

Report of the Inter-laboratory Comparison Project 2025 (Draft)

Chapter 4: 27th Inter-laboratory Comparison Project on Soil

Network Center for EANET



Participating laboratories

Seven laboratories from four countries participated in the 27th ILC Project on Soil.

Description of Soil Samples

Sample No.251s: Cambisols (Brown forest soils)

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- Soil samples were collected in Japanese cedar (*Cryptomeria japonica*) and Japanese cypress (*Chamaecyparis obtusa*) plantations in the Field Museum Oyasan of the University Forest, Tokyo University of Agriculture and Technology (TUAT), Japan.
- Soils were air-dried, sieved with 2 mm mesh, mixed well, and sterilized using gamma irradiation (50 kGy).

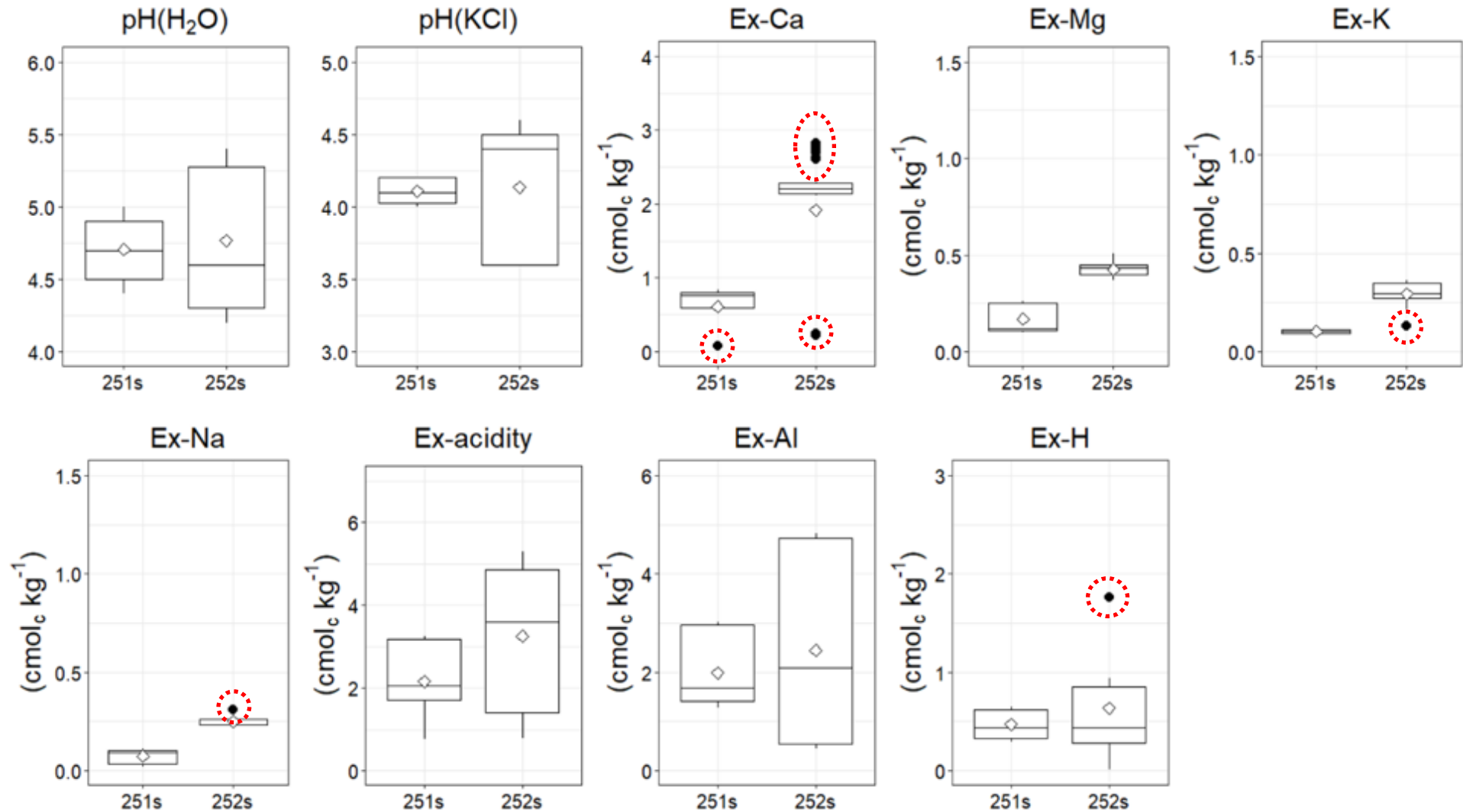
Analyzed Soil Chemical Properties

Parameters	Unit	Mandatory or not
a) Moisture Content	wt %	M
b) pH (H ₂ O)	-	M
c) pH (KCl)	-	M
d) Exchangeable Ca	cmol _c kg ⁻¹	M
e) Exchangeable Mg	cmol _c kg ⁻¹	M
f) Exchangeable K	cmol _c kg ⁻¹	M
g) Exchangeable Na	cmol _c kg ⁻¹	M
h) Exchangeable Acidity	cmol _c kg ⁻¹	M
i) Exchangeable Al	cmol _c kg ⁻¹	M
j) Exchangeable H	cmol _c kg ⁻¹	M

M: Mandatory items

- For all parameters except moisture content, **triplicate analyses** under repeatability conditions were **repeated twice** under within-laboratory reproducibility conditions, yielding **six results per parameter for each sample**.

