Supplementary Material

Retention of the antibiotic cefuroxime onto agricultural and forest soils

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Basic data regarding sampling areas

Table S1 shows data on the soils sampled for this study in different areas of Galicia (NW Spain). The 20 agricultural soils sampled were as follows: 13 vineyard soils, with 5 in Ourense province – VO1 to VO5- and 8 in Pontevedra province –VP1 to VP8-, and with the other 7 being corn (or maize) soils –M1 to M7-). In addition, the 3 forest soils sampled were: one of them under *Pinus* –FP-, another one under oak (*Q. robur*) –FC-, and the third one under *Eucaliptus* –FE-.

Table S1. Basic details corresponding to the 23 soils that were sampled for this study. M: maize (corn) soils; VO: vineyard soils (Ourense province); VP: vineyard soils (Pontevedra province); F: forest soils; CM and CV: control soils in maize and vineyard areas.

Code	Crop/Trees	Parent material	Mean temperature (°C)	Annual rainfall (mm)
M1	Corn	Schists, quartzite, pelite, sandstones and granites	12	995
M2 M3 M4 M5 M6	Corn	Schist and amphibolite	13	1270
M7	Corn	Granite	13.4	1587
VO1 VO2 VO3	Vineyard	Schist Slate Slate	11	850-1000
VO4 VO5	Vineyard	Granite and mica-schists	14.5	950
VP1 VP2 VP3	Vineyard	Granite	13.8	1540
VP4 VP5	Vineyard	Granite	14	1000-2000
VP6 VP7	Vineyard	Granite	13.8	1540
VP8	Vineyard	Granite	13.4	1587
FP FE FC	Pine, Eucalyptus, Oak	Granite and gneiss	11.2	1389

Quantification of soil parameters

Table S2 shows the results of the determinations of the basic parameters carried out on the 23 soils under study.

Regarding methods, soil texture was determined using the International Method of the Robinson Pipette. The pH values in water and pH in KCl (soil:liquid ratio 1:2.5) were measured with a CRISON-2001 pH meter (Crison, Spain). The determination of total C and N was carried out by elemental analysis, with a LECO CHN-100 equipment (Leco Corporation, St. Joseph, MI, USA). The exchangeable cations (Ca_e, Mg_e, Na_e, K_e and Al_e) were displaced using a 1M NH_4Cl solution in a 1:10 soil:solution ratio, and were then determined by atomic absorption spectrophotometry (Ca, Mg and Al) or atomic emission spectrophotometry (Na and K) with a Perkin Elemer AAnalyst 200 equipment (Perkin Elmer, USA). The sum of these exchangeable cations is considered the effective cation exchange capacity (eCEC). The available phosphorus was extracted using 0.5 M $NaHCO_3$ and determined by the phosphomolybdic complex method, using a UV-visible spectrophotometer (UV-1201, Shimadzu, Japan). To determine the total non-crystalline Fe and Al contents, an extraction was carried out with ammonium oxalate buffered at pH 3, stirring for 4 hours in the dark; five drops of 0.25% superfloc were added to the resulting extract, then centrifuged at 2000 rpm for 10 minutes; it was then filtered, and the supernatant is diluted 1:5; Fe and Al in non-crystalline form were measured by atomic absorption spectrophotometry. The determination of Fe and Al bound to organic matter (Fe_{pir} and Al_{pir}) was carried out by extraction with sodium pyrophosphate at pH 10; the extraction was carried out by shaking 1 g of sample with 100 mL of sodium pyrophosphate for 16 hours; the samples were diluted in half with distilled water and finally Fe and Al were measured in by atomic absorption spectrophotometry.

Table S2. Values corresponding to the basic parameters determined in the various soils studied. M: maize (corn) soils; VO: vineyard soils (Ourense province); VP: vineyard soils (Pontevedra province); F: forest soils; CM and CV: control soils in maize and vineyard areas. Average values (n=3), with coefficients of variation always < 5%.

