SUSTAINABLE NITROGEN MANAGEMENT: A WAY FORWARD FOR CLIMATE, THE ENVIRONMENT, AND FOOD SECURITY

Workshop summary and key messages

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1. Acknowledgements 3

2. The Workshop 4

3. Workshop presentations 5

3.1 Welcome and introduction 5

3.2 Setting the scene 6

3.3 Building on progress 10

4. The discussions 16

5. Key messages 20

6. Next steps 22

1. Acknowledgements

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- United Nations Environment Programme (UNEP).
- International Nitrogen Management System (INMS).
- GCRF South Asia Nitrogen Hub (SANH).
- International Nitrogen Initiative (INI).
- Global Partnership on Nutrient Management (GPNM).
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The aim of this workshop was to facilitate discussions among Member States on key challenges and ways forward for sustainable nitrogen management. We are grateful to our workshop attendees, who joined both in-person and online. Thirty countries attended: Australia, Brazil, Bolivia, Botswana, Burkina Faso, Canada, Ecuador, Germany, Italy, Japan, Jordan, Kenya, Kyrgyzstan, Madagascar, Maldives, Mozambique, Pakistan, Paraguay, Poland, Romania, Senegal, South Africa, Switzerland, Sweden, Trinidad and Tobago, Turkey, Uganda, United Kingdom, Uruguay and Zimbabwe.

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The organisation of the workshop and production of this document was led by Andrea Perez Valdez from Compassion in World Farming.

2. The Workshop

Nitrogen, a vital element that sustains life and supports food production worldwide, has become one of the most pressing but also most overlooked challenges of our time. While essential, the excessive and inadequate use of nitrogen leads to air and water pollution, soil degradation, biodiversity loss, and climate change, due to the release of its various forms, including ammonia, nitrogen oxides, nitrate, and nitrous oxide.

Scientific evidence shows that humanity has already exceeded safe planetary boundaries for nitrogen. With a growing global population and increasing consumption, urgent action is needed to tackle the nitrogen challenge. This is essential to protect ecosystems, support livelihoods, help combat climate change, and ensure long-term food and nutrition security.

In recent years, the United Nations (UN) have made significant strides in addressing this complex challenge through reports, resolutions, and declarations, such as the United Nations Environment Assembly (UNEA) resolutions on sustainable nitrogen management and the Colombo Declaration, which frame sustainable nitrogen management as a critical environmental priority. However, progress remains fragmented and siloed, often overshadowed by a predominant focus on carbon dioxide emissions. Given that nitrogen-related issues intersect with climate change, biodiversity, and food security, more integrated and coherent policy approaches are required.

The workshop described in this document was conceived and organised in this context: as a dedicated space for Member States to come together, reflect on existing pathways, and discuss persistent challenges. A key objective was to bridge the environmental discussions under the United Nations Environment Assembly (UNEA) with the climate change negotiations under the United Nations Framework Convention on Climate Change (UNFCCC), fostering stronger policy cohesion across these multilateral processes. By building on progress within the UN system, the workshop aimed to stimulate ongoing dialogue that can translate global ambition into bold, coordinated action at the national level.

This report synthesises the presentations and interventions of the workshop, key messages, and possible next steps, with the aim of contributing towards building the shared vision and collective action that sustainable nitrogen management urgently requires.

3. Workshop presentations

3.1 Welcome and introduction

Torsten Brezina, Director at the GIZ, welcomed speakers and participants, highlighting the importance of cooperation across programmes and sectors.

Andrea Perez, Senior International Affairs Manager for Compassion in World Farming International (CIWF), presented an overview of the purpose and agenda of the workshop.

She explained that the workshop aimed to provide an opportunity to reflect on how we can advance efforts to address the nitrogen challenge: a critical issue with implications extending beyond emissions reductions to climate, biodiversity, soil health, and, ultimately, food and nutrition security.

Workshop Agenda Overview:

1. **Setting the Scene:**
    a. The programme began with expert inputs to frame the workshop's context and underline why sustainable nitrogen management is key to tackling multiple global challenges.

2. **Building on Progress:**
    a. Within the UN System: This section aimed to highlight initiatives and share insights from UN entities working on nitrogen-related policies and action, such as UNEP and the UNFCCC.
    b. Country Case Study: This presentation focused on Pakistan's approach to sustainable nitrogen management as a concrete example of progress at the national level.

3. **Open Discussion:**
    a. Key challenges countries face,
    b. Paths to build on existing progress and scale efforts.
    c. Strengthening governance around nitrogen.

