Supplementary Information

Depth Profiles of PFAS in Community Garden and Agricultural Soils

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Text S1. Details of the PFAS extraction from soil.

Ten grams of soil from each soil were taken in duplicates in pre-cleaned 50 mL polypropylene tubes for PFAS extraction. Then, 100 µL mass-labeled PFAS internal standard (MPFAC-HIF-ES, Wellington Laboratories, Guelph, ON, Canada) was added to the sample and adequately mixed (Table S2). The targeted analytes, extracted internal standards, and non-extracted internal standards were similar to the EPA method 1633 (Table S3). PFAS were extracted from soil samples using a multi-step solvent extraction procedure. 8 mL of LC–MS grade methanol containing 0.3% ammonium hydroxide (Fisher Scientific, USA) was added to each sample tube, followed by shaking at 200 rpm for 24 hours using a shaker (Thermo Scientific, MA, USA) and centrifugation at 10,000 rpm for 2 hours at room temperature. The resulting supernatant was transferred to pre-cleaned 15 mL polypropylene tubes. A second extraction was performed by adding 2 mL of the same methanol–ammonium hydroxide solution to the remaining residue, shaking for 2 hours, and centrifuging for 30 minutes; the supernatant was then combined with that from the first extraction. For the third extraction, 2 mL of LC–MS grade methanol containing 0.3% ammonium hydroxide was added, vortexed for 5 minutes, centrifuged, and the resulting supernatant was merged with the previous extracts. The combined extract was concentrated to approximately 1 mL using a nitrogen blowdown evaporator and stored at 4 °C until PFAS analysis.

Text S2. Details of the quality assurance and quality control (QA/QC) measures for PFAS extraction and analysis.

All the soil samples were extracted for PFAS in duplicate. The PFAS concentration was averaged based on the duplicate results, and the error bars are also shown in the plots. We also prepared and analyzed blank samples by following the same PFAS extraction protocol for the soils. For preparing blanks, we took 10 mL of LC-MS grade methanol in a 50 mL polypropylene tube and then added 100 µL of the mixture of mass-labeled PFAS internal standard (MPFAC-HIF-ES; Wellington Lab, Guelph, ON). Then, tubes were agitated at 200 rpm for overnight, followed by centrifugation at 10000 rpm for 2 hours. After centrifuging, the content was concentrated to 1 mL with a nitrogen blowdown evaporator prior to 10 µL injection in the LC. An eight-point calibration (range 9–20,000 ng L^{-1}) curve was used for quantification using isotopic dilution and internal calibration methods. A regression fit of r^2>0.99 was set as the minimum requirement for the standards before performing quantification. The extraction efficiency of the mass-labeled internal standard for our samples ranged from 58 to 126%.

Text S3. Description of the UPLC−MS/MS analysis for PFAS quantification.

LC-MS grade 5 mM ammonium acetate in water (solution A) and acetonitrile (solution B) were utilized in a gradient solvent program for the analytes [1] (Table S5). A negative electrospray ionization analysis method was used. The capillary voltage was set to 1.5 kV, the flow rate of the desolvation gas (nitrogen) at 750 L h^{-1}, and the temperature at 350 ˚C. Additionally, a 325 ˚C temperature setting was used for the ion transfer tube.

Text S4. Details of the moisture content, pH, conductivity, and dissolved organic matter analysis process for soil samples.

The moisture content of soil samples was measured following the ASTM D2974 method [2]. Briefly, a known mass of fresh soil was dried at 105 °C until a constant weight was achieved. Moisture content was calculated based on the mass loss after drying and expressed as a percentage of the initial wet soil mass.

The pH and electrical conductivity of soil samples were measured using aqueous soil extracts prepared following the ASTM D3987-12 protocol [3]. Briefly, dried and homogenized soil samples were mixed with deionized water at a soil-to-water ratio of 1:10 (w/v). The suspensions were shaken for 24 h at room temperature, centrifuged at 10,000 rpm for 20 min, and filtered through 0.45 µm membrane filters. The pH of the filtrates was measured using a pH meter (Mettler Toledo, Fisher Scientific, USA), and electrical conductivity was measured using a conductivity meter (Mettler Toledo, Fisher Scientific, USA). The pH meter was calibrated using standard buffer solutions at pH 4.0, 7.0, and 10.0, while the conductivity meter was calibrated using standard conductivity solutions of 1,413 µS cm^{-1} and 12,880 µS cm^{-1} before analysis.

Dissolved organic matter (DOM) was quantified using the same filtered aqueous extracts. The filtrates were stored at 4 °C before analysis and analyzed using a Shimadzu total organic carbon (TOC) analyzer. DOM concentrations were reported based on the dissolved organic carbon content measured in the filtered extracts.

Text S5. Details of ultraviolet and fluorescence 3D excitation-emission matrix spectroscopy to characterize dissolved organic matter extracted from soils.

To avoid inner-filter effects on fluorescence 3D excitation-emission matrix (3D EEM) and ultraviolet-visible (UV-Vis) spectroscopy, the dissolved organic carbon concentration was normalized to 20 mg L^{-1} for all the extract samples before analysis [4]. UV absorbance of the extract samples was measured at 254 nm wavelength using a Genesys 150 UV-visible spectrophotometer (Thermo Scientific, USA). $SUVA_{254}$ was calculated by dividing the UV absorbance at 254 nm by the DOC concentration [5].

An FP-8350 spectrofluorometer (Jasco Inc., Japan) was used to perform the excitation and emission matrix for characterizing the DOM in soils based on the fluorescence intensity at emission wavelengths ranging from 250 to 550 nm and excitation wavelengths ranging from 200 to 500 nm. The fluorescence spectra were scanned with a slit width of 5 nm and a scanning speed of 2000 nm min^{-1} [6]. Spectral indices were calculated from the fluorescence 3D EEM spectroscopy, following the previously reported definition for fluorescence index (FI), biological index (BIX), and humification index (HIX) [6]. FI was calculated by the ratios of fluorescence intensity at emission wavelengths of 470 nm to 520 nm (excitation wavelength of 370 nm). BIX was calculated by the ratios of fluorescence intensity at emission wavelengths of 380 nm to 430 nm (excitation wavelength of 310 nm). HIX was calculated by dividing the average intensity at emission wavelength from 435 to 480 nm by the average intensity at emission wavelength from 300 to 345 nm; both measured at the excitation wavelength of 255 nm [7]. HIX has been widely used to indicate the degree of humification in DOM [7]. When $HIX<0.8$, the degree of humification is low; when $HIX>0.8$, the degree of humification is high [7]. FI is typically employed to distinguish the sources of DOM. Microbial activity is the main source of DOM for $FI>1.8$, and the contribution of microbial activity is low when $FI<1.5$ [6]. Biological Index (BIX) is commonly employed to estimate the biological components in any organic medium. $BIX>0.7$ indicates medium to high levels of biological components due to high microbial activity in soils, whereas $BIX<0.7$ indicates low levels of biological components [6].

Text S6. Anions and cation exchange capability measurement in soils.

To analyze anions in soils, we dissolved each soil sample in deionized water at a ratio of 1:10 (w/v) and subjected it to shaking for 24 hours. Following this, the suspension underwent centrifugation at 10,000 rpm for 20 minutes and was filtered through a Millipore 0.45 µm membrane filter. The resulting filtrate was stored at 4 °C before undergoing analysis. The quantification of anions, including chloride, sulphate, phosphate, nitrite, and nitrate, was carried out using ion chromatography (Thermo Scientific, DIONEX ICS 6000, USA).

To analyze the cation exchange capability (CEC), we followed the US EPA method 9080 [8]. Soil samples were first sieved through a 2-mm screen and dried at 60 °C. A 5.0 g portion of the dried, sieved soil was weighed into a 50 mL Falcon tube, and 25 mL of 1 M ammonium acetate (NH_4OAc) solution was added. The mixture was shaken for 30 min and centrifuged at 100,000 rpm for 15 min at 25 °C. The supernatant (NH_4OAc extract) was discarded, and the extraction step was repeated three additional times to ensure complete saturation. The soil was then washed with 95% ethanol to remove residual NH_4OAc by adding enough ethanol to cover the soil surface, capping the tube, inverting it several times, allowing the soil to settle, and discarding the ethanol. This washing process was repeated four more times. Subsequently, 25 mL of 1 M KCl was added to the soil to displace the adsorbed NH_4^+. The mixture was shaken for 30 min and centrifuged at 10,000 rpm for 15 min at 25 °C. The supernatant was filtered through a 0.45 µm Whatman filter paper to collect the extract containing displaced NH_4^+. Steps involving KCl addition, shaking, centrifugation, and filtration were repeated three more times, and the extracts were combined. The concentration of NH_4^+-N in the combined extract was determined colorimetrically. Then CEC was measured by the following equation: [CEC ($cmol_c$ kg^{-1}) = (NH_4-N in extract - NH_4-N in blank) / 18]. All samples were prepared in duplicate, and the average and standard deviation were calculated from the replicate measurements.

