Supporting Information

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SI Methods

Method S1. To evaluate how representative our sites were in comparison with the rest of the humid tropics, we calculated the proportion of area that has the same biophysical characteristics (soil type, elevation, and precipitation ranges) as our study sites (Table S1). Within the humid tropics [Food and Agriculture Organization of the United Nations (FAO) Global Ecological Zone map (41)], we identified the areal coverage of (*i*) deeply weathered soils [i.e., Acrisols and Ferralsols, FAO Harmonized World Soil Database (6)] with (*ii*) elevation range between 50 and 800 m above sea level [SRTM digital elevation model (42)] and (*iii*) precipitation range between 1,550 and 3,050 [WorldClim dataset (43)]. All datasets used have a resolution of 30 arcsec, which equates to ∼1-km resolution at the equator.

Method S2.

Study area descriptions. The sites in Indonesia were located in the central part of Jambi Province, Sumatra, where vast tracts of lowland forests were converted to oil palm (*Elaeis guineensis* Jacq.) and rubber [*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.] by both smallholder farmers and large corporations. The underlying rock formations are geologically speaking relatively young, consisting of mainly clastic sedimentary sequences formed in local "back arc basins" deposited between the Oligocene and Pleistocene time periods (28–0.13 Ma). The low-activity kaolinitic clay soils have been classified as Acrisols (FAO classification) with good to moderate soil drainage. We established a total of 42 plots in 12 clusters across the study region (Fig. S1), whereby there were 15 forest (reference) plots, 11 oil palm plots, and 16 rubber plantation plots. All oil palm and rubber plantations were owned by smallholders.

In Peru, 11 plots (six plot pairs of reference forest and oil palm plantation, owned by smallholders) were established in the Amazonian river basin in the Ucayali Region, west of the city of Pucallpa (Fig. S1). Throughout this region, recent drops in beef prices have encouraged many farmers to convert pastures to more commercially viable oil palm plantations. Located in the alluvial deposition zone of the Andes and in the flood plain of the Ucayali River, the soils often exhibit iron oxide mottles, indicative of poor drainage at deeper depths. The low-activity kaolinitic clay soils, classified as Acrisols, have developed from a sedimentary sequence of the Miocene and Pliocene time periods (23–2.6 Ma).

Last, in Cameroon we established 33 plots in six plot clusters across southern Cameroon (Fig. S1). These include forests ($n = 11$ plots), cacao (*Theobroma cacao* Linn.) agroforestry ($n = 11$), oil palm ($n = 5$), and rubber plantations ($n = 6$); all plantations were owned by smallholders. Cacao has historically been, and continues to be, an important cash crop for smallholder farmers and is also the most important Cameroonian agricultural export product (44). The geological formations underlying the soils are older than the two other study sites. Located on the Precambrian shield, the underlying geology of granites, gneises, and mica schists were formed during the Archean to Protozoic time periods (>542 Ma). The soil profiles examined were classified as either Ferralsols or Acrisols, and are all well drained.

Auxiliary information. Through interviews with the smallholder famers, we ascertained land use management practices (fertilization, weeding), how the sites were cleared, the approximate land use age, and when the sites were originally cleared. Additionally, for each plot, we recorded elevation, geographical coordinates, slope, and landscape positions. Given the remote location of these sites and the difficulty to access climatic data for their specific locations, we extracted the mean annual precipitation and mean annual temperature data from WorldClim (43) climatic grids with ∼1-km resolution.

Aboveground biomass carbon was measured in two of the three study regions (Cameroon and Peru) by our project partners using standard biomass mensuration protocols for tropical forests (45). We determined root biomass by removing soil monoliths (20 cm wide × 20 cm long × 10 cm depth) at 10-cm interval from the top down to 1-m depth and carefully separated all of the roots from the soil by wet sieving.

Method S3. Total SOC and total nitrogen were analyzed for all soil depths from air-dried, finely ground samples using a CN analyzer (CN Elementar Analyzer Vario EL). Soil texture was determined for two depths (0–10 cm and 50–100 cm) using the pipette method. Effective cation exchangeable capacity (ECEC) was measured for the same two depths by percolating air-dried, 2-mm sieved soils with an unbuffered 1 M NH_4Cl solution and measuring the percolate for cation concentrations (Ca, Mg, K, Na, Fe, Al, and Mn) using an inductively coupled plasma–atomic emission spectrometer (Spectroflame; Spectro Analytical Instruments). Base saturation was calculated as percentage exchangeable base cations of the ECEC. Soil pH was measured for all soil depths from air-dried, 2-mm sieved samples with soil to distilled water ratio of 4.