Data variation among 7 Laboratories



Significant outliers were found in many items.

Data verification by Cochran and Grubbs tests – 251s

**Table 4.3 Data verification by Cochran-Grubbs tests
No. 251s**

Country	Lab.	Repeat analysis	pH(H ₂ O)	pH(KCl)	Ex-Ca	Ex-Mg	Ex-K	Ex-Na	Ex-acidity	Ex-Al	Ex-H
					cmol _c kg ⁻¹						
Indonesia	ID01	1st	4.9	4.1	0.07 g	0.12	0.11	0.05	0.77	1.68	0.65
		2nd	4.8	4.2	0.07 g	0.12	0.12	0.05	0.77	1.68	0.65
	ID04	1st	4.9	4.2	0.61 g	0.12	0.09	0.09	2.03	1.40 c	0.62
		2nd	4.9	4.2	0.60 g	0.11	0.10	0.10	2.02	1.40 c	0.62
Japan	JP13	1st	5.0	4.2	0.76 g	0.11	0.08	0.03	2.13 c	1.68 c	0.45 c
		2nd	4.9	4.2	0.77 g	0.11	0.08	0.03	2.08 c	1.60 c	0.48 c
Mongolia	MN01	1st	4.5	4.1	NA	NA	NA	NA	1.71	1.28	0.43
		2nd	4.4	4.1	NA	NA	NA	NA	1.71	1.28	0.43
Vietnam	VN01	1st	4.6	4.0	0.80	0.25	0.10	0.10	3.19	2.97 c	0.33
		2nd	4.6	4.0	0.81	0.26	0.11	0.10	3.21	3.00 c	0.33
	VN04	1st	4.5	4.1	0.79	0.24	0.10	0.09	3.19	2.96	0.32
		2nd	4.5	4.1	0.82	0.25	0.11	0.09	3.17	2.96	0.32
	VN05	1st	4.7	4.0	NA	NA	NA	NA	NA	NA	NA
		2nd	4.7	4.0	NA	NA	NA	NA	NA	NA	NA

The outliers were determined by Cochran and Grubbs tests, and were indicated by "c" and "g" signs, respectively.

The data are mean values of triplicate analyses.

Yellow: low repeatability detected by the Cochran method; Green: significant difference among laboratories detected by the Grubbs method.