Text S7. Details of the statistical analyses conducted in this study.

A comprehensive data sheet in Excel (2021, version 16.54) was prepared with the concentration of analyzed PFAS in community garden and agricultural soils. For the average concentration and standard deviation of PFAS, we considered two replicates of PFAS for each depth in the soils. We observed that the concentration of PFAS was not normally distributed. To test the data normality, we performed Shapiro-Wilks tests on PFAS concentrations using JMP Pro (version 17.2) (Table S9). We observed that the concentration of all the PFAS was not normally distributed. In order to get a normal distribution of the data, we transformed the concentration of each PFAS into natural Log-transformed PFAS using JMP Pro (version 17.2). Several studies transformed the absolute concentration of PFAS into Log-transformed PFAS to conduct multivariate statistical analysis [9, 10]. We also performed Kruskal-Wallis one-way ANOVA analysis (non-parametric test) on the concentration of total PFAS and PFAS classes in soils across depths. This was performed to check the mean variability of total PFAS and PFAS classes.

Polynomial regression analysis was performed on (1) Log-transformed SOM vs. Log-transformed PFAS classes and total PFAS, (2) Log-transformed DOM vs. Log-transformed PFAS classes and total PFAS, (3) Log-transformed CEC vs. Log-transformed PFAS classes and total PFAS to predict the relationship using OriginPro (version 2025, 10.05). We adjusted the missing values (i.e., when targeted PFAS were not measured in soils) as blank, meaning ‘no data’ during statistical analysis. Several studies adjusted the non-identified and non-measured targeted PFAS in different environmental matrices (i.e., soil and water) as blank, referring to ‘no data’ for performing multivariate statistical analysis [11, 12]. Spearmen correlation analysis was performed to predict the relationship between the analyzed PFAS and other parameters (conductivity, pH, DOM, SOM, CEC, anions, soil texture, moisture, EEM indices, and DOM fractions) of soils using OriginPro (version 2025, 10.05). For both polynomial and Spearman correlation, we set the significance value at α=0.05. For correlation analysis, we considered a significant correlation when the correlation coefficient (r) exceeded 0.5 (r>0.5) and the P-value was less than 0.05.

Table S1. Sampling location coordinates for community garden soils. Samples were collected from each location at depths of 0, 1, and 2 ft and composited depth-wise to represent community garden soils within each depth category. Exact coordinates were not available for the agricultural and background soil sampling locations.

Sample Type	**Sample Location Coordinates**	
	Latitude	**Longitude**
Community Garden Soil	46.914474	-96.797309
	46.914506	-96.797177
	46.914663	-96.797118
	46.914663	-96.797289
	46.914649	-96.797434
	46.914654	-96.797579
	46.914851	-96.797593
	46.914465	-96.797552
	46.914524	-96.797447

Table S2. Certified concentrations of the mass-labelled PFAS in the PFAS extraction standard solution/mixture (MPFAC-HIF-ES, Wellington Laboratories, Canada).

Mass-labelled PFAS	**Extended forms of the Mass-labelled PFAS**	**Certified Concentration (ng mL^{-1})**
MPFBA	Perfluoro-n-($^{13}C_4$) butanoic acid	2000
M5PFPeA	Perfluoro-n-($^{13}C_5$) pentatonic acid	1000
M5PFHxA	Perfluoro-n-(1,2,3,4,6-$^{13}C_5$) hexanoic acid	500
M4PFHpA	Perfluoro-n-(1,2,3,4-$^{13}C_4$) heptanoic acid	500
M8PFOA	Perfluoro-n-($^{13}C_8$) octanoic acid	500
M9PFNA	Perfluoro-n-(13C$_9$) nonanoic acid	250
M6PFDA	Perfluoro-n-(1,2,3,4,5,6-$^{13}C_6$) decanoic acid	250
M7PFUdA	Perfluoro-n-(1,2,3,4,5,6,7-$^{13}C_7$) undecanoic acid	250
MPFDoA	Perfluoro-n-(1,2-$^{13}C_2$) dodecanoic acid	250
M2PFTeDA	Perfluoro-n-(1,2-$^{13}C_2$) tetra decanoic acid	250
M8FOSA	Perfluoro-1-($^{13}C_8$) octane sulfonamide	500
d-N-MeFOSA	N-methyl-d3-perfluoro-1-octanesulfonamide	500
d-N-EtFOSA	N-ethyl-d5-perfluoro-1-octanesulfonamide	500
d3-N-MeFOSAA	N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	1000
d5-N-EtFOSAA	N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	1000
d7-N-MeFOSE	2-(N-methyl-d3-perfluoro-1-octanesulfonamido) ethane-d4-ol	5000
d9-N-EtFOSE	2-(N-ethyl-d5-perfluoro-1-octanesulfonamido) ethane-d4-ol	5000
M3HFPO-DA	2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy) ($^{13}C_3$) propanoic acid	2000
M3PFBS	Sodium perfluoro-1-(2,3,4-$^{13}C_3$) butane sulfonate	500
M3PFHxS	Sodium perfluoro-1-(1,2,3-$^{13}C_3$) hexane sulfonate	500
M8PFOS	Sodium perfluoro-1-($^{13}C_8$) octane sulfonate	500
M2-4:2FTS	Sodium 1H,2H,2H-perfluoro(1,2-$^{13}C_2$) hexane sulfonate	1000
M2-6:2FTS	Sodium 1H,2H,2H-perfluoro(1,2-$^{13}C_2$) octane sulfonate	1000
M2-8:2FTS	Sodium 1H,2H,2H-perfluoro(1,2-$^{13}C_2$) decan sulfonate	1000

Table S3. Extracted internal standard (EIS) and non-extracted internal standard (NIS) were utilized for the quantification of targeted PFAS in this study [13].

Targeted PFAS in Soil	**Quantification Reference Compound**
PFBA	^{13}C4-PFBA
PFPeA	^{13}C5-PFPeA
PFHxA	^{13}C5-PFHxA
PFHpA	^{13}C4-PFHpA
PFOA	^{13}C8-PFOA
PFNA	^{13}C9-PFNA
PFDA	^{13}C6-PFDA
PFUdA	^{13}C7-PFUnA
PFDoA	^{13}C2-PFDoA
PFTrDA	^{13}C2-PFTeDA
PFTeDA	^{13}C2-PFTeDA
PFBS	^{13}C3-PFBS
PFPeS	^{13}C3-PFHxS
PFHxS	^{13}C3-PFHxS
PFHpS	^{13}C8-PFOS
PFOS	^{13}C8-PFOS
PFNS	^{13}C8-PFOS
PFDS	^{13}C8-PFOS
PFDoS	^{13}C8-PFOS
4:2FTS	^{13}C2-4:2FTS
6:2FTS	^{13}C2-6:2FTS
8:2FTS	^{13}C2-8:2FTS
PFOSA	^{13}C8-PFOSA
NMeFOSA	D3-NMeFOSA
NEtFOSA	D5-NEtFOSA
NMeFOSAA	D3-NMeFOSAA
NEtFOSAA	D5-N-EtFOSAA
NMeFOSE	D7-NMeFOSE
NEtFOSE	D9-NEtFOSE
HFPO-DA	^{13}C3-HFPO-DA
ADONA	^{13}C3-HFPO-DA
9Cl-PF3ONS	^{13}C3-HFPO-DA
11Cl-PF3OUdS	^{13}C3-HFPO-DA
3:3FTCA	^{13}C5-PFPeA
5:3FTCA	^{13}C5-PFHxA
7:3FTCA	^{13}C5-PFHxA
PFEESA	^{13}C5-PFHxA
PFMPA	^{13}C5-PFPeA
PFMBA	^{13}C5-PFPeA
NFDHA	^{13}C5-PFHxA
EIS Compounds	
^{13}C4-PFBA	N/A
^{13}C5-PFPeA	
^{13}C5-PFHxA	
^{13}C4-PFHpA	
^{13}C8-PFOA	
^{13}C9-PFNA	
^{13}C6-PFDA	
^{13}C7-PFUnA	
^{13}C2-PFDoA	

^{13}C2-PFTeDA	
^{13}C3-PFBS	
^{13}C3-PFHxS	
^{13}C8-PFOS	
^{13}C2-4:2FTS	
^{13}C2-6:2FTS	
^{13}C2-8:2FTS	
^{13}C8-PFOSA	
D3-NMeFOSA	
D5-NEtFOSA	
D3-NMeFOSAA	
D5-NEtFOSAA	
D7-NMeFOSE	
D9-NEtFOSE	
^{13}C3-HFPO-DA	
NIS Compounds	
^{13}C3-PFBA	N/A
^{13}C2-PFHxA	
^{13}C4-PFOA	
^{13}C5-PFNA	
^{13}C2-PFDA	
^{18}O2-PFHxS	
^{13}C4-PFOS	

N/A – These analytes do not produce a confirmation ion mass or do not have a quantitation reference compound.

