyfluoroalkyl phosphate dieasters and perfluorooctane sulfonamidoacetic acids). Both long- and short-chain PFAS could migrate downwards to deep soil profiles but to the varying extents, with the latter group transport deeper in soil profiles. The smallest-sized PFAS selected in this study, perfluorobutanesulfonic acid, was found to leach down to the depth of 180 cm at several farming sites, indicating short-chain PFAS could demonstrate a higher mobility and contaminate the larger regions of the agricultural land.