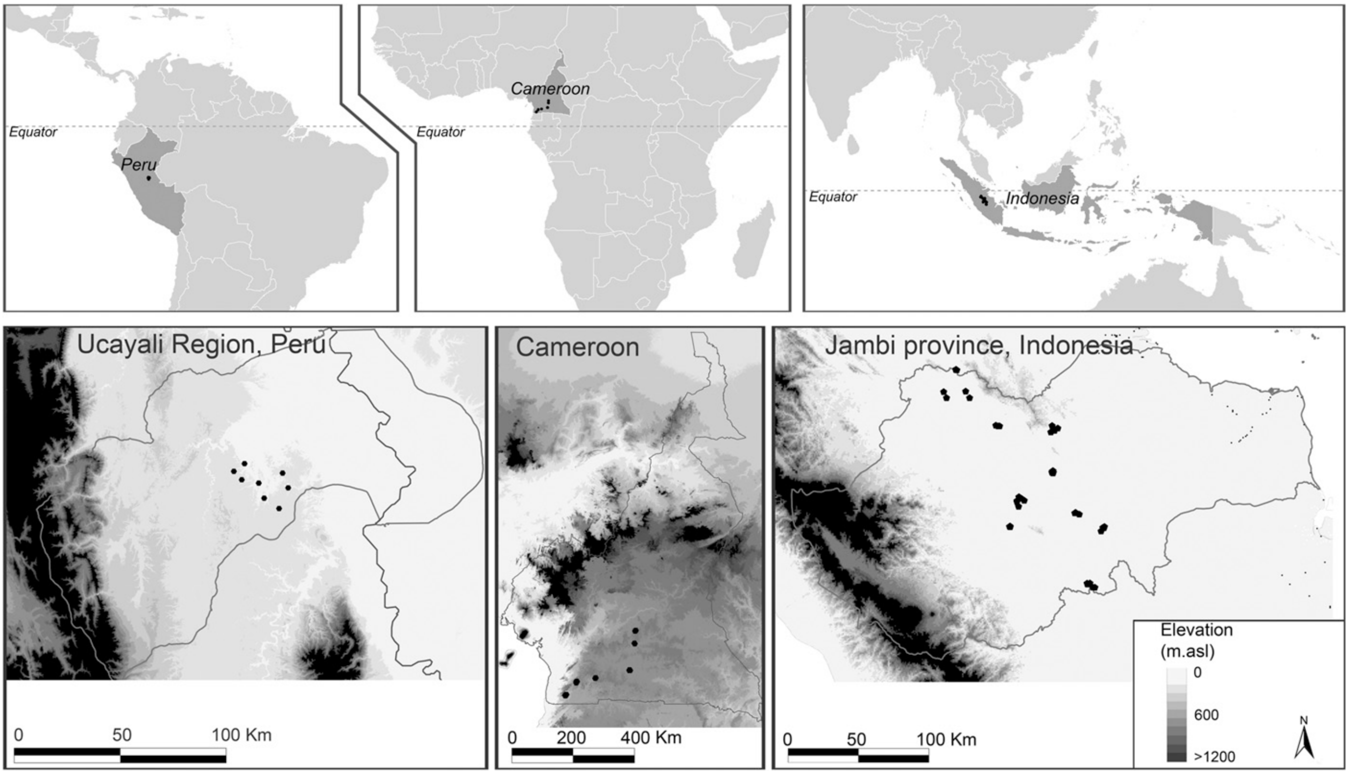

Fig. S1. Sampling locations (⬟) in Ucayali Region, Peru, southern Cameroon, and Jambi Province, Sumatra, Indonesia.