Table S4. Investigated PFAS, their classes, and subclasses. The number in parentheses refers to the number of carbons in that PFAS [14, 15].

Analyzed PFAS	Extended Form	PFAS Class	PFAS Subclass

PFBA (4)	Perfluorobutanoic Acid	Perfluoroalkyl acids (PFAAs)	Perfluorocarboxylic acids (PFCAs)
PFDA (10)	Perfluorodecanoic acid		
PFDoA (12)	Perfluorododecanoic acid		
PFHpA (7)	Perfluoroheptanoic acid		
PFHxA (6)	Perfluorohexanoic acid		
PFNA (9)	Perfluorononanoic acid		
PFOA (8)	Perfluorooctanoic acid		
PFPeA (5)	Perfluoropentanoic acid		
PFTeDA (14)	Perfluorotetradecanoic acid		
PFTrDA (13)	Perfluorotridecanoic acid		
PFUdA (11)	Perfluoro-undecanoic acid		
PFBS (4)	Perfluorobutane sulfonic acid		Perfluorosulfonic acids (PFSAs)
PFDoS (12)	Perfluorododecane sulfonic acid		
PFDS (10)	Perfluorodecane sulfonic acid		
PFHpS (7)	Perfluoroheptane sulfonic acid		
B. PFHxS (6)	Branched Perfluorohexane sulfonic acid		
L. PFHxS (6)	Linear Perfluorohexane sulfonic acid		
PFNS (9)	Perfluorononane sulfonic acid		
B. PFOS (8)	Branched Perfluorooctane sulfonic acid		
L. PFOS (8)	Linear Perfluorooctane sulfonic acid		
PFPeS (5)	Perfluoropentane sulfonic acid		
11-Cl-PF$_3$OUdS (10)	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid		Perfluoro ether sulfonic acids (PFESAs)
9-Cl-PF$_3$ONS (8)	Perfluoro(2-((6-chlorohexyl) oxy) ethane sulfonic acid)		
PFEESA (4)	Perfluoro(2-ethoxyethane) sulphonic acid		
GenX (HFPO-DA) (6)	Hexafluoropropylene oxide (HFPO) dimer acid		Perfluoro ether carboxylic acid (PFECAs)
NADONA (7)	Sodium dodecafluoro-3H-4,8-dioxanonanoate		
NFDHA (5)	Perfluoro-3,6-dioxaheptanoic acid- 3,6-OPFHpA		
PFMBA (5)	PF5OHxA - Perfluoro-4-methoxybutanoic acid		
PFMPA (4)	PF4OPeA-Perfluoro-3-methoxypropanoic acid		
EtFOSA (10)	N-Ethylperfluorooctane-1-sulfonamide	PFAAs Precursor	Perfluoroalkane sulfonamides (PASFs)
EtFOSAA (12)	N-ethyl perfluorooctane sulfonamido acetic acid		
EtFOSE (12)	N-ethyl perfluorooctanesulfonamidoethanol		
FOSA-1 (8)	Perfluorooctanesulfonamide		
MeFOSA (9)	N-Methylperfluorooctanesulfonamide		
MeFOSAA (11)	N-Methylperfluorooctanesulfonamidoacetic acid		
MeFOSE (11)	N-Methylperfluorooctanesulfonamidoethanol		
3:3 FTCA (6)	3:3 Fluorotelomer carboxylic acid		Fluorotelomer carboxylic acids (FTCAs)
5:3 FTCA (8)	5:3 Fluorotelomer carboxylic acid		
7:3 FTCA (10)	7:3 Fluorotelomer carboxylic acid		
4:2 FTS (6)	4:2 Fluorotelomer sulfonic acid		Fluorotelomer sulfonic acids (FTSs)
6:2 FTS (8)	6:2 Fluorotelomer sulfonic acid		
8:2 FTS (10)	8:2 Fluorotelomer sulfonic acid		

Table S5. The gradient program is used to run the Ultra-performance liquid chromatography (UPLC–MS/MS) analysis. Mobile Phase A = 5 mM ammonium acetate in LC-MS grade water, and Mobile Phase B = LC-MS grade Acetonitrile.

Time (min)	Flowrate (mL/min)	% of Phase A	% of Phase B

0	0.5	70	30
0.5	0.5	70	30
3	0.5	10	90
3.1	0.5	0	100
4.5	0.5	70	100
4.6	0.5	30	30
6.5	0.5	70	30

Table S6. Soil physiochemical characteristics, including conductivity, moisture, organic matter, cation exchange capability, concentration of anions, pH, soil texture, DOM components, ultraviolet, and fluorescence 3D excitation-emission matrix (3D EEM) spectroscopy indices for characterizing soils.

Parameters	**Unit**	**Types of Soil**					
		Agricultural Soil			**Garden Soil**		
		0 ft	**0.5 ft**	**1 ft**	**0 ft**	**1 ft**	**2 ft**
Conductivity	μs cm^{-1}	1380	840	1114	1566	800	634.2
MC	%	11.6	23.1	26.7	32.7	30.6	32.1
SOM	%	3.1	2.7	2.4	3.5	2.6	2.1
DOM	mg kg^{-1}	375	295	292	588	223	149
CEC	cmol$_c$ kg^{-1}	36	17	15	37	19	17
Chloride	mg kg^{-1}	17.5	43.1	33.6	25.6	30.7	18.3
Nitrite	mg kg^{-1}	0.3	0.9	1	8.2	3.1	1
Nitrate	mg kg^{-1}	7.1	4.0	1.2	8.3	4.1	4.5
Sulfate	mg kg^{-1}	75.7	103.1	133.4	107.4	109.7	81.4
Phosphate	mg kg^{-1}	----	----	----	2.3	----	----
pH	----	6.7	6.9	6.9	6.6	6.8	6.6
Sand	%	5.5	2.7	2.5	5.0	1.6	2.1
Slit	%	55.7	57.3	60	48.7	46	44.2
Clay	%	38.8	40	37.5	46.2	52.5	53.7
Humic-like	au	2653	1240	965	2770	2060	1610
Fulvic-like	au	2175	1260	1000	2330	2000	1570
FI	----	1.6	1.7	1.5	1.6	1.6	1.4
BIX	----	0.9	0.6	0.3	1.2	0.5	0.3
HIX	----	1.3	0.9	0.7	1.4	0.9	0.6
SUVA$_{254}$	L mg^{-1} m^{-1}	0.6	0.5	0.3	0.7	0.3	0.2

Table S7. Fluorescence 3D excitation-emission matrix spectroscopy parameters of the dissolved organic matter extracted from soils at different depths.

Depth (ft)	**Community Garden Soil**	**Ref.**

	Identified Peaks	**Excitation Wavelength (nm)**	**Emission Wavelength (nm)**	**Highest Intensity (au)**	**Fluorescent Compounds**	
0 ft	A	320-340	430-450	2,770	Human-like substances	[16, 17]
	B	220-260	420-460	2,330	Fulvic-like substances	
1 ft	A	320-340	430-450	2,060	Human-like substances	
	B	220-260	420-460	2,000	Fulvic-like substances	
2 ft	A	320-340	430-450	1,610	Human-like substances	
	B	220-260	420-460	1,570	Fulvic-like substances	
Agricultural Soil						
0 ft	A	320-340	430-450	2,650	Human-like substances	
	B	220-260	420-460	2,190	Fulvic-like substances	
0.5 ft	A	320-340	430-450	1,270	Human-like substances	
	B	220-260	420-460	1,250	Fulvic-like substances	
1 ft	A	320-340	430-450	970	Human-like substances	
	B	220-260	420-460	990	Fulvic-like substances	

Table S8. The details of ultraviolet and fluorescence 3D excitation-emission matrix (3D EEM) spectroscopy indices used to characterize the dissolved organic matter (DOM) extracted from soils.

