T20 POLICY BRIEF

G20 BRASIL 2024

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Task Force 01

FIGHTING INEQUALITIES, POVERTY, AND HUNGER

Combating Nitrous Oxide Emissions for Sustainable Food Systems: Innovation in Policy, Investment and Technology

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Abstract

N2O is the third largest contributor to climate change, yet it has received relatively less attention and resources. The global food system contributes more than two thirds share of anthropogenic nitrous oxide (N2O) emissions. Failure to address N2O emissions, particularly by the largest emitter nations – most of which are G20 member states- will render food systems unsustainable. The world will likely miss the *1.5*° C Paris Agreement target and seriously jeopardize the overall global bioeconomy. Tackling food systems' N2O emissions, without endangering food and nutrition security, will require considerable innovation in policy, investments and technology. Recent developments including US-China Bilateral Action on Non-CO2 gases, the UAE Declaration on Food Systems and the next round of Nationally Determined Contributions (NDCs) provide opportune moments to address nitrous oxide emissions; the G20 can lead by raising climate ambition in their NDCs that include non-CO2 gases and super-pollutants, more broadly. We provide recommendations for the G20 to lay the groundwork for these innovations, starting with a global, non-binding goal to tackle N2O emissions using newly available the scientific evidence[1]. Existing technologies can phase down industrial emissions and significantly abate food systems emissions. Second, create an N2O

[1] Updated Global Nitrous Oxide Budget (2024). Available at: https://www.globalcarbonproject.org/nitrousoxidebudget/20/hl-compact.htm

Global Nitrous Oxide Assessment (Forthcoming), https://www.climateweeknyc.org/events/nitrous-oxide-science-and-governance-forgotten-super-pollutant Also refer Inside Climate News feature on the Assessment preview: https://insideclimatenews.org/news/26092024/us-and-china-greenhouse-gas-nitrous-oxide-emissions/

emissions monitoring facility using remote sensing. Third, develop innovative finance facilities to fund adaptation and mitigation efforts tackling N2O emissions, including a public funding commitment as part of the new climate finance goal. Moreover, N2O is the largest ozone depleting substance being emitted today and has sustainable development co-benefits, making the case for addressing those emissions even more urgent.

Keywords: Nitrous oxide (N2O), climate change, sustainable food systems, agriculture, food and nutrition security, global N2O goal, Superpollutants, NDC, NCGQ/COP29, Climate and Clean Air Coalition, COP30, G20.

Context and Challenge

The global food system contributes more than two thirds share of global nitrous oxide (N2O) anthropogenic emissions, which pose a serious and growing climate problem[2] N2O is the third largest contributor to climate change[3], yet it has received relatively less attention and resources. Failure to address N2O emissions, particularly by the largest emitter nations – most of which are G20 member states- will render food systems unsustainable, and the world will likely miss the *1.5°* C Paris Agreement target; and, seriously jeopardize the overall global bioeconomy.

The nitrous oxide (N2O) molecule is 273 times as potent as carbon dioxide in heating the atmosphere[4]. N2O emissions are currently rising at alarming rates, and in line with the most pessimistic pathways explored by the IPCC in its 5th and 6th assessment reports (The Global Carbon Project, 2024)[5]. N2O emissions are expected to double by 2050 (Environmental Protection Agency, 2019). We must urgently address nitrous oxide

[2] According to the Global Carbon Project, in 2006-2017, N2O emissions from agricultural production alone accounted for 70 percent of anthropogenic emissions. Other estimates vary, but it is safe to state that least 2/3rd share of N2O emissions come from food systems based on available studies including Tian et al; the upcoming Global Nitrous Oxide Assessment puts that figure a bit higher.

[3] The Global Carbon Project, "N2O Budget: Highlights." https://www.globalcarbonproject.org/nitrousoxidebudget/20/hl-compact.htm

[4] Ibid

[5] The Global Carbon Project, "N2O Budget". Available at: https://www.globalcarbonproject.org/nitrousoxidebudget/index.htm

emissions if we are to limit warming to well below the Paris Agreement targets[6]. N2O is also the most significant ozone depleting substance in the atmosphere today (Ravishankara et al 2009; IGSD, no date[7]). In addition to countering ozone depletion, there are several other co-benefits associated with N2O emissions reductions including sustainable development outcomes.

