nature portfolio

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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	No special software was used to collect the data.
Data analysis	All data analysis was performed in Mathematica 12. Methodology, where not standard, is fully explained in the "Methods" section. Therefore no special code was developed beyond the details given in the "Methods" section but the Mathematica notebook available upon request.

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

The experimental data we analysed have been published previously and are publicly available on https://doi.org/10.6084/m9.figshare.21512352.v1

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 human participants or human data were used in this study
Reporting on race, ethnicity, or other socially relevant groupings	No human participants or human data were used in this study
Population characteristics	No human participants or human data were used in this study
Recruitment	No human participants or human data were used in this study
Ethics oversight	No human participants or human data were used in this study

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

Ecological, evolutionary & environmental sciences study design

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

Study description	The experimental data have been published previously and are publicly available. Full details on data collection are in https://doi.org/10.1038/s41467-022-35189-2. The data were collected from 76 plots in which 1,2,4,8 or 16 different plant species were sown.
Research sample	A total of 60 plant species typical of local grasslands were selected, including 12 legumes, 16 grasses, 20 tall herbs, and 12 small herbs. For full details see ull details on data collection are in https://doi.org/10.1038/s41467-022-35189-2
Sampling strategy	Biomass were collected from all plots from the 3rd year of the experiment onward (2005). Plant aboveground biomass was sampled from four 0.5 x 0.2 m quadrats per plot until 2009 after which only two 0.5 x 0.2 m quadrats were used, sorted to species, dried and weighed.
Data collection	We used data was collected yearly over the yearas 2005-2019. The data was collected by various researchers and graduate students over the 17 year period. Data was collected with shearers to cut plants, an oven to dry plants, a balance to weigh dry biomass and a pen and paper to record it and entered in Excel. For further details see https://doi.org/10.1038/s41467-022-35189-2
Timing and spatial scale	Data were collected 2005-2019 in 76 plots in the Jena Grassland Experiment. In the first two years after sowing (2003 and 2004) no species abundance data were collected. For full details see https://doi.org/10.1038/s41467-022-35189-2.
Data exclusions	Two intitially sown plots with monocultures were abandoned in 2005 and 2008 because the species sown were barely present in these plots. Two treatments with 16 species with monofunctional-group mixtures of legumes or small herbs could not be established. These plots are not included in the 74 plots mentioned above.
Reproducibility	All species-richness levels had 16 different species compositions as biological replicates, except for the 16-species mixture, which had only 14 different species compositions (no monofunctional-group mixtures of legumes or small herbs could be established at this level). see https://doi.org/10.1038/s41467-022-35189-2
Randomization	Species for each particular mixture were chosen randomly (with replacement) from a species pool wtih 60 species. Random allocation of species to the experimental mixtures including monocultures was restricted by the requirement that each functional group should be equally represented at every species richness level. See https://doi.org/10.1016/j.baae.2017.06.002 for further detail
Blinding	NA

Did the study involve field work? ☒ Yes ☐ No

Field work, collection and transport

Field conditions	Reported in detail in https://doi.org/10.1016/j.baae.2017.06.002
Location	50°55′ N, 11°35′ E; 130 m above sea leve
Access & import/export	The experimental site where the plant communities are maintained is owned by the University of Jena.
Disturbance	The plant communities are being maintained through weeding.

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

Dual use research of concern

Policy information about dual use research of concern

Hazards

Could the accidental, deliberate or reckless misuse of agents or technologies generated in the work, or the application of information presented in the manuscript, pose a threat to:

No	Yes	
☒	☐	Public health
☒	☐	National security
☒	☐	Crops and/or livestock
☒	☐	Ecosystems
☒	☐	Any other significant area

Experiments of concern

Does the work involve any of these experiments of concern:

No	Yes	
☒	☐	Demonstrate how to render a vaccine ineffective
☒	☐	Confer resistance to therapeutically useful antibiotics or antiviral agents
☒	☐	Enhance the virulence of a pathogen or render a nonpathogen virulent
☒	☐	Increase transmissibility of a pathogen
☒	☐	Alter the host range of a pathogen
☒	☐	Enable evasion of diagnostic/detection modalities
☒	☐	Enable the weaponization of a biological agent or toxin
☒	☐	Any other potentially harmful combination of experiments and agents

Plants

Seed stocks	Reported in https://doi.org/10.1016/j.baae.2017.06.002
Novel plant genotypes	NA
Authentication	NA