Indices	**Equation**	**Specific Excitation (Ex)**	**Uses**	**Standard Range**	**Ref.**

		Wavelength, nm			
SUVA$_{254}$ (L mg^{-1} m^{-1})	Absorbance at UV$_{254}$ (m^{-1}) /DOC (mg L^{-1})	---	To characterize the aromaticity of DOM molecules	The higher the value, the higher the aromaticity	[4, 5]
Fluorescence Index (FI)	Intensity of Em 470/ Em 520	Ex 370	To identify the sources	Microbial activity is the main source of DOM when FI>1.8, terrestrial and microbial sources 1.4<FT>1.8	[6]
Biological Index (BIX)	Intensity of Em 380/ Em 430	Ex 310	To estimate biologically derived components	BIX>0.7 indicates medium to high levels of biological components due to high microbial activity	[7, 18]
Humification Index (HIX)	Average Intensity of (Em 435-480)/ (Em 300-345)	Ex 255	To characterize the degree of humification	When HIX<0.8, the degree of humification is low; When HIX>0.8, the degree of humification is high	[6]

Table S9. Normality test of the analyzed PFAS in the community garden and agricultural soil. PFAS concentrations are reported on a dry-weight basis.

Analyzed PFAS and Classes	**Sample size, N**	**Statistic**	**P-value**	**Decision at level at α=0.05 level**

PFBA	12	0.68105	<0.0001	Reject normality
PFPeA	12	0.68499	<0.0001	Reject normality
PFHxA	12	0.76269	<0.0001	Reject normality
PFHpA	12	0.79076	<0.0001	Reject normality
PFOA	12	0.7456	<0.0001	Reject normality
PFNA	12	0.62618	<0.0001	Reject normality
PFDA	12	0.69685	<0.0001	Reject normality
PFUdA	12	0.74568	<0.0001	Reject normality
PFDoA	12	0.73023	<0.0001	Reject normality
PFBS	12	0.70507	<0.0001	Reject normality
B. PFHxS	12	0.75	<0.0001	Reject normality
L. PFHxS	12	0.74568	<0.0001	Reject normality
PFHxS	12	0.73506	<0.0001	Reject normality
B. PFOS	12	0.73023	<0.0001	Reject normality
L. PFOS	12	0.6505	<0.0001	Reject normality
PFOS	12	0.66233	<0.0001	Reject normality
6:2 FTS	12	0.69885	<0.0001	Reject normality
∑PFCA	12	0.78843	<0.0001	Reject normality
∑PFSA	12	0.76061	<0.0001	Reject normality
∑PFAA	12	0.7552	<0.0001	Reject normality
∑FTS	12	0.75885	<0.0001	Reject normality
∑FTS	12	0.73939	<0.0001	Reject normality
∑PFAS	12	0.75252	<0.0001	Reject normality

Table S10. Kruskal-Wallis one-way ANOVA analysis (significant at 0.05) of the individual PFAS compounds in community garden soil and agricultural soil.

Null Hypothesis	**Test**	**Significant at 0.05**	**Decision**
The concentration of individual PFAS is the same in the community garden and agricultural soil	Independent -Samples Kruskal-Wallis test	<0.001	Reject the null hypothesis
Test Summary			
Total N	38		
Test Statistics	20.221		
Degree of Freedom	2		
Asymptotic Significance	<0.001		

Table S11. Detected PFAS species and their concentrations in community garden, agricultural, and background soils. Linear and branched isomers were combined for PFHxS and PFOS and counted as one PFAS species for each compound. Numbers in parentheses indicate the carbon number of the corresponding PFAS compound.

PFAS Classes	Detected PFAS	Community Garden Soil	Agricultural Soil	Background Soil
		ng kg^{-1}	ng kg^{-1}	ng kg^{-1}
PFCAs	PFBA (4)	924±103	392±39	347±27
	PFPeA (5)	523±91	182±9	98±4
	PFHxA (6)	40±8	33±1	77±1
	PFHpA (7)	59±7	63±10	118±5
	PFOA (8)	185±47	146±7	281±1
	PFNA (9)	119±10	122±4	179±7
	PFDA (10)	143±0	47±2	103±25
	PFUdA (11)	96±5	52±4	77±8
	PFDoA (12)	17±1	17±1	50±10
	PFTrDA (13)			28±1
	PFTeDA (14)			14±2
PFSAs	PFBS (4)	39±2	56±3	54±3
	B. PFHxS (6)		2±1	12±2
	L. PFHxS (6)	247±5	19±1	85±7
	PFHxS (6)	247±5	21±1	96±9
	B. PFOS (8)	257±101	59±5	237±38
	L. PFOS (8)	1303±170	296±17	1069±20
	PFOS (8)	1561±271	355±22	1305±59
PFAS Precursors	6:2 FTS (8)	52±6	37±2	28±2
	EtFOSAA (12)			13±1
	FOSA (8)			11±2
PFAS Classes and total PFAS	∑PFCA	2088±283	1054±76	1372±71
	∑PFSA	1847±278	432±50	1456±42
	∑PFAA	3934±210	1486±46	2827±32
	∑Precursors	52±6	37±2	51±3
	∑PFAS	3987±146	1523±25	2878±110

Table S12. Kruskal-Wallis one-way ANOVA analysis (significant at 0.05) of PFAS classes, and total PFAS in community garden soil and agricultural soil.

Null Hypothesis	Test	Significant at 0.05	Decision

The concentration of PFAS classes and total PFAS is the same in the community garden and agricultural soil	Independent -Samples Kruskal-Wallis test	<0.001	Reject the null hypothesis
Test Summary			
Total N	10		
Test Statistics	16.567		
Degree of Freedom	2		
Asymptotic Significance	<0.001		

Table S13. Polynomial regression analysis between soil organic matter (SOM) and PFAS classes, and total PFAS at different depths in the community garden and agricultural soil.

Equation	**y = Intercept + B1*x^1 + B2*x^2**				
PFAS Classes	PFCAs	PFSAs	PFAAs	ΣFTS	ΣPFAS
Intercept	10746.9± 9572.5	35712.2 ± 8631.9	46459.1 ± 16735.8	-497.2± 783.9	46942.1 ± 15877.8
B1	-8355.6 ± 6309.6	-25124.57 ± 5689.7	-33480.2 ± 11031.3	336.9 ± 516.7	-33830.4 ± 10465.7
B2	1693.5 ± 1031.4	4436.5 ± 930.1	6130.1 ± 1803.3	-51.7 ± 84.4	6195.7 ± 1710.9
RSS	64906.0	52777.8	198392.5	435.2	178571.7
R^2	0.96	0.97	0.97	0.34	0.97
Adj. R^2	0.94	0.95	0.95	-0.08	0.96
P value	0.0001	0.0001	0.0001	0.54	0.0001

Table S14. Polynomial regression analysis between dissolved organic matter (DOM) and PFAS classes, total PFAS at different depths in the community garden and agricultural soil.

Equation	**y = Intercept + B1*x^1 + B2*x^2**			
PFAS Classes	∑PFAA	∑PFAS	∑PFCA	∑PFSA
Intercept	28.2 ± 7.1	26.5± 7.2	23.7 ± 8.2	35.2± 6.7
B1	-21.4 ± 5.8	-20.0± 5.9	-17.6 ± 6.6	-27.9 ± 5.4
B2	4.5 ± 1.1	4.2 ± 1.1	3.7 ± 1.3	5.9 ± 1.1
RSS	0.07	0.07	0.09	0.06
R^2	0.84	0.83	0.72	0.92
Adj. R^2	0.77	0.76	0.60	0.88
P value	0.01	0.01	0.04	0.002

Table S15. Polynomial regression analysis between cation exchange capacity (CEC) and PFAS classes, total PFAS at different depths in the community garden and agricultural soil.

