

## 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

1) The data from peer-reviewed and published articles were extracted in following platforms: Web of Science (Thomson Reuters, New York, NY, USA), Baidu Xueshu (<https://xueshu.baidu.com/>), China National Knowledge Infrastructure (CNKI) and China Wanfang Data (<https://www.wanfangdata.com.cn/>).  
2) Open-source data of climatic factors (MAT, MAP) were gined from WorldClim 2 (<https://www.worldclim.org/>), and soil properties (soil clay content, initial SOC, soil pH) were from Harmonized World Soil Database1.2 (<https://www.fao.org/soils-portal/en/>), and fertilization conditions were from EARTHSTAT (<http://www.earthstat.org/>).  
3) When the data were presented as figures, GetData Graph digitizer software was used to extract the data.

#### Data analysis

The R software (version 4.0.5), and Microsoft Excel 2016 were used for data statistic, modelling, projection and visualization.

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 data used in this study is publicly available, Climatic factors from WorldClim 2 (<https://www.worldclim.org/>), soil properties from Harmonized World Soil Database1.2 (<https://www.fao.org/soils-portal/en/>), and fertilization conditions from EARTHSTAT (<http://www.earthstat.org/>). Source data are provided with this paper. All data and code in this study are upload at Figshare (<https://doi.org/10.6084/m9.figshare.25193996>).

## Human research participants

Policy information about [studies involving human research participants and Sex and Gender in Research](#).

Reporting on sex and gender	N/A
Population characteristics	N/A
Recruitment	N/A
Ethics oversight	N/A

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://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	In this study, we studied global rice production comprehensively considering rice yield and carbon budget (including emissions of nitrous oxide (N <sub>2</sub> O) and CH <sub>4</sub> , as well as soil organic carbon sequestration) following organic N source application. The machine learning was used to investigate rice yield and carbon budget based on global data syntheses (4654 observations from 467 published articles). Finally, we innovated an improved organic nitrogen source management by integrating optimal organic N source management (OPTM) and intermittent flooding to the co-benefits of carbon budget and rice production.
Research sample	<ol style="list-style-type: none"> <li>1) The dataset for meta-analysis was consist of published available data , including 1935 paired observations from 199 articles.</li> <li>2) In the meta-analysis, there are two dominant organic N source management strategies: he substitution of synthetic N with organic N sources (SN) and the addition of organic N sources to synthetic N (AN), and the number of paired observations for SN and AN was 948, and 987, respectively.</li> <li>3) To analyze effects of water management, 2719 observations from 251 published papers were collected, and water management was categorized into two groups: conventional flooding (including continuous flooding, single drainage, and rainfed), and intermittent flooding (including alternate wetting/drying and multiple drainages).</li> <li>4) The dataset of water management included yield (conventional flooding, 770 observations; intermittent flooding, 355 observations), CH<sub>4</sub> emission (conventional flooding, 426 observations; intermittent flooding, 384 observations), N<sub>2</sub>O emission (conventional flooding, 270 observations; intermittent flooding, 283 observations), and SOC sequestration (conventional flooding, 180 observations; intermittent flooding, 51 observations).</li> </ol>
Sampling strategy	<ol style="list-style-type: none"> <li>1) These data from peer-reviewed and published articles were collected on Web of Science, Baidu Xueshu, China National Knowledge Infrastructure and China Wanfang Data.</li> <li>2) To minimize uncertainties from time, the papers included in dataset were published from 2000 to 2019.</li> <li>3) The terms, 'paddy' OR 'rice' AND 'nitrogen' OR 'organic amendment' OR 'animal manure' OR 'green manure' OR 'crop residue' AND 'yield' OR 'nitrous oxide' OR 'methane' OR 'soil organic carbon' OR 'greenhouse gas', were used to search papers.</li> </ol>
Data collection	<ol style="list-style-type: none"> <li>1) The data from peer-reviewed and published articles were extracted in following platforms: Web of Science (Thomson Reuters, New York, NY, USA), Baidu Xueshu (<a href="https://xueshu.baidu.com/">https://xueshu.baidu.com/</a>), China National Knowledge Infrastructure (CNKI) and China Wanfang Data (<a href="https://www.wanfangdata.com.cn/">https://www.wanfangdata.com.cn/</a>).</li> <li>2) The articles identified using search terms were further screened through selection criteria described in section of Methods.</li> </ol>

3) The data were presented as figures, GetData Graph digitizer software was used to extract the data.  
 4) Open-source data of climatic factors (MAT, MAP) were gained from WorldClim 2 (<https://www.worldclim.org/>), and soil properties (soil clay content, initial SOC, soil pH) were from Harmonized World Soil Database1.2 (<https://www.fao.org/soils-portal/en/>), and fertilization conditions were from EARTHSTAT (<http://www.earthstat.org/>).  
 5) For the missing climate records in articles, we extracted MAT or MAP from WorldClim 2 (<https://www.worldclim.org/>) based on latitude and longitude.  
 6) Soil clay content was provided based on USDA texture class according to soil texture.

Timing and spatial scale

1) The data in dataset were published from 2000 to 2019.  
 2) The distributions of observed sites are in global rice-producing area.

Data exclusions

1) Observations from non-field condition were excluded.  
 2) This study excluded data from using biochar, enhanced-efficiency fertilizers.

Reproducibility

Our study is an integrated study mainly based on model simulation ,statistical data and reference data. Our results can be reproduced when following the described methods and data.

Randomization

1) A hierarchical mixed-effect meta-analysis was performed to examine the effect sizes of target variables (rice yield, emissions of CH<sub>4</sub> and N<sub>2</sub>O, and SOC).  
 2) Publication bias was evaluated by Funnel plots and Egger tests.

Blinding

Blinding during data analysis was ensured through coding of the studies, observations and treatments.

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
<input checked="" type="checkbox"/>	<input type="checkbox"/> Antibodies
<input checked="" type="checkbox"/>	<input type="checkbox"/> Eukaryotic cell lines
<input checked="" type="checkbox"/>	<input type="checkbox"/> Palaeontology and archaeology
<input checked="" type="checkbox"/>	<input type="checkbox"/> Animals and other organisms
<input checked="" type="checkbox"/>	<input type="checkbox"/> Clinical data
<input checked="" type="checkbox"/>	<input type="checkbox"/> Dual use research of concern

### Methods

n/a	Involved in the study
<input checked="" type="checkbox"/>	<input type="checkbox"/> ChIP-seq
<input checked="" type="checkbox"/>	<input type="checkbox"/> Flow cytometry
<input checked="" type="checkbox"/>	<input type="checkbox"/> MRI-based neuroimaging