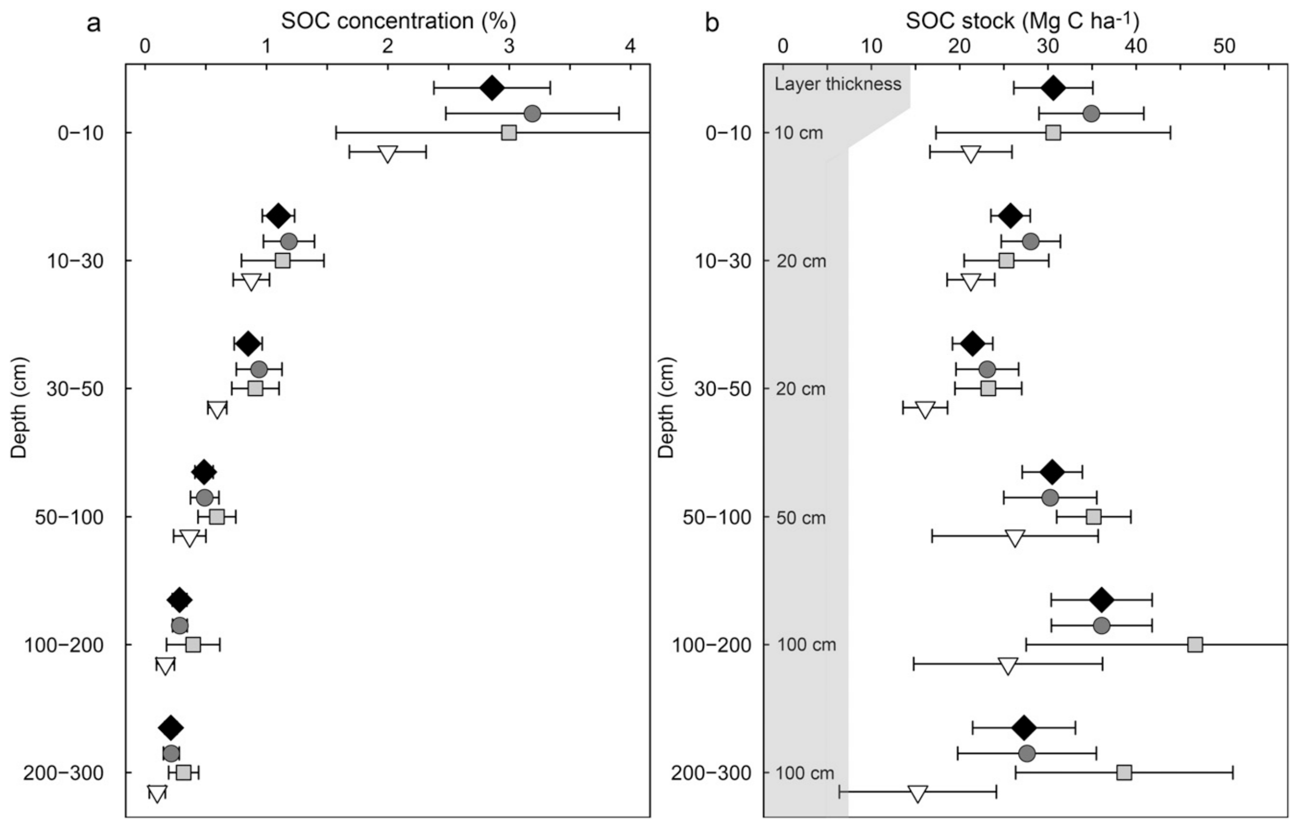

Fig. S2. (*A*) Soil organic carbon (SOC) concentration and (*B*) SOC stock in the 0- to 3-m soil profile of the reference forest sites across the three regions (◆), Indonesia (●), Cameroon (□), and Peru (▽). Error bars indicate 95% confidence intervals based on Student's *T* distribution. The gray-shaded area on the *y* axis in *B* indicates the thickness of soil layer for which SOC stocks was determined.