Data verification by Cochran and Grubbs tests – 252s

Table 4.3 Data verification by Cochran-Grubbs tests (continued)

No. 252s

Country	Lab.	Repeat analysis	pH(H ₂ O)	pH(KCl)	Ex-Ca	Ex-Mg	Ex-K	Ex-Na	Ex-acidity	Ex-Al	Ex-H
					cmol _c kg ⁻¹						
Indonesia	ID01	1st	5.3	4.5	0.23 g	0.38	0.23 c	0.25	2.35	0.64	0.01
		2nd	5.3	4.5	0.24 g	0.39	0.29 c	0.26	2.35	0.64	0.01
	ID04	1st	5.1	4.5	2.26	0.44	0.29	0.24	1.39	0.52 c	0.87
		2nd	5.1	4.5	2.28	0.44	0.29	0.24	1.39	0.52 c	0.88
Japan	JP 13	1st	5.4	4.5 c	2.69 g	0.39	0.22	0.23	0.80	0.50 c	0.31
		2nd	5.4	4.5 c	2.73 g	0.40	0.21	0.22	0.80	0.51 c	0.29
Mongolia	MN01	1st	4.6 c	4.4	NA	NA	NA	NA	5.28	3.52	1.76
		2nd	4.5 c	4.4	NA	NA	NA	NA	5.28	3.52	1.76
Vietnam	VN01	1st	4.3	3.6	2.18	0.45	0.35	0.27	4.86	4.75 c	0.43
		2nd	4.3	3.6	2.19	0.46	0.35	0.27	4.86	4.75 c	0.42
	VN04	1st	4.2	3.6	2.17	0.47	0.35	0.26	4.84	4.73	0.43
		2nd	4.2	3.6	2.18	0.45	0.36	0.26	4.83	4.73	0.43
	VN05	1st	4.5	3.9	NA	NA	NA	NA	NA	NA	NA
		2nd	4.5	3.9	NA	NA	NA	NA	NA	NA	NA

The outliers were determined by Cochran and Grubbs tests, and were indicated by "c" and "g" signs, respectively.

The data are mean values of triplicate analyses.

Yellow: low repeatability detected by the Cochran method; Green: significant difference among laboratories detected by the Grubbs method.