Even though N2O mitigation needs to be the next frontier in tackling the climate crisis, N2O is largely the forgotten global greenhouse gas (Brind'Amour and Lee 2022), when it comes climate policy agenda and hence we focus on the climate lens in this brief. CO2 dominates climate policy and global efforts to combat the greenhouse effect. Non-CO2 gases, and super-pollutants broadly[8], like methane and HFCs have global mitigation goals or targets, and strong frameworks to tackle their emissions directly.

N2O has no global mitigation goal, nor does it have any specific policy or investment frameworks. In the 2023 G20, a T20 brief was dedicated to the issue of creating a policy framework to address N2O emissions broadly (Dhawan et al 2023), largely using entry points in the Montreal Protocol and the UNFCCC processes.

We build on that analysis and target food systems N2O emissions, since new scientific evidence shows existing abatement technologies can tackle N2O emissions from all sectors. There is also momentum building up to address all super-pollutants, including

[6] UNFCC, The Paris Agreements. Available at: https://unfccc.int/process-and-meetings/the-paris-agreement

[7] Available at: https://www.igsd.org/publications_topic/ozone-layer/

[8] Climate and Clean Air Coalition, Meet the Superpollutants. Available at: https://www.unep.org/interactives/super-pollutants/

N2O, bilaterally by US and China, the Climate and Clean Air Coalition and in updated NDCs in the run-up to COP30.

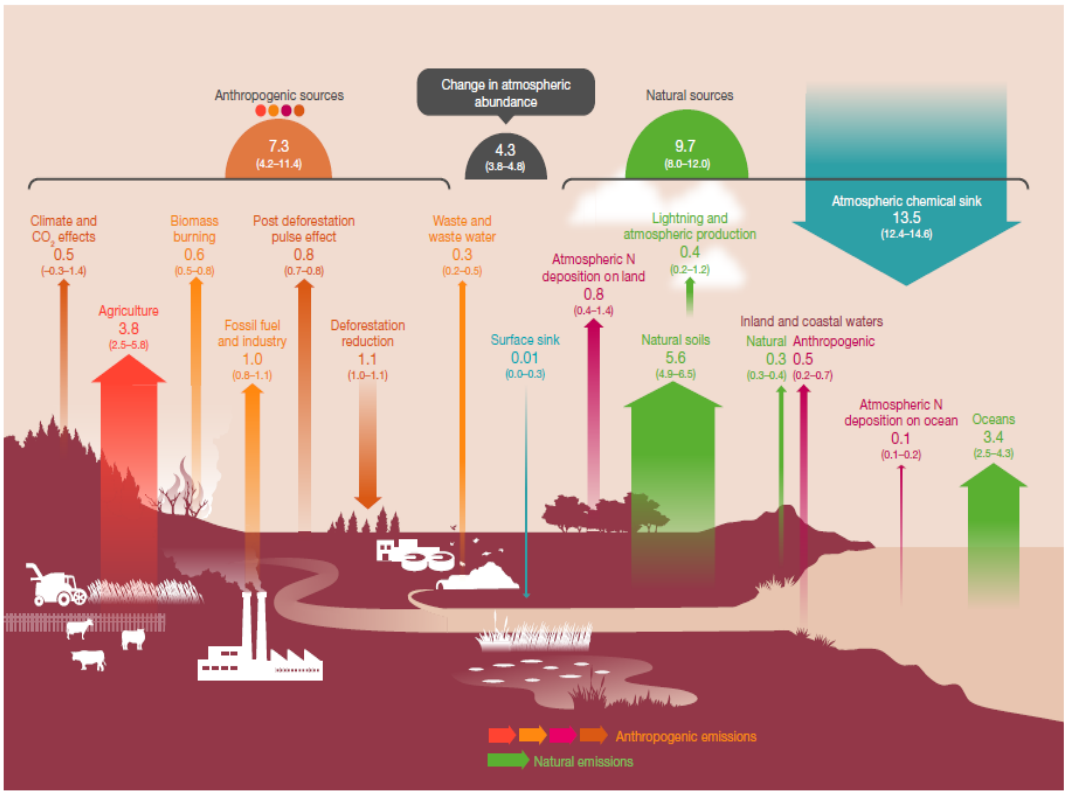

Figure 1. Global Carbon Project, Global N2O Budget. *Source*: The Global Carbon Project (2024)[9]