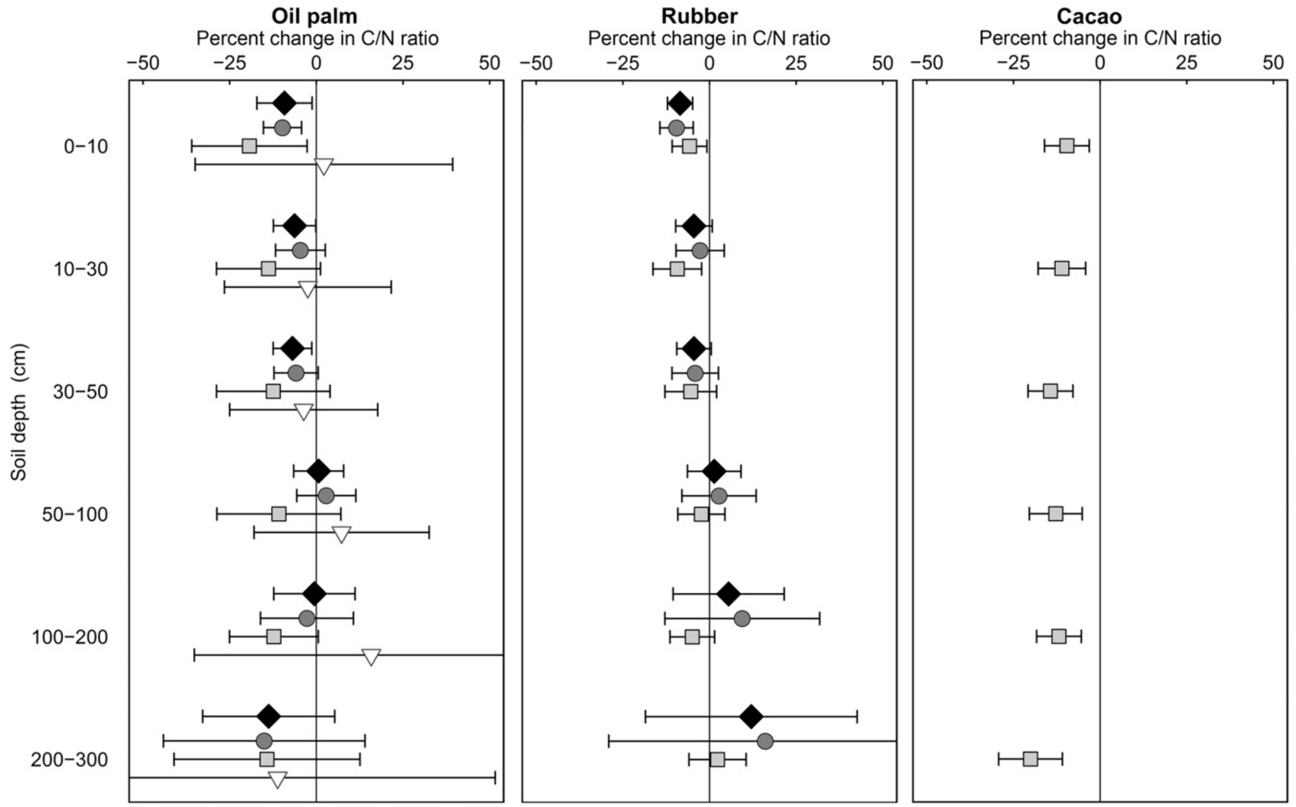

Fig. S3. Percentage change [(forest – plantation)/forest × 100] in soil C/N ratios in the 0- to 3-m soil profile of the three plantation types across the three regions (◆), Indonesia (●), Cameroon (□), and Peru (▽). Error bars indicate 95% confidence intervals based on Student's *T* distribution.

