

Reporting Summary

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Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed
☒	☐ The exact sample size (<i>n</i>) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒ A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒ The statistical test(s) used AND whether they are one- or two-sided <i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i>
☐	☒ A description of all covariates tested
☒	☐ A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒ A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒ For null hypothesis testing, the test statistic (e.g. <i>F</i> , <i>t</i> , <i>r</i>) with confidence intervals, effect sizes, degrees of freedom and <i>P</i> value noted <i>Give P values as exact values whenever suitable.</i>
☒	☐ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☐	☒ Estimates of effect sizes (e.g. Cohen's <i>d</i> , Pearson's <i>r</i>), indicating how they were calculated

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection	Village-level surveys were administered using KoboCollect (version 2.022.08, https://www.kobotoolbox.org/), a mobile data collection platform. Structured questionnaires were programmed in KoboCollect and administered on tablets by the first author during fieldwork in Ghana (June-September 2022). Survey responses were automatically compiled into xlsx format and uploaded to the KoboToolbox server for quality assurance and data management. Semi-structured key informant interviews were conducted virtually via Zoom and Microsoft Teams in 2024, with interview notes recorded manually and subsequently transcribed. Remote sensing data were obtained from existing public repositories: cocoa plantations from Kalischek et al. (2023), forest loss from European Commission JRC Tropical Moist Forest dataset, shade tree cover from Becker et al. (2025), and population data from WorldPop. All datasets are publicly available and required no custom collection software. No custom data collection code was developed for this study beyond the questionnaire logic programmed in KoboCollect.
Data analysis	Data were analysed using: 1. Statistical analysis: Stata 17 (StataCorp, College Station, TX, USA) - Beta regression models with logit link function 2. Geospatial analysis and figure generation: R version 4.2.1 - Packages: sf (v1.0-9), ggplot2 (v3.4.0), terra (v1.7-3), tidyverse (v1.3.2), viridis (v0.6.2) 3. Spatial autocorrelation testing: Moran's I statistic calculated in R

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

Provide your data availability statement here.

Research involving human participants, their data, or biological material

Policy information about studies with [human participants or human data](#). See also policy information about [sex, gender \(identity/presentation\), and sexual orientation](#) and [race, ethnicity and racism](#).

Reporting on sex and gender

The analysis did not include information on sex and gender

Reporting on race, ethnicity, or other socially relevant groupings

The analysis did not include race, ethnicity, or socially relevant groupings.

Population characteristics

Study participants included village leaders (chiefs, assembly members), cocoa-buying company clerks, and Ghana Cocoa Board extension officers from 77 villages in Ghana's High Forest Zone across eight districts. Participation varied by village depending on stakeholder availability. Six semi-structured interviews with NGOs, academics and government officials working in the cocoa and forest sector were conducted virtually.

Recruitment

Villages were selected using systematic random sampling: every second village from an ordered list of settlements within 2-3 km of forest reserve boundaries. Village leaders and cocoa-buying company representatives were invited to participate through the cocoa extension officers. Attendance varied by village depending on stakeholder availability and interest. Self-selection bias may have occurred due to voluntary participation. Village leaders and extension officers may have influenced attendance. Seasonal timing of fieldwork may have affected farmer availability. However, systematic village selection and triangulation with district level company officers, companies sustainability reports, satellite data and field observations help mitigate these biases.

Ethics oversight

The study was approved by the Ethics Committee of ETH Zurich

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☒ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description

The study used correlational mixed-methods combining both quantitative and qualitative data.

Research sample

The research was conducted in 77 villages as case study

Sampling strategy

Villages were selected using systematic random sampling: every second village from an ordered list of settlements within 2-3 km of forest reserve boundaries. Village leaders and cocoa-buying company representatives were invited to participate through the cocoa extension officers.

Data collection

Village-level surveys were administered using KoboCollect (version 2.022.08, <https://www.kobotoolbox.org/>), a mobile data collection platform. Structured questionnaires were programmed in KoboCollect and administered on tablets by the first author during fieldwork in Ghana (June-September 2022). Survey responses were automatically compiled into xlsx format and uploaded to the KoboToolbox server for quality assurance and data management. Semi-structured key informant interviews were conducted virtually via Zoom and Microsoft Teams in 2024, with interview notes recorded manually and subsequently transcribed. Remote sensing data were obtained from existing public repositories: cocoa plantations from Kalischek et al. (2023), forest loss from European Commission JRC Tropical Moist Forest dataset, shade tree cover from Becker et al. (2025), and population data from WorldPop.

Timing	Data collection were done in June-September 2022 with village participants and April 2024 for the semi-structured interviews
Data exclusions	We excluded 8 villages from the original sample of 85 villages because those villages were either exclusively inside a protected area or outside protected area and therefore did not meet the criteria of having their boundaries inside and outside forest reserves to compare.
Non-participation	No participants/village dropped out or declined to participate
Randomization	There was no randomisation

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems		Methods	
n/a	Involved in the study	n/a	Involved in the study
☒	☐ Antibodies	☒	☐ ChIP-seq
☒	☐ Eukaryotic cell lines	☒	☐ Flow cytometry
☒	☐ Palaeontology and archaeology	☒	☐ MRI-based neuroimaging
☒	☐ Animals and other organisms		
☒	☐ Clinical data		
☒	☐ Dual use research of concern		
☒	☐ Plants		

Plants

Seed stocks	Report on the source of all seed stocks or other plant material used. If applicable, state the seed stock centre and catalogue number. If plant specimens were collected from the field, describe the collection location, date and sampling procedures.
Novel plant genotypes	Describe the methods by which all novel plant genotypes were produced. This includes those generated by transgenic approaches, gene editing, chemical/radiation-based mutagenesis and hybridization. For transgenic lines, describe the transformation method, the number of independent lines analyzed and the generation upon which experiments were performed. For gene-edited lines, describe the editor used, the endogenous sequence targeted for editing, the targeting guide RNA sequence (if applicable) and how the editor was applied.
Authentication	Describe any authentication procedures for each seed stock used or novel genotype generated. Describe any experiments used to assess the effect of a mutation and, where applicable, how potential secondary effects (e.g. second site T-DNA insertions, mosaicism, off-target gene editing) were examined.