3.2 Setting the scene

1 The role of **Sustainable Nitrogen Management** for addressing climate change and achieving food security:

The first presentation was given by Mark Sutton, Director of the International Nitrogen Management System (INMS) and GCRF South Asian Nitrogen Hub (SANH), co-chair of the UNECE Task Force on Reactive Nitrogen (TFRN) and co-chair of the UNEP Global Partnership on Nutrient Management (GPNM).

Prof. Sutton highlighted the **unique role of nitrogen** compared to other major nutrients like phosphorus and potassium. While phosphorus and potassium are mainly a water and resource issue, **nitrogen crosses multiple bounds**. It is relevant for climate (via nitrous oxide emissions), water quality, biodiversity, soil health, and air quality. Nitrogen is also the **largest agricultural nutrient input**, both in cost and quantity, making its efficient use critical for farmers.

A central message was that **sustainable nitrogen management supports, not threatens, food security**. A common misconception is that reducing nitrogen losses would reduce yields. In reality, nitrogen lost to the air or water represents wasted resources, meaning farmers paid for fertiliser that did not benefit their crops. By improving nitrogen-use efficiency, farmers can increase yields, lower costs, and reduce pollution, making this a clear **'win-win' solution**.

Prof. Sutton stressed that this is relevant in two contrasting global contexts:

- **Regions of excess nitrogen** (e.g., parts of Europe, North America, Southeast Asia): Reducing waste reduces pollution, lowers input needs, and increases profitability.
- **Regions with limited nitrogen resources** (e.g., Sub-Saharan Africa): Improving efficiency ensures every bit of nitrogen is used effectively, maximising food production where inputs are scarce.

In addition, ongoing international initiatives were highlighted:

- **International Nitrogen Management System (INMS)**: Developing science-based guidance, including a nitrogen budgeting tool and a database of over 150 technologies to improve nitrogen efficiency.
- **First International Nitrogen Assessment**: The first global evaluation of nitrogen's threats and benefits, including studies of the major world regions, scheduled for release early next year.
- **South Asian Nitrogen Hub**: A collaboration among eight South Asian countries producing data, models, and a draft roadmap for sustainable nitrogen management, which has already led to two UNEA resolutions (led by India and Sri Lanka) and the Colombo Declaration.

Finally, Prof. Sutton stressed the economic opportunity: around $300 billion worth of nitrogen resources are currently wasted annually[1]. Halving this waste would save approximately $150 billion each year, in addition to all the externalities. More efficient nitrogen management reduces nitrous oxide emissions (benefiting climate), ammonia emissions (improving air quality), and nitrate runoff (improving water quality), while looking towards building a nitrogen circular economy.

2 Presentation on the **United Nations Global Nitrous Oxide Assessment:**

David Kanter, Chair of the International Nitrogen Initiative (INI) and Professor of Environmental Studies at New York University (NYU), presented findings from the **Global Nitrous Oxide (N_2O) Assessment**, the first of its kind in over a decade, conducted with UNEP, FAO, INMS, and the Climate and Clean Air Coalition (CCAC). He highlighted that **nitrous oxide is the third most important greenhouse gas**, responsible for about **10% of global warming to date**, and now the **largest remaining threat to the ozone layer**, with current emissions exceeding those of all other ozone-depleting substances combined.

Most anthropogenic emissions come from **agriculture**, driven by fertiliser use and livestock production. Industrial sources, particularly nitric and adipic acid production, offer the quick and cost-effective opportunities for immediate reductions.

The assessment found that, with ambitious action, **global nitrous oxide emissions could be cut by 40% by 2050**, potentially reaching **60% by 2100**. This would **avoid up to 0.2°C of warming** by the end of the century-equivalent to **six years of current fossil CO_2 emissions**-while delivering five times the ozone-protection benefits of the accelerated HCFC phase-out under the Montreal Protocol.

Because of nitrous oxide's links to the wider nitrogen cycle, action would also reduce air pollution and water contamination, potentially preventing up to twenty million premature deaths worldwide.

Prof. Kanter emphasised that nitrous oxide has been largely overlooked in climate policy discussions, despite its substantial impact. Proven mitigation measures exist for both agriculture (more efficient fertiliser application on the production side, and dietary shifts on the consumption side) and industry (abatement in chemical production), meaning fast, cost-effective progress is possible with coordinated global action.

3 Presentation on the **Sustainable nitrogen management in agrifood systems report:**

Dr. Aimable Uwizeye, Livestock Policy Officer at the Food and Agriculture Organization of the United Nations (FAO), presented the findings of the FAO's first global report on sustainable nitrogen management in agrifood systems, published in January 2025.

Developed by a multidisciplinary team of researchers from FAO and several universities, the report addresses the critical challenge of improving nitrogen use efficiency across the entire agrifood chain, encompassing not just crop production but also livestock systems, fertiliser production, processing, and other related activities.