Soil	pH_{H20}	OC	OM	N	Sand	clay	eCEC	Ca	Mg	Na	K	Al	Fe_{ox}	Fe_{pir}	Al_{ox}	Al_{pir}
		%					$cmol_c\ kg^{-1}$						$mg\ kg^{-1}$			
M1	8.02	4.98	8.58	0.33	49.57	22.50	42.81	39.44	2.07	0.60	0.69	0.01	4140	1501	5351	2111
M2	5.33	2.66	4.59	0.27	43.42	24.65	6.88	5.35	0.67	0.02	0.44	0.40	5745	3159	3401	2871
M3	5.65	2.58	4.44	0.25	43.57	22.43	7.48	6.18	0.77	0.00	0.28	0.24	5780	3315	3881	2717
M4	5.01	2.04	3.52	0.21	45.64	22.43	5.94	4.58	0.67	0.10	0.17	0.43	4545	2923	2896	1945
M5	6.11	7.67	13.21	0.63	63.35	12.36	20.84	18.81	1.60	0.08	0.33	0.02	6990	3719	11651	6179
M6	6.43	5.56	9.59	0.53	59.28	16.50	24.35	21.65	1.60	0.16	0.93	0.02	6525	3231	4991	4087
CM	5.38	3.09	5.33	0.23	61.35	20.50	6.63	4.85	0.39	0.13	0.38	0.89	3320	2561	3246	3483
VO1	5.6	0.63	1.09	0.06	61.40	13.14	5.96	2.85	0.73	1.39	0.31	0.68	1665	1273	634	1961
VO2	5.7	1.00	1.72	0.11	48.05	22.44	5.43	3.15	0.32	1.48	0.43	<0.06	2515	715	484	173
VO3	5.6	1.61	2.78	0.18	43.50	22.90	6.02	3.38	0.26	1.83	0.5	<0.06	2555	1047	894	1047
VO4	5.87	1.94	3.35	0.11	47.50	18.22	6.41	3.69	0.88	0.15	0.52	1.17	1980	1421	1601	1321
VO5	6.04	1.77	3.06	0.10	49.57	24.14	7.42	4.94	0.86	0.16	0.69	0.77	1790	1171	1556	1141
VP1	5.6	3.69	6.36	0.26	68.60	14.23	19.52	4.74	1.07	1.64	11.91	0.16	3045	2353	5739	4543
VP2	6.1	4.38	7.55	0.37	50.16	20.25	22.58	8.43	1.56	2.46	10.12	<0.05	3220	6309	4024	3897
VP3	6.1	2.83	4.88	0.23	60.62	18.35	37.23	6.33	1.48	18	11.4	<0.05	3460	4889	4294	3005
VP4	5.5	6.58	11.35	0.49	65.54	21.07	10.51	6.55	0.37	2.60	0.27	0.72	3540	6459	6624	14857
VP5	5.7	4.81	8.30	0.40	58.22	21.38	17.36	13.40	1.09	2.32	0.55	<0.10	2765	4519	3679	3965
VP6	7.05	2.43	4.19	0.14	67.42	22.43	9.09	8.11	0.51	0.08	0.37	0.02	1720	1225	3981	1703
VP7	7.27	3.56	6.14	0.22	67.50	12.22	12.32	10.53	1.04	0.44	0.27	0.04	1945	823	4576	1597
CV	5.8	4.01	6.91	0.30	61.57	20.07	8.60	5.73	0.83	0.17	1.13	0.74	2690	2129	3861	3573
FP	4.88	7.70	13.27	0.48	69.35	12.86	6.43	0.07	0.00	0.11	0.09	6.16	5410	9239	8184	10767
FE	4.8	9.78	16.87	0.67	67.28	12.86	6.59	0.05	0.00	0.12	0.12	6.29	5805	8249	10189	11347
FC	4.68	7.15	12.32	0.49	69.35	14.86	7.48	0.18	0.07	0.00	0.22	7.01	3055	6789	5619	9457

Experimental data on adsorption

These data are shown in Table S3, corresponding to CFX adsorbed onto the different soils studied, expressed as amounts and as percentage values.