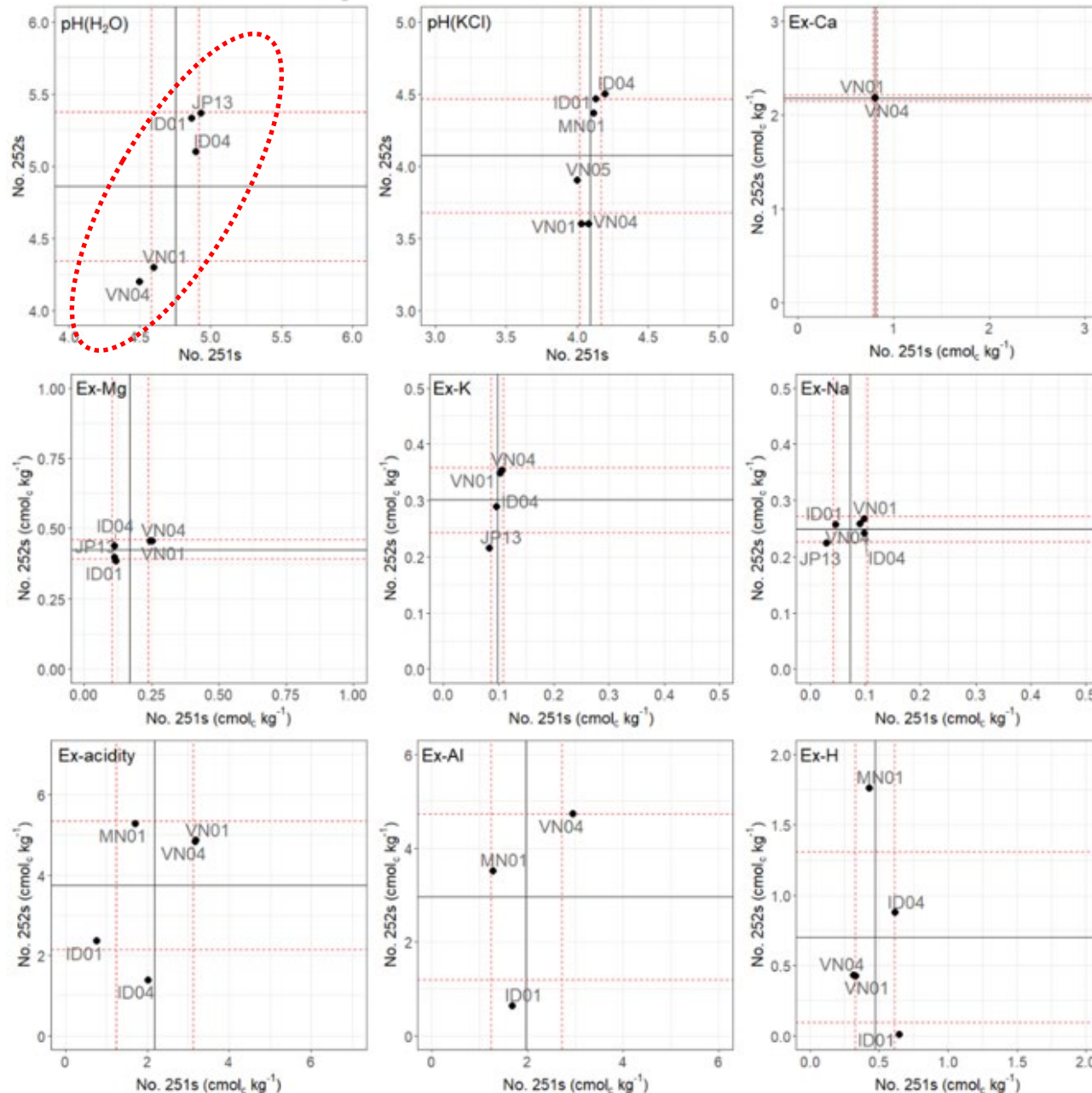
Precisions estimated by analysis of variance

Statistics	No. 251s								
	pH(H ₂ O)	pH(KCl)	Ex-Ca	Ex-Mg	Ex-K	Ex-Na	Ex-acidity	Ex-Al	Ex-H
Inter-laboratories precision CV (%)	4.3	1.9	0.15	43.99	11.76	44.25	47.49	44.47	33.20
Within-laboratory precision CV (%)	0.7	0.5	1.67	2.92	6.00	4.79	0.34	0.00	0.00
Repeatability precision CV (%)	1.0	0.8	2.78	3.41	5.11	17.86	0.94	0.00	4.92

Statistics	No. 252s								
	pH(H ₂ O)	pH(KCl)	Ex-Ca	Ex-Mg	Ex-K	Ex-Na	Ex-acidity	Ex-Al	Ex-H
Inter-laboratories precision CV (%)	11.7	10.4	2.36	7.95	21.46	6.86	60.69	70.90	97.58
Within-laboratory precision CV (%)	0.0	0.0	0.46	2.00	1.71	1.34	0.11	0.00	0.97
Repeatability precision CV (%)	1.0	0.8	1.49	3.64	3.03	8.32	0.40	0.00	5.74