The biggest challenge for sustainable food systems and N2O emissions is that N fertilizers are critical to food production and account for the majority of the increase in atmospheric N2O (The Global Carbon Project, 2024), including organic fertilizers produced by livestock.

Moreover, there is no alternative to the use of N fertilizers without greenhouse gas emissions, "unlike the case for fossil fuels, which can be replaced with renewables" (The

[9] Available at: https://www.globalcarbonproject.org/nitrousoxidebudget/index.htm

Global Carbon Project, 2024) makes the challenge of tackling N2O emissions even more critical (Environmental Protection Agency 2019). That is the crux of the issue: Tackling N2O emissions, principally from agriculture related aspects of the food system, without endangering food and nutrition security, will require considerable innovation beyond technological fixes, particularly in the realm of policy and investments.

G20 and the N2O Challenge

The Brazil G20 is well-placed to lay the groundwork for policy, investment and technological innovation, given its focus on bioeconomy and food security: N2O emissions are at the core of both issues. Moreover, G20 member states form the core of global food production, as well as nitrogen fertilizer production and use; G2O based companies are the largest agricultural input suppliers as well as the largest food companies. Eighteen of the top twenty N2O emitter nations are part of the G20 [10]. Given their disproportionate share of N2O emissions without G20 leadership and endorsement, there can be little progress on the issue.

The global climate and food agendas are coalescing, with UAE elevated food systems as a priority for the COP28 agenda, resulting in 154 countries endorsing the Emirates

[10] The data is from 2020 and derived from various regional and national sources: EDGAR database for European Union, EPA for US, Russian Federal Service for Hydrometeorology and Environmental Monitoring; Environment and Climate Change GHG Sinks Summary, Government of Canada, and Australian Government Department of Industry, Science, Energy and Resources.

*marks EU member state (EU being part of G20).

Declaration on Sustainable Agriculture, Resilient Food Systems and Climate Action that looks to address GHG emissions from food systems comprehensively[11], creating the space to look at non-CO2 gases, or super-pollutants, such as methane and nitrous oxide. The first global stock-take around the goals of the Paris Agreement, with the technical group focusing on non-CO2 GHGs, and an inclusion of food systems in the GST text (UNFCCC 2023) [12]. Countries can now address super-pollutants including N2O in their NDCs/climate mitigation plans. Despite their opposing positions on many issues, the G20s largest economies, China and the U.S. have acknowledged the need to address N2O emissions in their joint Sunnylands Statement on Enhancing Cooperation to Address the Climate Crisis (Department of State 2023), prior to COP28. The changing global context of climate and food systems, in both inter-governmental processes and among major G20 economies, creates the condition to address N2O emissions, both from industrial and food sectors. This issue needs to be taken up immediately by the G20 in concert with bilateral, multilateral and plurilateral processes. Multilateral processes can continue but given the time sensitivity of the issue, more informal governance mechanisms like the G20 can address the issue in a faster manner (Dreyfus and Ulman 2024; CCAC 2024[13]; Climate advisers no date[14]). We provide recommendations for the G20 in the next section, starting with policy innovation: to create a global goal/target set to address N2O emissions.

[11] UAE, Emirates Declaration on Sustainable Agriculture, Resilient Food Systems and Climate Action (2023).