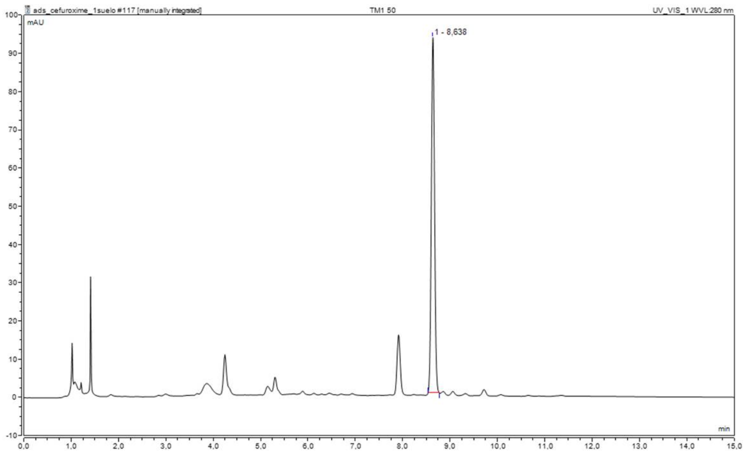
Table S3. CFX adsorption, expressed in µmol kg^{-1} (and in percentage between brackets), onto the various soils studied, as a function of the concentration of antibiotic added. M: maize (corn) soils; VO: vineyard soils (Ourense province); VP: vineyard soils (Pontevedra province); F: forest soils; CM and CV: control soils in maize and vineyard areas. Average values (n=3), with coefficients of variation always < 5%.

Soil	CFX added (µmol/L)	CFX adsorbed, concentration and %	Soil	CFX added (µmol/L)	CFX adsorbed, concentration and %
M1	0	0 (0)	VO1	0	0 (0)
	2.5	5.88 (94.12)		2.5	5.06 (81.01)
	5	12.10 (96.81)		5	10.66 (85.26)
	10	24.52 (98.09)		10	22.16 (88.65)
	20	49.43 (98.87)		20	47.41 (94.81)
	30	74.29 (99.06)		30	72.71 (96.95)
	40	99.24 (99.24)		40	91.35 (91.35)
	50	123.88 (99.10)		50	114.26 (91.42)
M2	0	0 (0)	VO2	0	0 (0)
	2.5	5.87 (93.95)		2.5	5.28 (84.54)
	5	12.08 (96.61)		5	10.67 (84.86)
	10	24.53 (98.12)		10	22.43 (89.72)
	20	49.39 (98.79)		20	47.36 (95.67)
	30	74.36 (99.15)		30	70.89 (94.99)
	40	98.98 (98.96)		40	91.41 (91.41)
	50	123.91 (99.12)		50	118.89 (95.59)
M3	0	0 (0)	VO3	0	0 (0)
	2.5	3.13 (55.94)		2.5	4.28 (68.54)
	5	8.63 (62.39)		5	10.48 (83.89)
	10	14.51 (60.17)		10	23.17 (92.67)
	20	33.06 (65.42)		20	47.86 (92.73)
	30	46.98 (61.94)		30	71.29 (95.06)
	40	54.18 (57.74)		40	94.23 (94.23)
	50	76.13 (59.41)		50	114.14 (91.31)
M4	0	0 (0)	VO4	0	0 (0)
	2.5	4.14 (73.67)		2.5	5.12 (90.91)
	5	10.90 (80.31)		5	12.70 (93.56)
	10	17.49 (73.27)		10	22.47 (93.17)
	20	48.35 (94.74)		20	47.29 (94.05)
	30	49.77 (65.62)		30	71.63 (94.45)
	40	50.09 (53.38)		40	90.32 (96.24)
	50	99.91 (78.36)		50	122.87 (95.89)
M5	0	0 (0)	VO5	0	0 (0)
	2.5	3.25 (58.34)		2.5	4.52 (80.34)
	5	7.86 (57.07)		5	11.82 (85.80)
	10	13.25 (54.98)		10	20 (84.18)
	20	27.08 (53.58)		20	44.37 (86.93)
	30	44.47 (58.92)		30	64.55 (85.54)
	40	50.02 (52.77)		40	81.69 (86.62)
	50	71.35 (55.96)		50	101.06 (79.26)