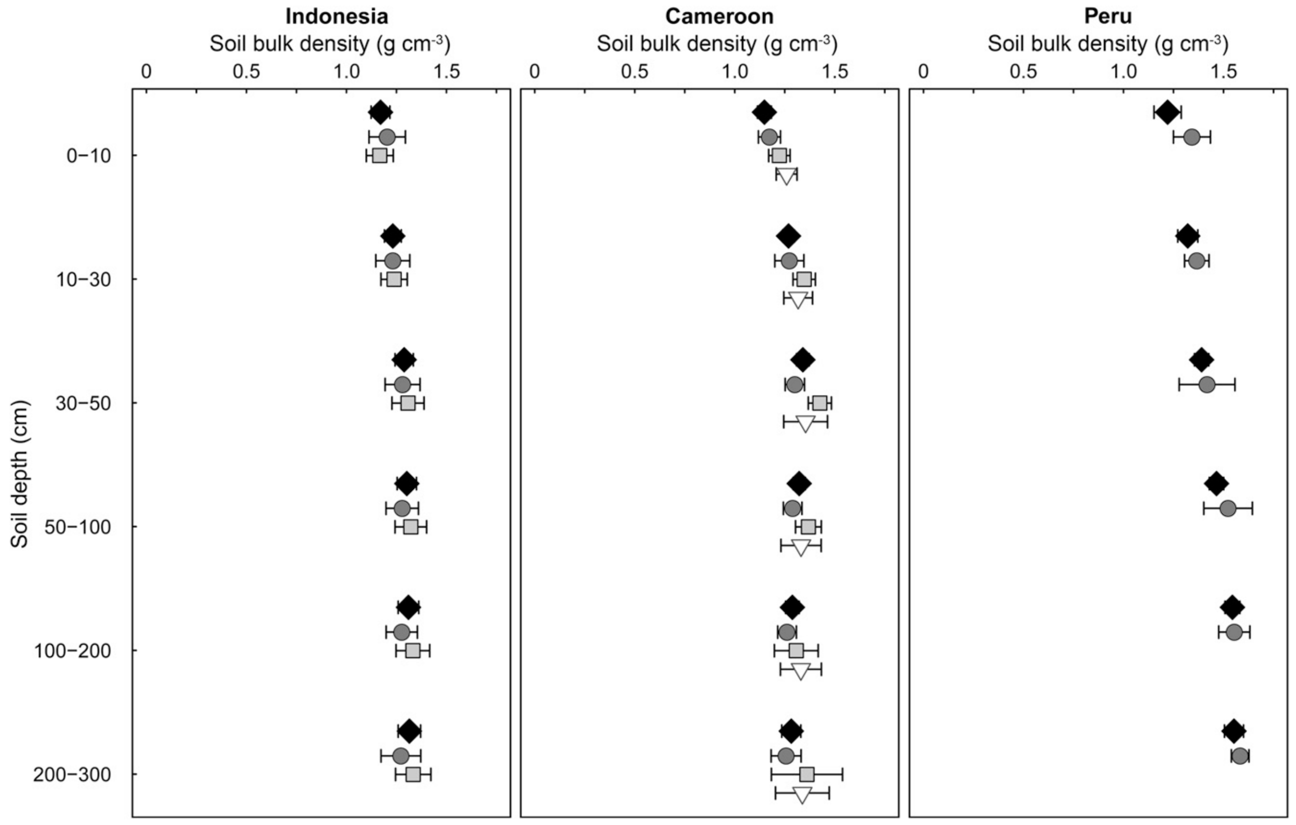

Fig. S4. Soil bulk density in the 0- to 3-m soil profile of the reference forest sites (◆), oil palm (●), rubber (□), and cacao (▽) plantations in Indonesia, Cameroon, and Peru. Error bars indicate 95% confidence intervals based on Student's *T* distribution.

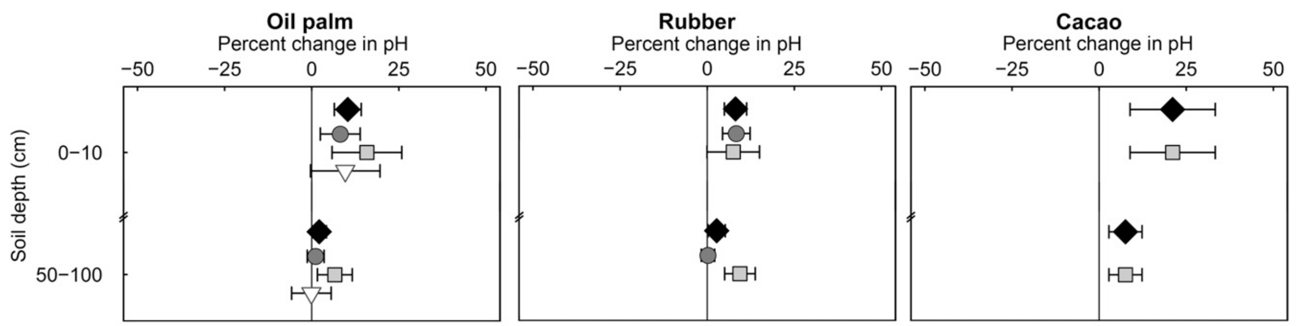

Fig. S5. Percentage change [(forest – plantation)/forest × 100] in soil pH in the 0- to 10-cm and 50- to 100-cm depths of the three plantation types across the three regions (◆), Indonesia (●), Cameroon (□), and Peru (▽). Error bars indicate 95% confidence intervals based on Student's *T* distribution.