Equation	**y = Intercept + B1*x^1 + B2*x^2**			
PFAS Classes	∑PFAS	∑PFCA	∑PFSA	∑PFAA

Intercept	-3.5 ± 8.8	-8.3 ± 6.8	2.7 ± 13.8	-4.4 ± 9.0
B1	8.4 ± 12.9	15.2 ± 9.9	-2.0 ± 20.3	9.6 ± 13.2
B2	-2.5 ± 4.6	-5.0 ± 3.5	1.3 ± 7.3	-2.9 ± 4.7
RSS	0.10	0.06	0.25	0.10
R^2	0.77	0.82	0.67	0.77
Adj. R^2	0.67	0.74	0.53	0.66
P Value	0.03	0.01	0.04	0.03

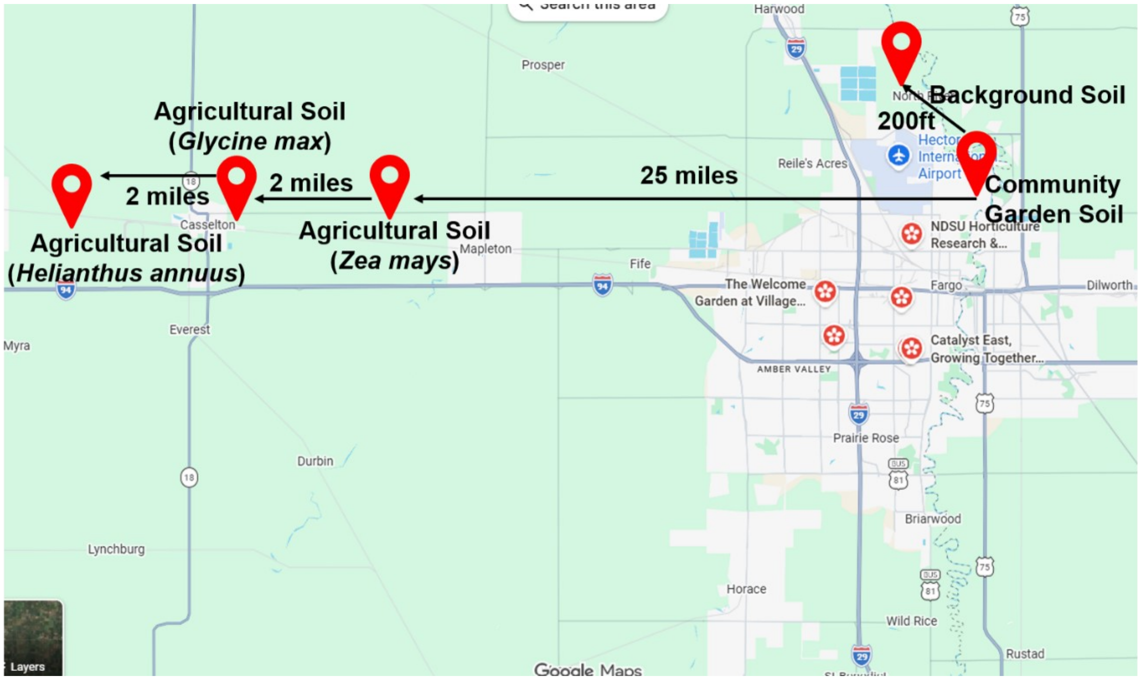


Figure S1. Study area map showing the approximate locations of the community garden, background, and agricultural soil sampling sites, with the background soil site located approximately 200 ft north-west of the community garden soil location, the corn (*Zea mays*) agricultural field approximately 25 miles west of the community garden soil location, the soybean (*Glycine max*) field approximately 2 miles west of the corn field, and the sunflower (*Helianthus annuus*) field approximately 2 miles west of the soybean field.

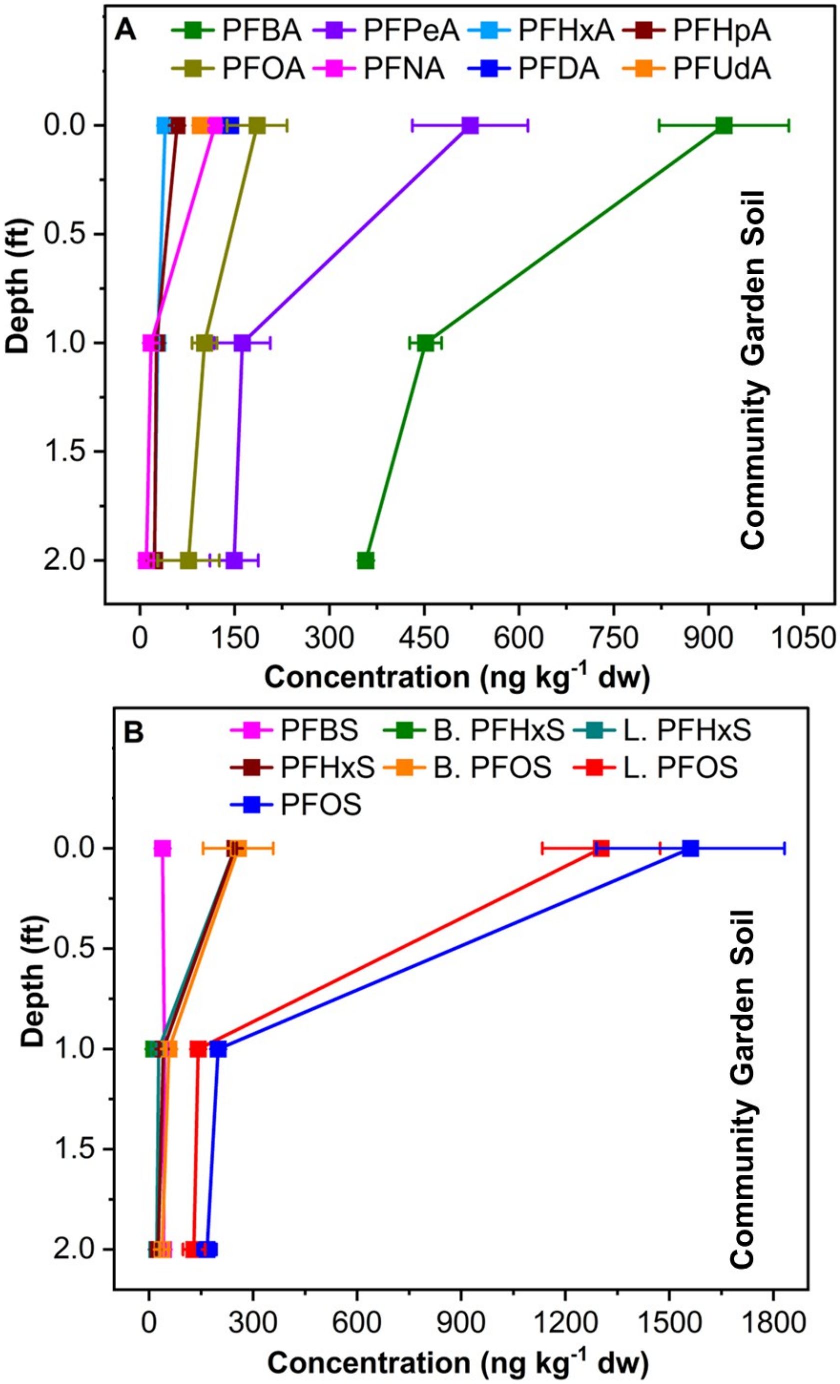
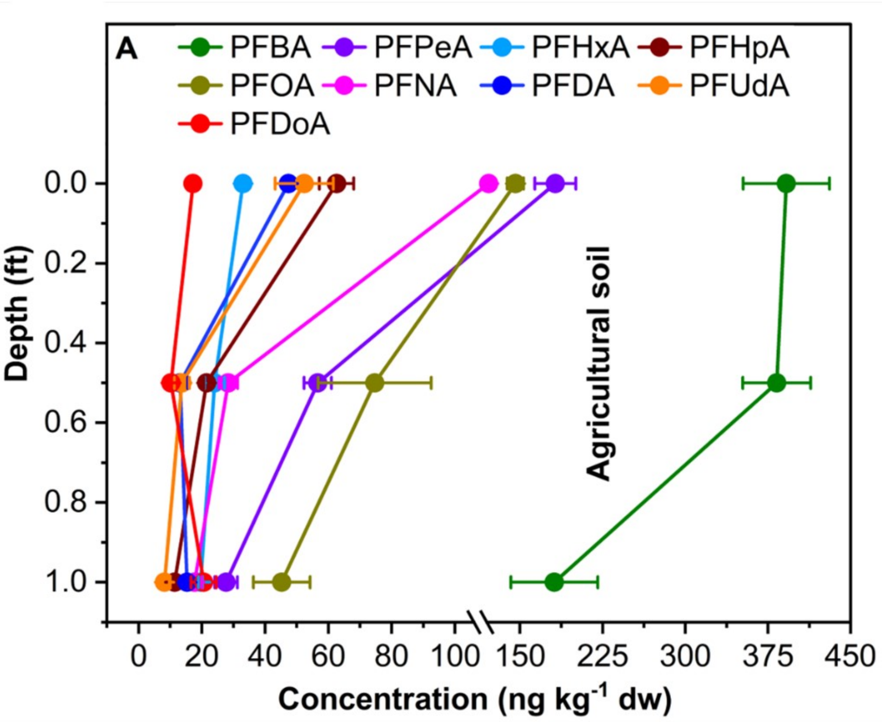


Figure S2. Concentrations of analyzed PFAS in community garden soil. Eight perfluorocarboxylic acid PFAS species (A) and three perfluorosulfonic acid PFAS species (B) were detected in community garden soil in all analyzed depths. The mean and standard error of each compound were calculated from two replicates. Extended forms of PFAS are available in Table S3.