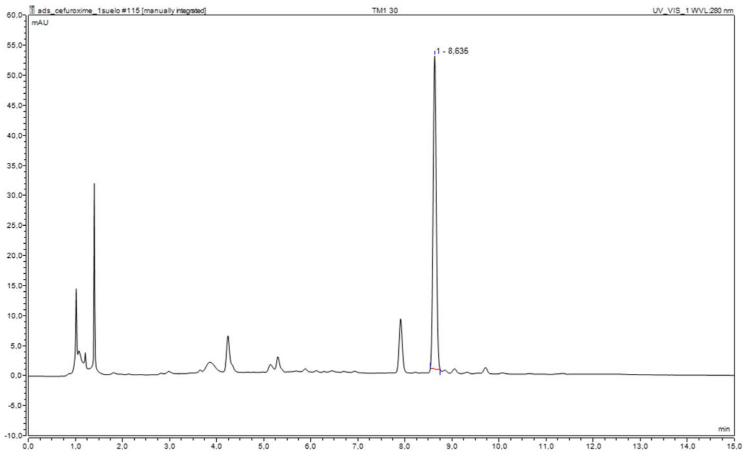
Soil	CFX added (μmol/L)	CFX adsorbed, concentration and %	Soil	CFX added (μmol/L)	CFX adsorbed, concentration and %
M6	0	0 (0)	VP1	0	0 (0)
	2.5	4.96 (88.23)		2.5	5.85 (93.69)
	5	12.78 (93.65)		5	12.08 (96.66)
	10	22.25 (92.25)		10	24.44 (97.75)
	20	44.97 (88.98)		20	49.21 (98.41)
	30	71.23 (93.92)		30	73.68 (98.24)
	40	89.14 (94.51)		40	98.58 (98.58)
	50	119.39 (93.17)		50	123.30 (98.64)
M7	0	0 (0)	VP2	0	0 (0)
	2.5	2.75 (49.48)		2.5	5.85 (93.56)
	5	8.60 (62.77)		5	11.98 (96.30)
	10	16.03 (67.12)		10	24.47 (97.87)
	20	42.51 (83.29)		20	49.60 (98.70)
	30	63.52 (84.16)		30	74.23 (98.96)
	40	89.30 (96.78)		40	98.83 (98.83)
	50	123.40 (96.78)		50	124.26 (98.92)
FP	0	0 (0)	VP3	0	0 (0)
	2.5	4.64 (74.57)		2.5	2.96 (52.65)
	5	10.19 (82.31)		5	9.40 (68.26)
	10	22.07 (88.30)		10	21.73 (90.11)
	20	44.80 (90.05)		20	30.97 (60.99)
	30	67.64 (91.09)		30	39.53 (51.86)
	40	88.64 (89.09)		40	38.63 (40.76)
	50	109.88 (88.78)		50	54.40 (42.67)
FE	0	0 (0)	VP4	0	0 (0)
	2.5	4.63 (75.13)		2.5	5.55 (88.79)
	5	10.63 (85.45)		5	11.72 (93.80)
	10	22.44 (90.65)		10	21.90 (87.61)
	20	46.16 (92.32)		20	45.15 (90.31)
	30	69.91 (93.21)		30	64.23 (85.63)
	40	92.54 (93.47)		40	87.43 (87.43)
	50	116.71 (93.36)		50	111.96 (89.57)
FC	0	0 (0)	VP5	0	0 (0)
	2.5	4.29 (68.58)		2.5	3.87 (69.39)
	5	10.15 (82.43)		5	9.5 (68.62)
	10	21.55 (87.51)		10	13.51 (56.58)
	20	49.26 (90.84)		20	32.40 (63.48)
	30	68.89 (92.31)		30	42.11 (55.53)
	40	90.77 (91.68)		40	65.75 (69.36)
	50	114.65 (91.72)		50	74.86 (58.71)

