

Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our [Editorial Policies](#) and the [Editorial Policy Checklist](#).

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 (*n*) 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
Only common tests should be described solely by name; describe more complex techniques in the Methods section.
- ☐

☒
- 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. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted
Give P values as exact values whenever suitable.
- ☒

☐
- 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 *d*, Pearson's *r*), 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	The dataset was generated from the literature search. We first defined a list of keywords for the subject to be discussed in our SOMA to determine how plastic mulching impacts crop yield, water use efficiency, and environmental sustainability. Then, we identified original first-order meta-analyses most relevant to the defined subject areas by searching the popular academic search engines, including, but not limited to, Web of Science, ScienceDirect, and CNKI databases.
Data analysis	We used Comprehensive Meta-Analysis (v3.7) software, one of the most popular programs for implementing meta-analyses, to estimate effect sizes for categories of plastic use impacting water, soil, crop productivity, and ecosystem functioning. Study-specific moderators such as climate, crop type, and mulching practices were recorded, along with any reported interactions between factors. We applied inverse-variance weighting for precise estimates, reducing the influence of lower-quality studies. We employed a hierarchical analytical framework, with a random-effects model applied to aggregate all anthropogenic activities. The analysis was then stratified into three thematic pillars: (1) crop yield, (2) water productivity, and (3) environmental consequences. Subgroup analyses via the CMA program within each pillar quantified the contribution of individual drivers (i.e., crop- and soil-related management practices).

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](#)

All data and the analyzed results are presented in the Main and the Supplementary File. The raw data and the source data are deposited in fishare repository.

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

No

Reporting on race, ethnicity, or other socially relevant groupings

No

Population characteristics

No

Recruitment

No

Ethics oversight

No

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)

Ecological, evolutionary & environmental sciences study design

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

Study description

A second-order meta-analysis (i.e., SOMA) was employed to identify anthropogenic practices influencing the plastic use in agroecosystems.

Research sample

We systematically identified and reviewed relevant first-order meta-analyses, synthesizing trends from thousands of field experiments reported in those primary studies. This rigorous process (detailed in the Supplementary file) yielded 70 qualifying meta-analyses for the primary field studies worldwide, encompassing 11,712 experiments and 110,809 individual observations.

Sampling strategy

We extracted relevant data from each first-order meta-analysis, including effect ratios, percentage changes, confidence intervals, measures of variability (e.g., standard deviations), and the number of primary studies and observations. We converted all metrics—including standardized mean differences and percentage changes—into ratios to enable standardized comparisons across studies. After synthesis, log-transformed ratios and confidence intervals were back-transformed to express percentage changes.

Data collection

All data were collected by the authors, which were used to determine the effects of plastic use in agro-ecosystems on production, water use efficiency, and environmental sustainability. A full list of first-order meta-analyses with full papers was included in the SOMA.

Timing and spatial scale

The datasets are generated from extraction of first-order meta-analysis articles published between 2011 and 2024.

Data exclusions

No data was excluded from the analysis.

Reproducibility

The study is reproducible using the methods and procedures detailed in the manuscript and supplementary material.

Randomization

N/A

Blinding

Blinding is not relevant to our study

Did the study involve field work?

☐ Yes

☒ No

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

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Plants

Seed stocks

No

Novel plant genotypes

No

Authentication

No