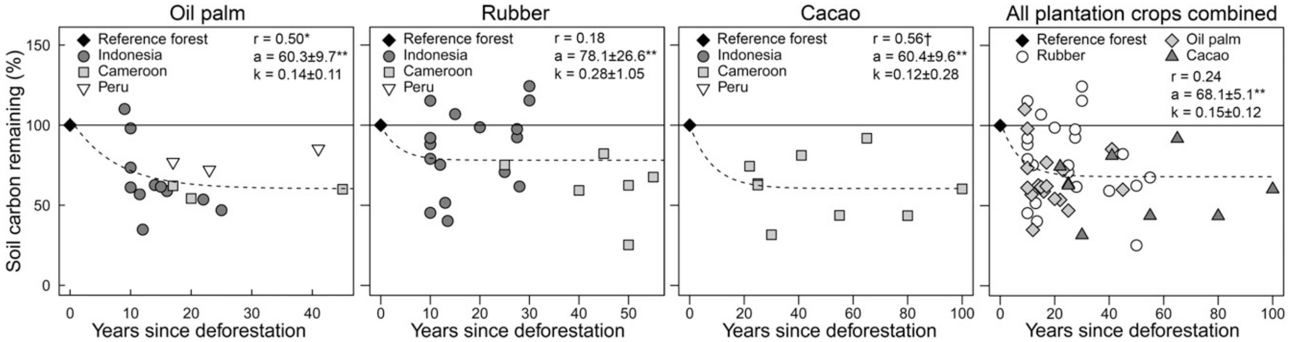

Fig. S6. Percentage of SOC remaining in the top 10-cm depth [(plantation/forest) × 100], following conversion of forests to oil palm, rubber, cacao plantations, and all plantations combined. The dashed lines show the best-fitted monoexponential decay functions (39), using R, version 2.14.2 (40), through the data points. The *r* is the Pearson correlation coefficients between observed and fitted values; *a* is the equilibrium ratio (%) (±SE), and *k* is the decay rate per year (±SE). Pearson's *r* and model parameter estimates are significant at $P \leq 0.05$ (*), $P \leq 0.01$ (**), and marginally significant at $P \leq 0.09$ (†).

Table S1. Physical, biomass carbon, and soil biochemical characteristics of the three study regions

Characteristics	Jambi Province, Indonesia	Southern Cameroon	Ucayali Region, Peru
Elevation range, m asl	50–160	400–800	190–250
Mean annual precipitation range, mm	2,200–3,050	1,550–2,200	2,100–2,750
Mean annual temperature range, °C	26.1–26.9	23.1–24.1	26.0–26.3
Net primary production, Mg C·ha^{-1}·y^{-1}			
Natural forests	23–26*	—	—
Oil palm	30–33 (yield is 49–60% of NPP)*	—	—
Rubber	15–20 (yield is 13–20% of NPP)*	—	—
Cacao agroforest	9.8 (yield is 21% of NPP)†	—	—
Aboveground carbon, Mg C·ha^{-1}‡			
Natural forests	384‡	194.3 ± 17.4	135.5 ± 10.1
Oil palm	50‡	22.4 ± 12.2	14.7 ± 1.5
Rubber	78‡	—	—
Cacao agroforest	—	60.6 ± 11.6	—
Total SOC stock (0–3 m), Mg C·ha^{-1}			
Natural forests	179.6 ± 8.7	199.9 ± 11.8	125.7 ± 10.7
Oil palm	160.6 ± 9.0	188.3 ± 13.1	107.4 ± 10.7
Rubber	176.4 ± 14.7	155.2 ± 12.1	—
Cacao agroforest	—	149.8 ± 6.6	—
Root carbon stock (0–1 m), Mg C·ha^{-1}§			
Natural forests	18.6 ± 2.7	19.6 ± 3.1	24.9 ± 2.3
Oil palm	16.5 ± 2.5	10.2 ± 1.5	14.2 ± 3.0
Rubber	9.8 ± 1.3	8.4 ± 1.2	—
Cacao agroforest	—	14.4 ± 3.6	—
Subsoil effective cation exchange capacity, mmol$_c$·kg^{-1}¶	82.2 ± 19.5	40.9 ± 1.7	143.8 ± 42.5
Subsoil base saturation, %¶	4.6 ± 0.5	12.1 ± 3.7	14.7 ± 8.2
Subsoil pH (H_2O)¶	4.0 ± 0.1	4.4 ± 0.1	5.0 ± 0.2
Subsoil clay, %¶	51 ± 5	55 ± 5	46 ± 5

Values are either the range or the mean ± SE of the parameters.
*Net primary production (sum of woody biomass, litter fall, and root production in the top 50-cm depth) measured in two landscapes of Jambi Province, Indonesia, in natural forests and oil palm and rubber plantations (28).
†Net primary production measured a cacao-*Gliricidia* agroforestry system (29) in Sulawesi, Indonesia. Dry matter (DM) biomass (19.6 Mg DM·ha^{-1}·y^{-1}) was recalculated to carbon assuming 50% carbon in biomass.
‡Total aboveground carbon measured in two landscapes of Jambi Province, Indonesia, in natural forests and oil palm and rubber plantations (28).
§Root biomass was converted to root carbon by assuming 50% carbon in biomass (mean ± SE).
¶Values from reference forest plots at the 50- to 100-cm depth (mean ± SE).