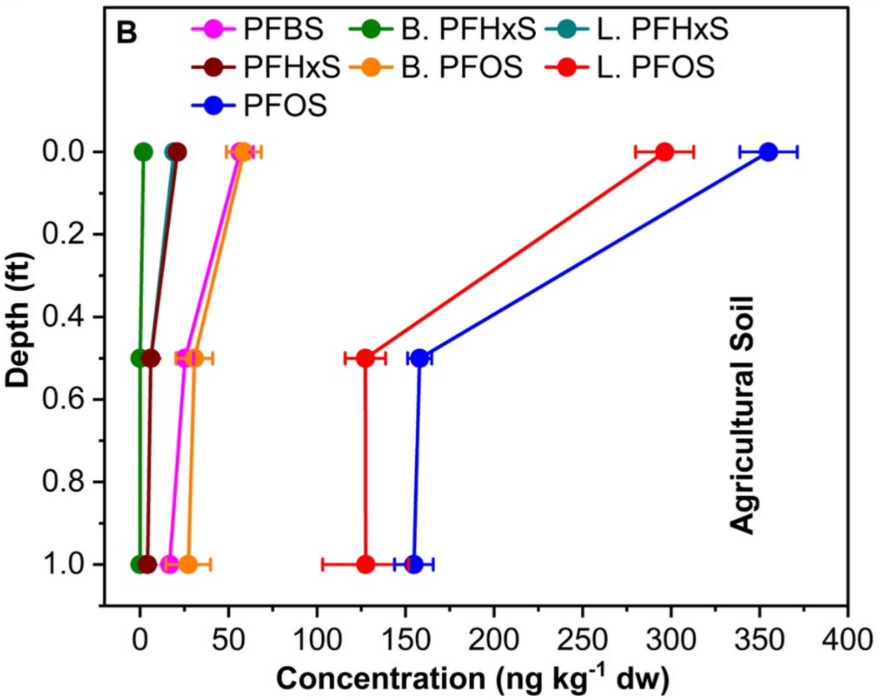


Figure S3. Concentrations of analyzed PFAS in agricultural soil. Nine perfluorocarboxylic acid PFAS species (A) and three perfluorosulfonic acid PFAS species (B) were detected in community garden soil in all analyzed depths. The mean and standard error of each compound were calculated from two replicates. Extended forms of PFAS are available in Table S3.

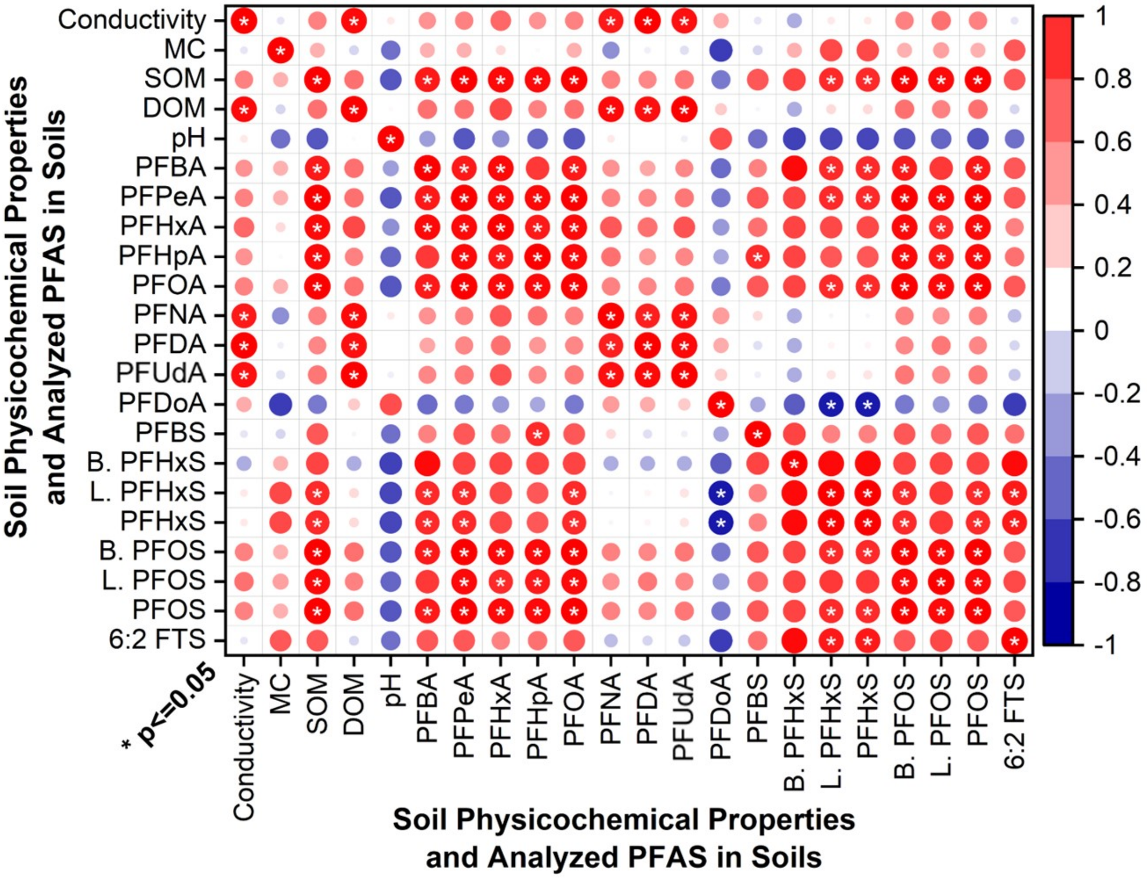


Figure S4. Spearman correlation analysis between soil physicochemical properties and individual PFAS compounds at different soil depths in the community garden and agricultural soil. Physiochemical properties include soil conductivity, moisture content (MC), soil organic matter (SOM), dissolved organic matter (DOM), and pH. The red circle with '*' denotes a significant correlation between the pairs. The red color in the right-side bar indicates the intensity of a strong correlation, and the blue color denotes the intensity of a weak correlation among the pairs. Extended forms of the PFAS are provided in Table S3.