Soil	CFX added (μmol/L)	CFX adsorbed, concentration and %
VP6	0	0 (0)
	2.5	5.81 (93.49)
	5	11.99 (96.43)
	10	24.20 (97.77)
	20	48.81 (98.10)
	30	73.22 (98.60)
	40	97.94 (98.44)
	50	122.66 (98.62)
VP7	0	0 (0)
	2.5	5.50 (97.67)
	5	13.54 (98.26)
	10	23.63 (98.47)
	20	49.94 (98.33)
	30	73.82 (98.30)
	40	93.34 (98.47)
	50	125.57 (98.49)
VP8	0	0 (0)
	2.5	5.76 (93.07)
	5	11.99 (95.95)
	10	24.50 (97.99)
	20	48.91 (97.35)
	30	73.66 (99.20)
	40	98.45 (99.43)
	50	124.47 (99.57)

Soil M2. Concentration of CFX added 50 µmol L^{-1}



Soil M4. Concentration of CFX added 30 µmol L^{-1}



Soil VP4. Concentration of CFX added 20 µmol L^{-1}

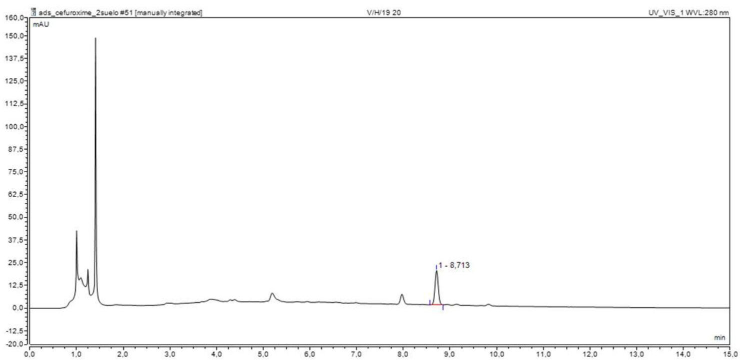
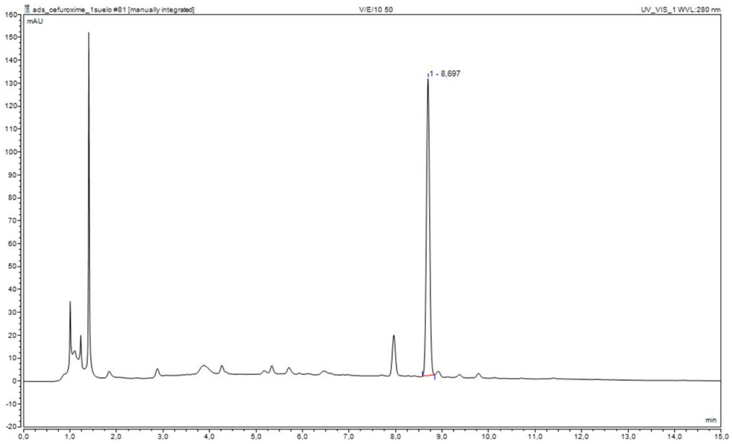
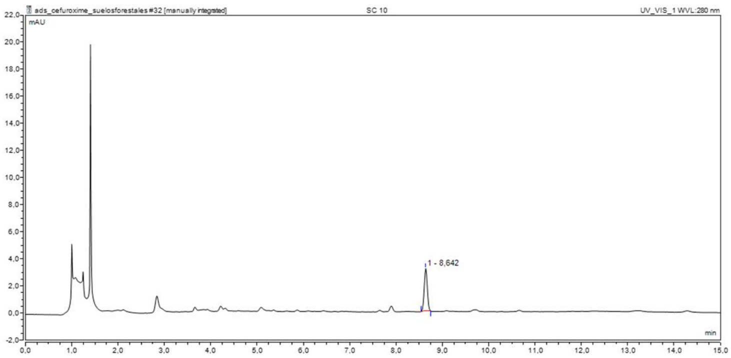


Figure S1. Selected chromatograms corresponding to the quantification of the antibiotic cefuroxime.