[12] UNFCCC, First Global Stock Take. (2023). Available at: https://unfccc.int/sites/default/files/resource/cma2023_L17_adv.pdf?download

[13] Available at: https://www.ccacoalition.org/news/super-pollutants

[14] Climate Advisers, Global Nitrous Oxide Hub. Available at: https://n2oaction.org

If nitrous oxide emissions are not tackled proactively, it will be difficult to reach the 1.5 °C Paris Agreement target, and with current projection levels we may even exceed the 2 °C target. Both the updated Global Nitrous Oxide Budget, and the upcoming Global Nitrous Oxide Assessment show this; refer figure 2 from the Global Nitrous Oxide budget below. We need to raise climate ambition and action on N2O to address the challenge of GHG emissions.

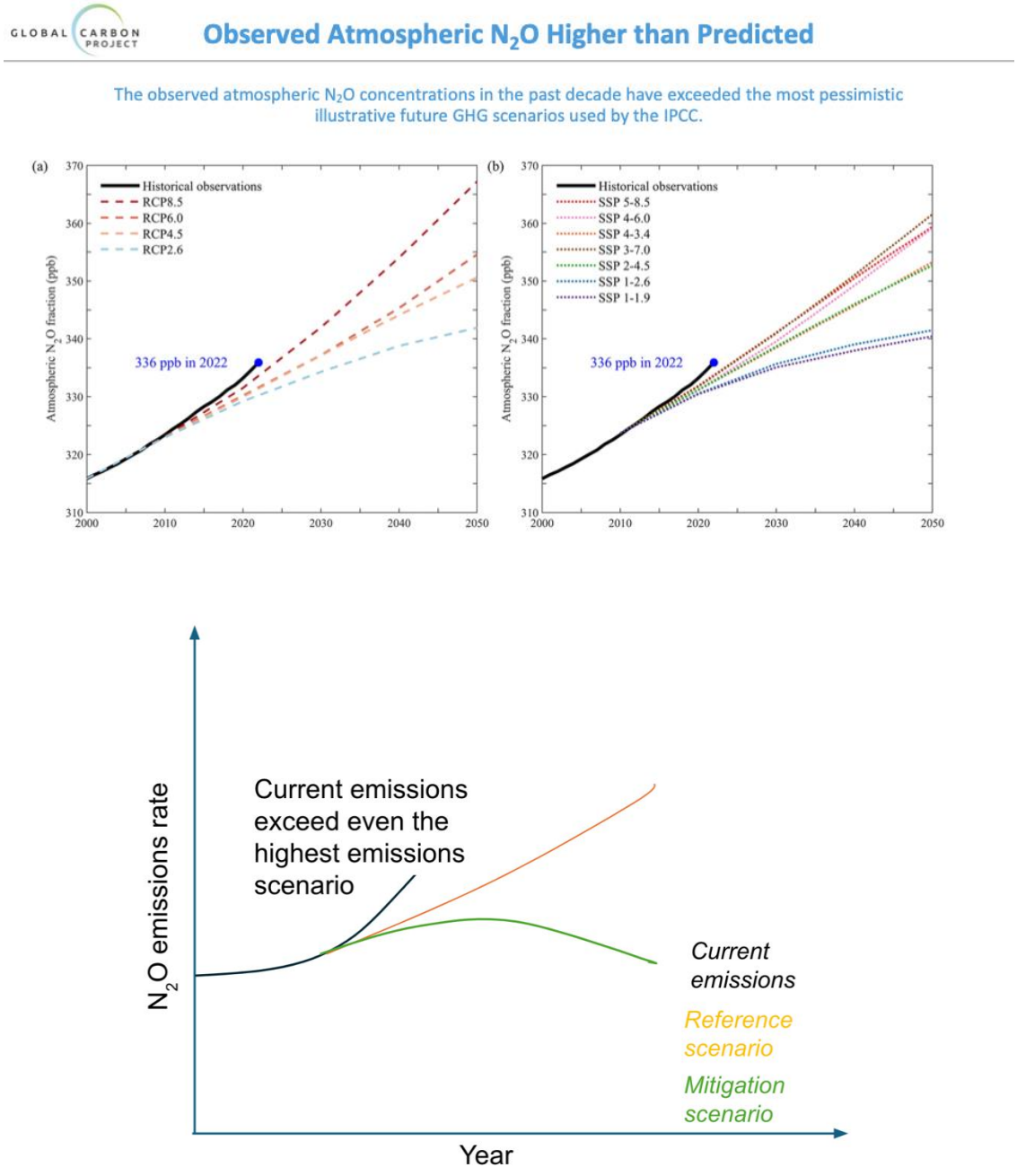

Figure 2. Nitrous Oxide Emissions Scenarios

Global N2O Goal/Target-set for Food Systems and Industry

The G20 should call for a global goal on N2O emissions that is sensitive to food security concerns. An ambitious, non-binding global goal could commit countries to increase N fertilizer use efficiency by having a focused target/set of targets in sight that are aligned with the SDGs and the Paris Agreement. The Global Methane Pledge[15], launched at COP26, could serve as a template for a global N2O goal at COP30, but it would have to consider the greater complexities associated with adaptation and mitigation issues in nitrous oxide versus methane.

First, an N2O emissions goal or target/set of targets would need to be disaggregated by sector: food systems/agriculture and industrial. It would be feasible, based on latest research and modeling to phase down industrial N2O emissions in a cost-effective manner (Climate Advisers 2024a) with existing abatement technologies (Climate Advisers 2024b; Pike 2024). *A goal phasing down industrial N2O emissions -including those related to the production of synthetic fertilizers - by 2040 would be an ambitious goal, starting with US-China climate action on the issue (*Climate Advisers 2024b; Pike 2024 McKenna 2024).

A separate financing facility to help Global South countries cover the cost of abatement would ensure equity; other regulatory and market based mechanisms can also be explored concomitantly.