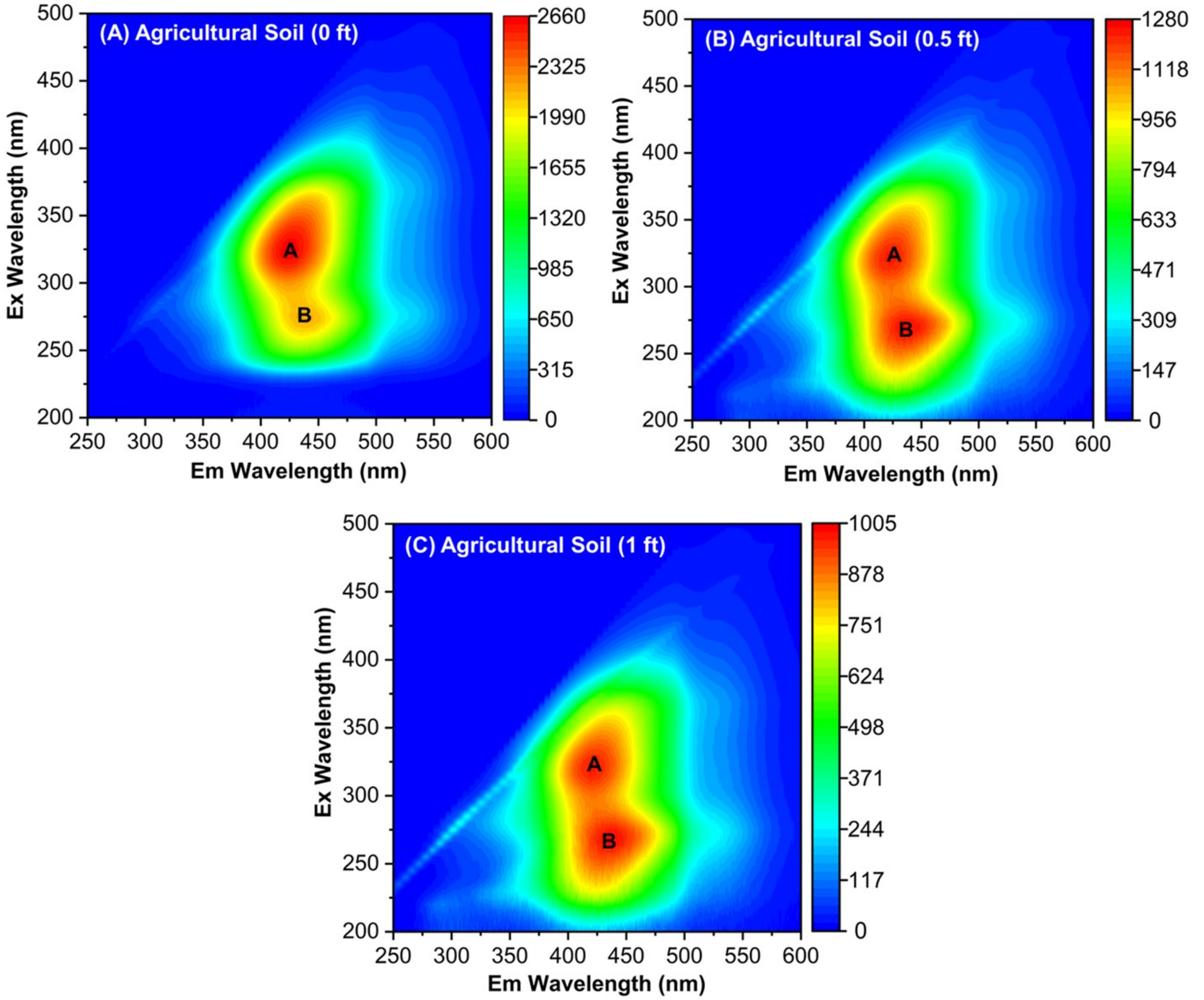


Figure S5. (A-C). Fluorescence three-dimensional excitation–emission matrix (3D EEM) spectra of dissolved organic matter (DOM) in agricultural soil. The three-dimensional data were plotted as two-dimensional contour plots to elucidate different organic fractions in soil DOM. Peaks A and B represent humic-like and fulvic-like substances, respectively. The highest fluorescence intensities of these peaks were considered to infer the relative levels of humic- and fulvic-like substances in soils across depths. Detailed excitation and emission wavelengths corresponding to the identified peaks are listed in Table S6.

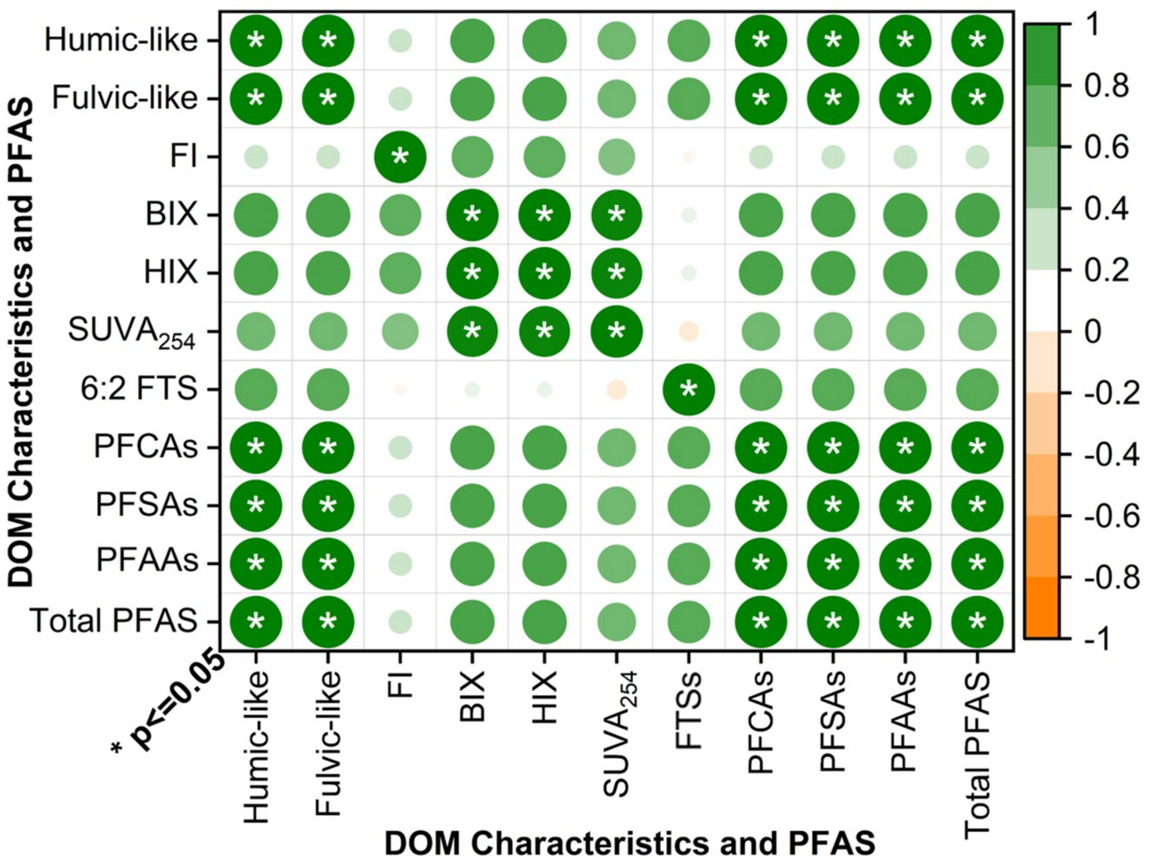


Figure S6. Spearman correlation analysis between dissolved organic matter characteristics and PFAS classes, including total PFAS at different soil depths in the community garden and agricultural soil. The highest intensity of humic- and fulvic-like substances was considered to infer the relative levels of these components in soils at various depths, providing an indirect measure of their concentrations. Fluorescence index (FI), biological index (BIX), and humification index (HIX) were calculated based on excitation and emission absorbance data. The green circle with '*' denotes a significant correlation between the pairs. The green color in the right-side bar indicates the intensity of a strong correlation, and the orange color denotes the intensity of a weak correlation among the pairs. Extended forms of the PFAS are provided in Table S3.