Soil VP3. Concentration of CFX added 50 µmol L^{-1}



Soil FC. Concentration of CFX added 10 μmol L^{-1}



Soil FP. Concentration of CFX added 50 μmol L^{-1}

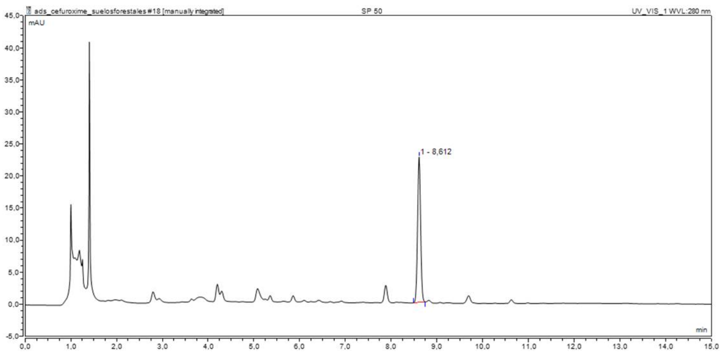


Figure S1 (continuation). Selected chromatograms corresponding to the quantification of the antibiotic cefuroxime.

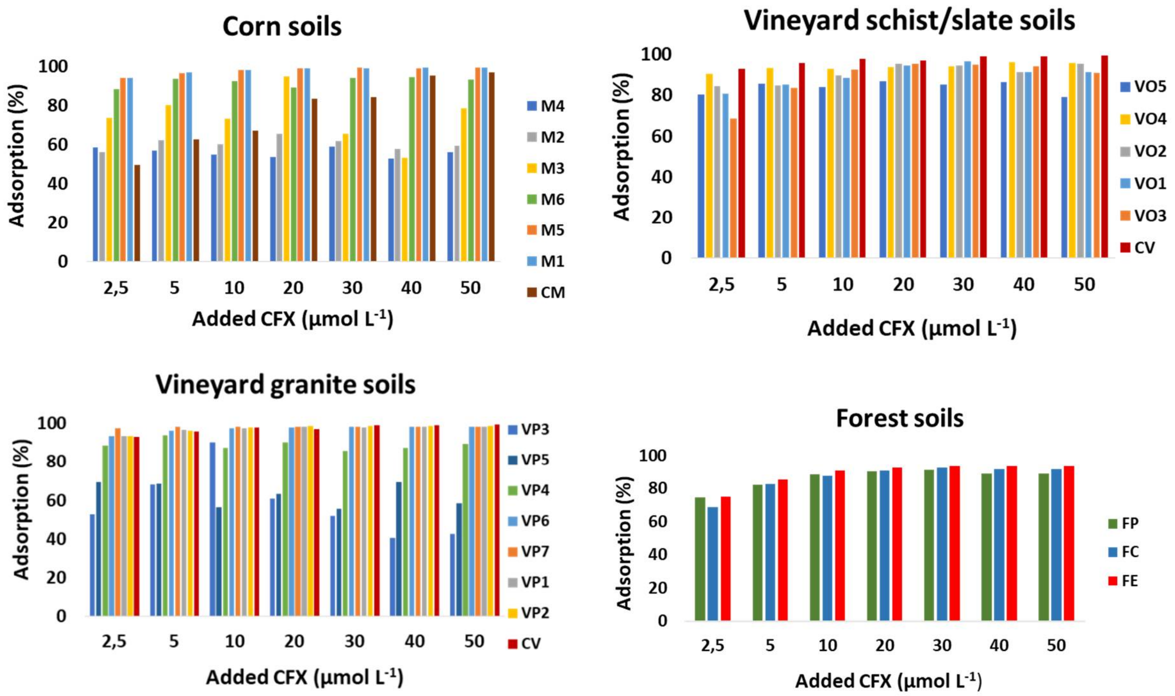


Figure S3. Percentage CFX adsorption on the various soils studied as a function of the concentration of antibiotic added. M: maize (corn) soils; VO: vineyard soils (Ourense province); VP: vineyard soils (Pontevedra province); F: forest soils; CM and CV: control soils in maize and vineyard areas. Average values (n=3), with coefficients of variation always < 5%.