[15] Available at: https://www.globalmethanepledge.org/

Second, addressing N2O emissions from agriculture side of food systems directly impacts food security, and there are no available alternatives to replace N fertilizers in food production. Reducing N leaks and increasing N fertilizer efficiency with targeted application helps, with policies and incentives for farmers, as has been seen in China, Europe and US.

China's case study on fertilizer use efficiency:

China has been offering subsidies to implement the Soil Test-Based Fertilizer Application Program, which provides technical support to around 190 million farmers to improve fertilizer efficiency. In recent years, the government has also introduced policies to promote organic fertilizer use, including subsidies for farmers adopting commercial organic fertilizers and straw recycling. These management practices have resulted in an 18 percent increase in nitrogen use efficiency across the country.

Ref: Notice on soil testing and formula fertilization pilot projec 2005: http://www.moa.gov.cn/nybgb/2005/dsyq/201806/t20180618_6152543.htm

Duan, J., Liu, H., Zhang, X. et al. Agricultural management practices in China enhance nitrogen sustainability and benefit human health. Nat Food 5, 378–389 (2024). https://doi.org/10.1038/s43016-024-00953-8.

However, one would need to base the overall goal/target set on an analytically tractable evidence base. The Global N2O Assessment and the Agri-Food Assessments of the Climate and Clean Air Coalition will provide such an evidence base have commenced

and will publish their results soon, supplementing the findings of the updated Global N2O Budget.

Global N2O mitigation observations by experts:

Global N2O budget goal: *'For net-zero emission pathways consistent with the Paris Agreement (stabilizing global temperatures below 2°C from pre-industrial levels), anthropogenic N_2O emissions must decline by at least 20% relative to 2019 levels by 2050.*

Global Nitrous Oxide Assessment: "*Currently available mitigation measures could reduce global anthropogenic nitrous oxide emissions by more than 40 per cent below current levels by around 2050*."