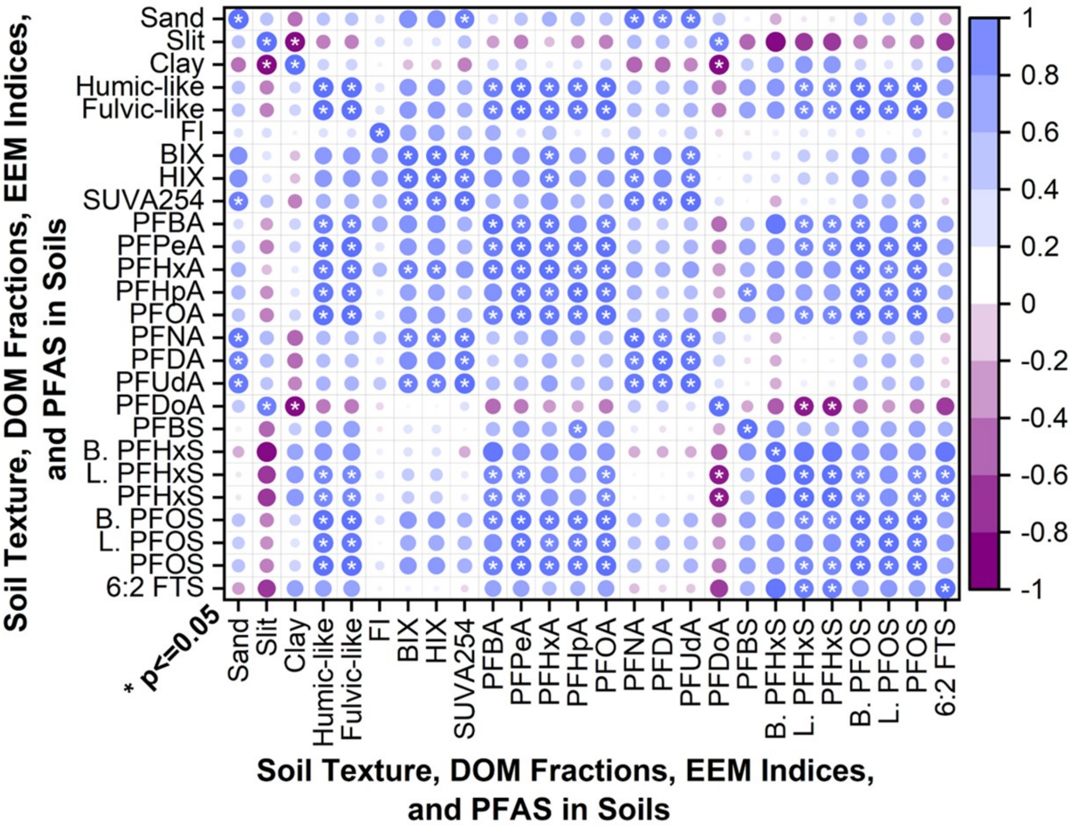


Figure S7. Spearman correlation analysis between soil texture, DOM components, fluorescence indices, and analyzed PFAS in community garden and agricultural soil across depths. Soil texture represents the percentage of sand, clay, and slit. The highest intensity of humic- and fulvic-like substances was considered to infer the relative levels of these components in soils at various depths, providing an indirect measure of their concentrations. Fluorescence index (FI), biological index (BIX), and humification index (HIX) were calculated based on excitation and emission absorbance data. The blue circle with '*' denotes a significant correlation between the pairs. The blue color in the right-side bar indicates the intensity of a strong correlation, and the purple color denotes the intensity of a weak correlation among the pairs. Extended forms of the PFAS are provided in Table S3.

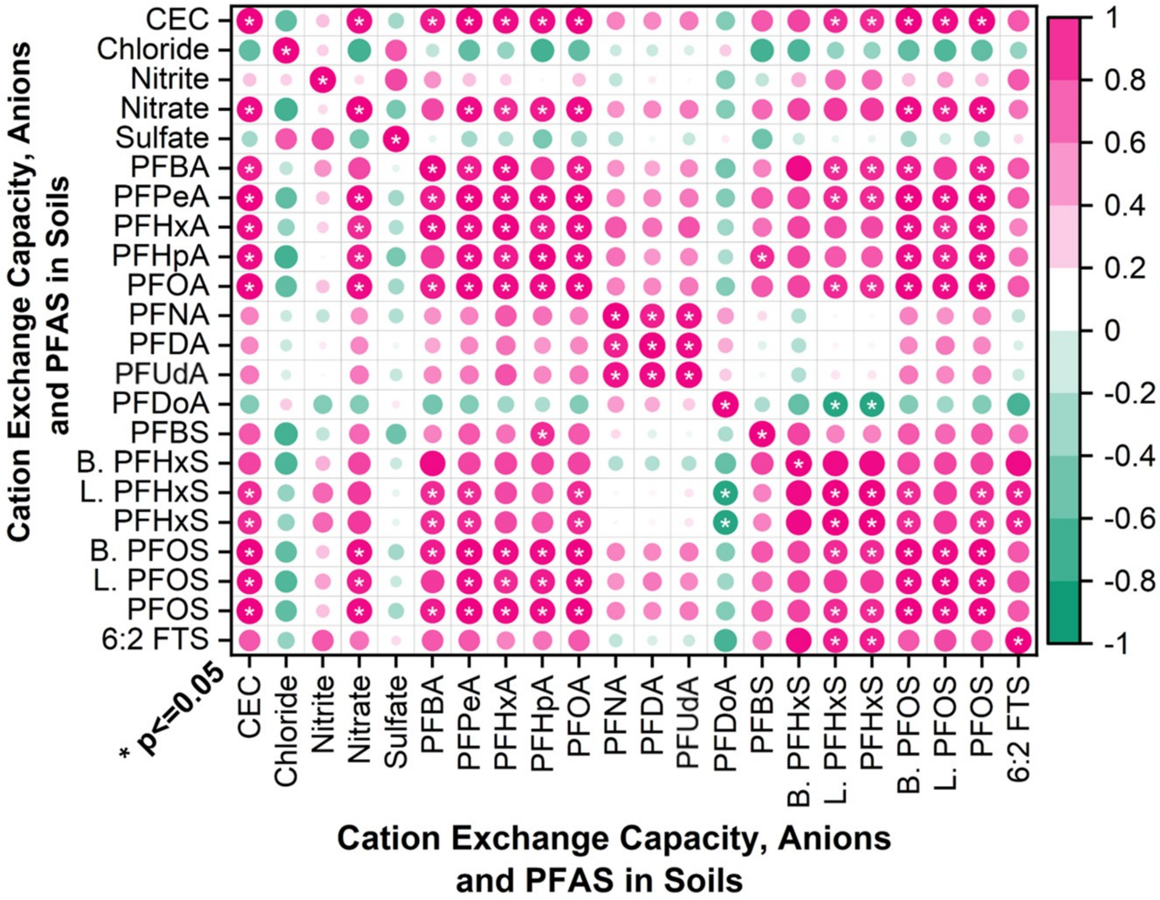


Figure S8. Spearman correlation analysis between cation exchange capacity, anion concentrations, and analyzed PFAS in the community garden and agricultural soil across depths. Among the measured anions, phosphate (PO_4^{3-}) was excluded from this analysis because it was detected only in surface soil from the community garden. The pink circle with '*' denotes a significant correlation between the pairs. The pink color in the right-side bar indicates the intensity of a strong correlation, and the green color denotes the intensity of a weak correlation among the pairs. Extended forms of the PFAS are provided in Table S3.

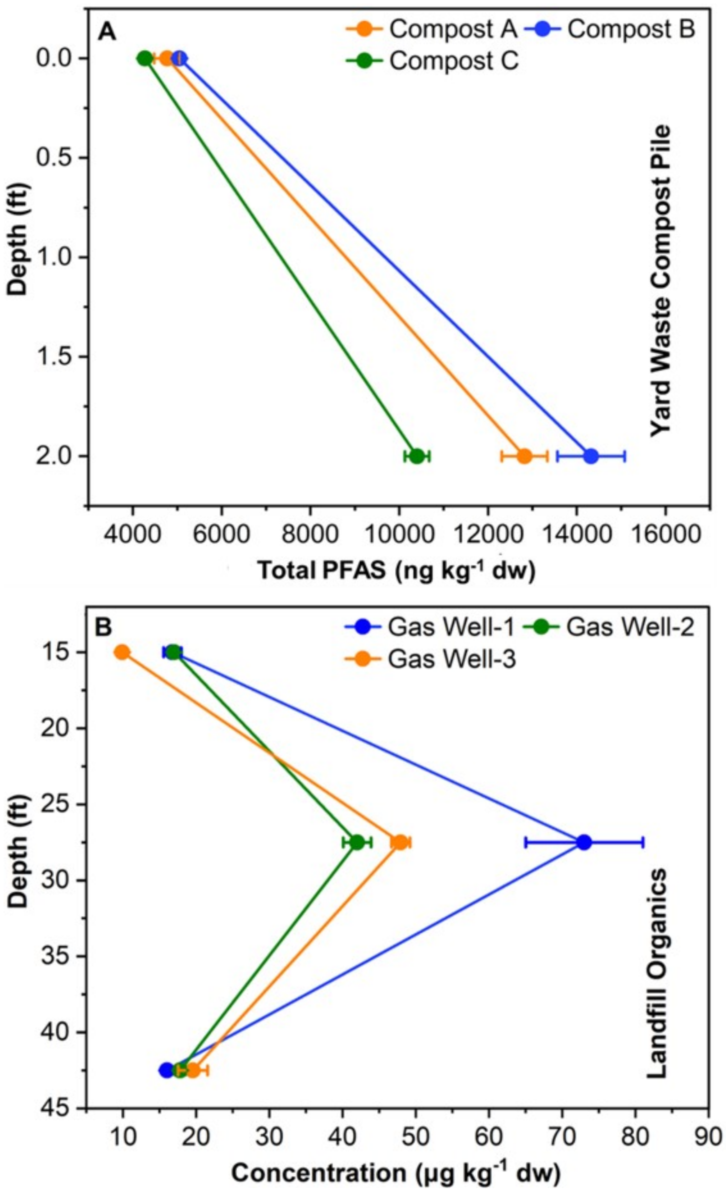


Figure S9. Vertical distribution of total PFAS concentrations in different environmental matrices. The data for this figure were collected from our previous studies [1, 19]. A. Total PFAS concentrations in an idle yard waste compost pile at different depths. Compost A, Compost B, and Compost C are three randomly selected locations within the compost pile. B. Total PFAS concentrations in landfill organics at different depths. Landfill organics were collected during boring for gas-well installation; a total of seven gas wells were investigated and results for three are shown here.

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