

## Hangzhou Joint Statement

As a follow-up to the 2022 meeting between President Xi and President Biden in Bali, Indonesia, the Special Envoys for Climate Change from China and the United States met in November 2023 and released the [Sunnylands Statement](#). This agreement recalls, reaffirms, and commits to the effective and sustained implementation of the previous [U.S.-China Joint Statement Addressing the Climate Crisis](#).

The Sunnylands Statement was also remarkable for including a new clause that the two countries intend to cooperate on respective measures to manage emissions of nitrous oxide (N<sub>2</sub>O), which is the third most important greenhouse gas and the largest ozone-layer depleting substance emitted today.

Bilateral collaboration between the U.S. and China on N<sub>2</sub>O abatement is particularly important because these two countries are the largest emitters of N<sub>2</sub>O from the industrial sector (nitric acid production for making fertilizers and munitions, and adipic acid production for nylon)<sup>1</sup>. In addition, China and the U.S. together apply nearly 40% of global nitrogen fertilizer production to their croplands, and as a consequence, they emit nearly half of all direct emissions of N<sub>2</sub>O from global agricultural croplands<sup>2</sup>.

Since the Sunnylands Statement, progress has been made in reducing N<sub>2</sub>O emissions in **the industrial sector** by recruiting adipic acid and nitric acid manufacturing plants in both countries to pledge to adopt abatement measures, utilizing funding from voluntary carbon markets. Abatement is relatively cost-effective in this sector, with the potential to reduce emissions to near zero within a few years. Progress in the industrial sector may help build trust and serve as a model for much needed efforts in other sectors.

In contrast to the industrial sector, limited progress has been made in reducing N<sub>2</sub>O emissions from **the agricultural sector**, even though agricultural emissions of N<sub>2</sub>O are more than ten times larger than industrial sector emissions. A reduction of agricultural N<sub>2</sub>O emissions would also provide significant economic and environmental co-benefits. However, the associated costs are generally high, variable, and less certain. Hence, the agricultural sector represents both the largest potential for N<sub>2</sub>O abatement and the biggest challenge to implement effective and economically viable abatement measures. Fortunately, scientists and practitioners in the U.S. and China already possess a wealth of knowledge and experience on sustainable nitrogen management, and their studies of the similarities and contrasts in agricultural systems offer rich opportunities to learn from each other's successes and challenges<sup>3,4</sup>.

To that end, [a joint project](#) funded in 2020 by the U.S. National Science Foundation and the National Natural Science Foundation of China has been advancing scientific collaboration between the two countries to improve our understanding of sustainable nitrogen management in agriculture, thereby offering insights for N<sub>2</sub>O abatement. The project team, led by scientists at the Institute of Soil Science, Chinese Academy of Sciences and Zhejiang University and the University of Maryland Center for

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<sup>1</sup> Davidson, E. A. & Winiwarter, W. Urgent abatement of industrial sources of nitrous oxide. *Nat. Clim. Chang.* **13**, 599–601 (2023).

<sup>2</sup> Tian, H. *et al.* Global nitrous oxide budget (1980-2020). *Earth Syst. Sci. Data* **16**, 2543–2604 (2024).

<sup>3</sup> Cui, X. *et al.* The global potential for mitigating nitrous oxide emissions from croplands. *One Earth* **7**, 401–420 (2024).

<sup>4</sup> Gu, B. *et al.* Cost-effective mitigation of nitrogen pollution from global croplands. *Nature* **613**, 77–84 (2023).

Environmental Science, hosted a joint workshop on September 18, 2024 in Hangzhou, at Zhejiang University. At this workshop, scientists, students, and stakeholders from both countries discussed the results of their collaboration on developing sustainability at the food-energy-water nexus through managing nitrogen.

In light of the challenge of the Sunnylands Statement to reduce N<sub>2</sub>O emissions, the workshop participants reached consensus on the following conclusions:

#### **Development of national action plans for curbing agricultural N<sub>2</sub>O**

With increasing international pressure to combat climate change, actions to reduce N<sub>2</sub>O emissions must intensify. However, concrete targets and coordinated efforts are still lacking. We therefore call for each country to develop a national action plan to reduce N<sub>2</sub>O emissions through improved sustainable nitrogen management technologies and policies that are appropriate for each country's specific socioeconomic, technological, and environmental conditions. These national action plans must be grounded in state-of-the-art science, involve stakeholders across agriculture-food systems, and include specific N<sub>2</sub>O emissions targets that will be incorporated into Nationally Determined Contributions for their respective 2035 commitments to the Paris Agreement. Such plans should also present roadmaps of policies and technologies that will lead to national reductions in uses of synthetic nitrogen fertilizers<sup>5</sup> while still meeting demands for abundant and nutritious food and profitability for farmers.

#### **Extending partnerships across the boundaries of disciplines and sectors**

Local stakeholders, including governments, farmers, and agricultural businesses, face shared challenges in implementing N<sub>2</sub>O abatement measures in both countries, and partnerships across the sectors and borders offer new opportunities to address these challenges. While technological solutions have become increasingly available, the socioeconomic barriers to implementing these technologies are still poorly understood. Therefore, both governments should incentivize agronomists, soil scientists, crop scientists, animal scientists, economists, and social scientists to work across disciplinary boundaries and partner with governments, farmers and other practitioners to co-produce knowledge that will enable further development and adoption of improved nitrogen management in sustainable production and consumption.

#### **Leveraging agricultural trade to benefit sustainability for both countries**

Agricultural trade between the U.S. and China is mutually beneficial, providing high-quality products and opportunities to optimize both environmental and economic outcomes. Despite volatile political relationships between the two countries in recent years, maintaining agricultural trade relationships and optimizing the trade portfolio can minimize environmental impacts without threatening basic food security in either country<sup>6</sup>. The two countries should apply state-of-the-science information to advance the mutual nutritional, economic, and environmental benefits of trade policies.

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<sup>5</sup> Reductions in fertilizer use could be achieved through measures that increase nitrogen use efficiency (NUE), increase recycling of manure, or increase use of biological nitrogen fixation (BNF).

<sup>6</sup> Wang, Y., Davidson, E. A., Gu, B. & Zhang, X. Shifting trade from feed to food reduces agricultural nitrogen loss and GHG emissions in U.S. and China. Preprint at <https://www.researchsquare.com/article/rs-4533060/v1> (2024).

**Sharing knowledge and advancing education**

Development and implementation of N<sub>2</sub>O abatement measures require more scientists and practitioners to build the capacity to work across disciplines, sectors, and borders. Sharing knowledge between countries also prevents unnecessary duplication of research efforts, allowing scientists to build upon existing work for more effective results. But transdisciplinary training and cross-country exchange remain limited. Thus, the U.S. and China should expand educational and research collaboration exchanges by supporting transdisciplinary training for young scientists, farmers, and other practitioners in the agriculture-food system. Maintaining and strengthening communication and collaboration in the agricultural sector is crucial, which can be achieved through web-based platforms and in-person conferences that foster dialogue and cooperation.

There is great enthusiasm among researchers and students to tackle nitrogen management challenges in both countries, and in doing so, set an example for the world to emulate. We are confident that collaboration among our research and education institutions will help illuminate pathways toward achieving the goals of the Sunnylands Statement.

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## Signatories

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<sup>7</sup> NSF and NSF China joint project. [https://www.nsf.gov/awardsearch/showAward?AWD\\_ID=2025826](https://www.nsf.gov/awardsearch/showAward?AWD_ID=2025826)

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