The G20 as a whole, or a sub-set of the member states, could endorse the findings of the CCAC – which also has G20 members. This could enable the creation of a food systems N2O emissions goal/target set by COP30. Our recommendation here supplements the call for using the Montreal Protocol and other processes to tackle N2O emissions,[16] as was advocated in the 2023 T20 brief (Dhawan et al 2023). Given the

[16] Other processes would include having N2O integrated in NDCs and be part of the GST process; the new round of NDCs to be unveiled at COP30 should explicitly address non-CO2 GHG emissions. CCAC has developed guidance on including super-pollutants in NDCs. Available at: https://www.ccacoalition.org/news/super-pollutant-guidance-ndc-30-game-changer-climate-action

urgency of tackling these emissions we recommend using the G20 or an ambitious coalition of countries - like the Global Methane Pledge signatories- as vehicles to endorse a global goal on N2O emissions to create sustainable food systems, and an overall balanced bioeconomy.[17]

Global Finance Facility for Food Systems and Industrial N2O Emissions

Substantial financial investments will be needed in both adaptation and mitigation to address N2O emissions. For instance, in 2019/2020, mitigation finance for agricultural production represents only 0.3 percent of total climate finance (Chiriac et al, 21). The COP29 global goal on climate finance is an avenue to address non-CO2 emissions, especially from N2O, given the dearth of financing in tackling these emissions until now.

Food systems related N2O financing requires substantial R&D investments, given the lack of technologies to replace N fertilizer, as noted by the Global Carbon Project as well as the Innovation Commission on Climate Change, Food Security and Agriculture[18].

[17] All these bilateral, multilateral and plurilateral processes can complement each other.

[18] Innovation Commission on Food Security, Climate Change and Agriculture. Microbial Fertilizer (2023). Available at: https://innovationcommission.uchicago.edu/research_briefs/microbial-fertilizer/

The Global Carbon Project, "N2O Budget". Available at: https://www.globalcarbonproject.org/nitrousoxidebudget/index.htm

An innovative finance facility like the Agricultural Innovation Mission for Climate or the Breakthrough Agenda, dedicated to nitrogen use N2O emissions in agriculture can help create technologies to replace N fertilizer, like EVs help replace fossil fuel dependent automobiles. A public R&D effort to the tune of $10Bn/year committed by G20 countries to catalyze innovation in replacing N fertilizer. The outputs of publicly funded N2O abatement technologies should be treated as a public good so that Global South also benefits from these innovations. In addition, the G20 should call for all climate smart agriculture, and all food systems, related global financing facilities to be sensitive to N2O emissions concerns to help proactively address the issue.

Global Monitoring Mechanism for N2O Emissions

The G20 should support a strong N2O emissions monitoring framework, akin to the methane monitoring effort using remote sensing. Ideally, the secretariat for such an effort should be hosted at the World Meteorological Organization, as part of the overall GHG monitoring effort already underway there[19]. G20 member states should support this effort in financially and via secondments should that be warranted.

The monitoring framework should also have aligned definitions with other technical bodies such as the Global Carbon Project, the CCAC and the International Nitrogen Initiative, so all emissions data is comparable. It should also be as close to real-time as possible to measure success of the mitigation and adaptation efforts funded by the global finance facilities discussed above. In an ideal case scenario, one could develop carbon equivalent trading mechanism or pay for performance measures in N2O using a strong

[19] World Meteorological Organization. Global Greenhouse Gas Watch. See: https://wmo.int/activities/global-greenhouse-gas-watch-g3w

monitoring framework. For example, in the EU ETS, a continuous emission monitoring system (CEMS) is applied to monitor abated N2O emission at adipic and caprolactam production facilities (Scholz and Felix 2022, 39)

Considering N2O Emissions in Mitigation and Adaptation

N2O is a forgotten gas in that many mitigation and adaptation measures in other GHGs fail to consider the impact nitrous oxide emissions. For instance, there are policies under consideration to reduce high CO2 emissions from shipping fuel by using green ammonia as an alternate fuel.[20] However, we do not know the overall impact on GHGs of this policy and how it will impact N2O emissions. We would note that N2O emissions potential be taken into consideration in any adaptation or mitigation policy, particularly when it comes to food systems since they have direct impacts on food production. All G20 efforts related to sustainable food systems, and sustainability broadly, should assess impacts on all major GHGs.

[20] World Maritime Organization. Ammonia as a shipping fuel. (2022). Available at: https://www.globalmaritimeforum.org/news/ammonia-as-a-shipping-fuel

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