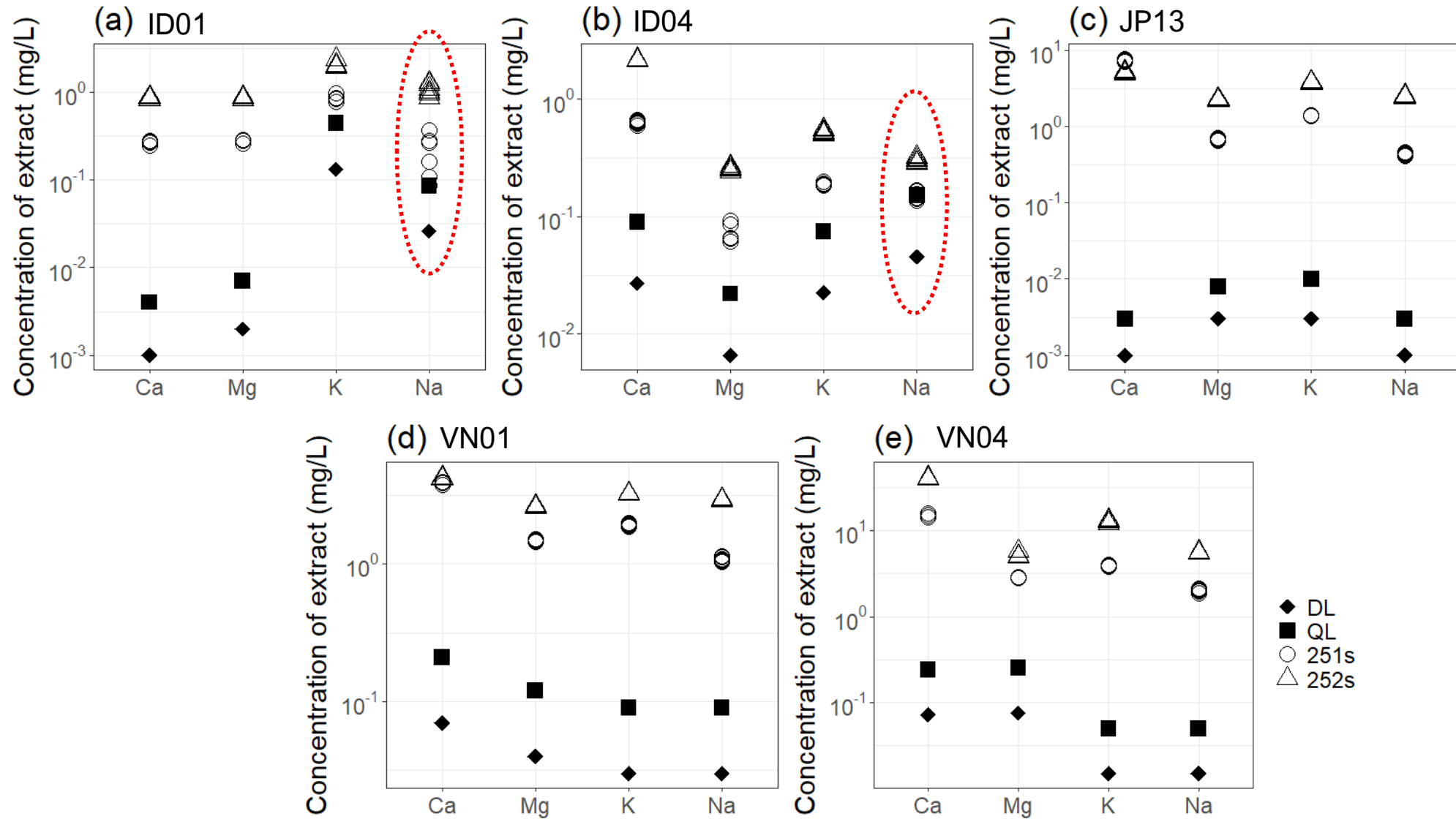
- Coefficients of variation (CVs, %) for repeatability and within-laboratory precisions were sufficiently small for most parameters, suggesting that **the participating laboratories were able to effectively analyze the parameters using their own standard procedures.**
- Although the CVs for inter-laboratory precision of pH were relatively small, those for the other parameters remained high, particularly for Ex-acidity, Al, and H. Since these parameters were measured manually using a titration method, there is considerable room for improvement.

Relationships of concentrations between 251s and 252s



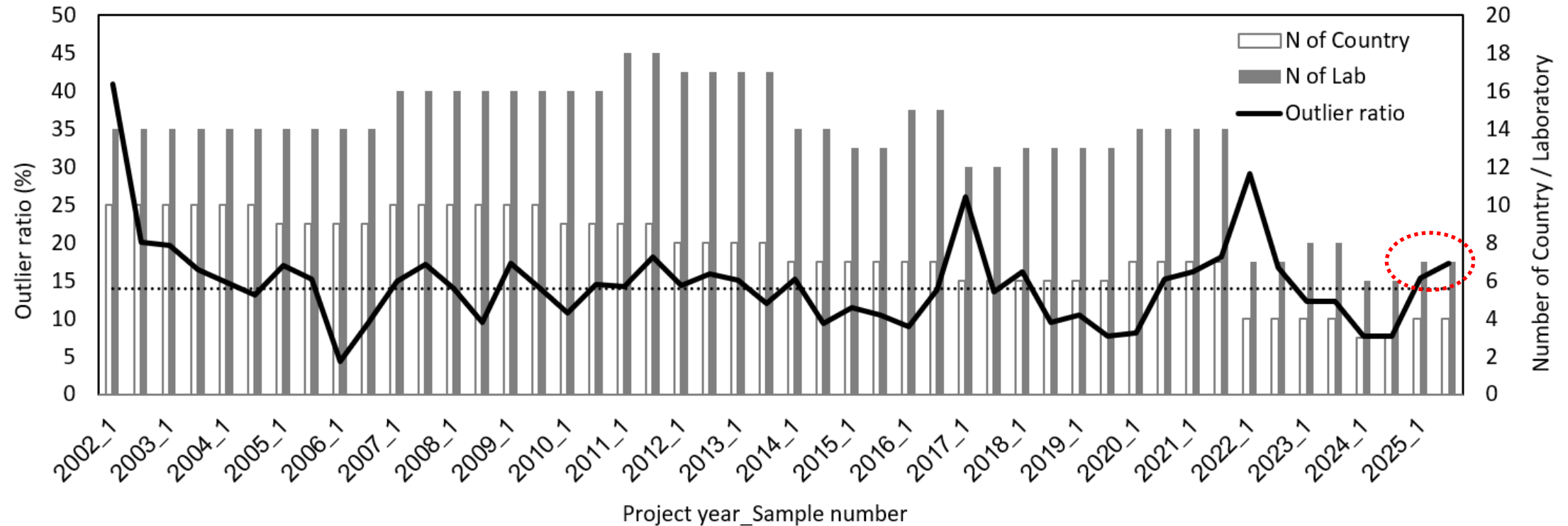
- Linear correlations indicate potential systematic errors.
- The number of participating laboratories is very small.

Relationships between DL, QL and Ex-base cations in soil



Measured concentrations were much higher than the detection limit (DL) and quantification limit (QL), except for Na in ID01 and ID04.

Ratio of outliers from 2002 to 2025



- The ratio of outliers* was higher than the average outlier ratio from 2003 to 2024.
- In addition, the reduced number of participating laboratories — fewer than the minimum required number for statistical assessments — poses increasing challenges in sustaining the evaluation framework of the ILC Soil project.

Summary

- Seven laboratories from four countries participated in the 27th Inter-laboratory Comparison (ILC) Project on soil analysis.
- Outliers were detected for several measurement items. However, the small number of participating laboratories made it difficult to perform robust statistical analyses and identify possible sources of data variability.
- Nevertheless, the participating laboratories successfully analyzed the parameters using their standard procedures.
- The average of triplicate analyses conducted under repeatability conditions can be used as a representative value for each laboratory.
- Inter-laboratory reproducibility should be improved for exchangeable ions, particularly for exchangeable acidity (Ex-Acidity), Al, and H.
- To maintain and enhance the data quality of soil analysis, the number of laboratories participating in the ILC should be increased.