Dr. Uwizeye highlighted that nitrogen is essential for food security and nutrition; however, its poor management has significant negative environmental impacts, including water pollution, eutrophication, and contributions to climate change. The report aims to provide guidance for countries and stakeholders seeking to implement effective solutions that balance nitrogen use and reduce associated environmental impacts.

According to the report, about 70% of new nitrogen inputs, is applied to croplands in the form of fertilisers, biological nitrogen fixation, and atmospheric deposition, while the remaining 30% is directed to grasslands, mainly for livestock feed production. Livestock plays a particularly important role in nitrogen flows within agrifood systems. Yet, despite high nitrogen inputs for animal feed, only around 10% of the nitrogen consumed by livestock is converted into animal-source food for human consumption.

A proportion of nitrogen, approximately 42%, is recycled back into the system via manure application on croplands or direct deposition on grasslands. However, an **estimated 82% of nitrogen used globally in agrifood systems leaks into the environment,** causing widespread ecological damage.

The report highlights the **complexity and inefficiencies of livestock systems**, noting **significant variations in nitrogen use efficiency** between production types**.** A key challenge is the growing spatial disconnect between livestock production and crop cultivation, particularly in areas where animal populations are dense, but cropland is scarce, making nutrient recycling more difficult. Restrictions on reusing food leftovers as animal feed due to biosecurity concerns further limit circular economy opportunities in different countries, thus increasing food waste.

To address these challenges, Dr Uwizeye emphasised the need for a range of solutions. These include improvement of feed production and lower dietary protein, adopting best practices in manure management, and promoting integrated farming systems where livestock and crops are managed more closely together to facilitate nutrient recycling. Reducing food waste and safely reusing food leftovers as feed could also help minimise nitrogen losses.

Policy interventions are vital, with countries encouraged to create incentives and market-based instruments that **reward farmers for improving nitrogen efficiency.** Capacity building and knowledge transfer will be essential to ensure farmers can effectively adopt sustainable practices. Public and private investments should focus on technologies and methods to increase the efficiency of synthetic fertiliser use, which remains a major source of nitrogen loss. Furthermore, **sustainable nitrogen** management should be integrated into **national climate action**, in particular **nationally determined contributions (NDCs) and biodiversity frameworks,** with active engagement from the private sector to drive sustainable transformation across agrifood systems.

Dr. Uwizeye concluded by stressing that nitrogen is embedded in the Sustainable Development Goals, underpinning food security and economic growth while also posing environmental risks if mismanaged. He called for policies that reconcile nitrogen's dual nature, as both a **necessary nutrient and a potential pollutant.**

4 Presentation on the **Nitric Acid Climate Action Group (NACAG):**

Emilio Martin from the GIZ presented on the contribution of synthetic nitrogen fertilisers to global greenhouse gas emissions, focusing on the emissions generated during the production stage. He highlighted that **synthetic nitrogen fertilisers** are responsible for around **2% of total global greenhouse gas emissions**, with approximately **40% of these emissions originating during production**. This stage is often overlooked in discussions on nitrogen management, yet it presents a major opportunity for cost-effective mitigation efforts. Emissions from production mainly include carbon dioxide (CO_2) and nitrous oxide (N_2O), the latter primarily resulting from the production of nitric acid used in manufacturing nitrates, which make up around 20% of synthetic fertilisers globally. **Tackling nitrous**

oxide emissions is particularly important because of their **high climate impact** and the **large mitigation potential** available at relatively **low costs**.

Emilio Martin explained that GIZ has been leading an initiative, launched by the German Government nearly a decade ago, aimed at supporting countries in reducing emissions from nitric acid production. The initiative operates through two main pillars: technical support and financial assistance. Technical support is provided to partner governments and fertiliser plant operators, covering technology transfer, policy design, and implementation of monitoring systems. Financial support is tied to the purchase and installation of nitrous oxide abatement technologies and is conditional on partner governments committing to long-term measures that ensure the permanence of emission reductions. These commitments are formalised through agreements that encourage countries to integrate these reductions into their Nationally Determined Contributions (NDCs) under the Paris Agreement, thereby aligning the sector's mitigation efforts with national climate goals.

To illustrate the initiative's impact, Emilio Martin shared examples from Peru and Colombia. Peru joined the initiative in 2021 and has since developed a regulatory framework to control emissions from nitric acid production, introduced a monitoring, reporting, and verification (MRV) system, and incorporated this sector into its NDC. Colombia joined in 2022, also integrating the sector into its NDCs. The country is now on track to fully equip its nitric acid plants with abatement technology.

To date, 11 countries have committed to reducing and sustaining nitrous oxide emission reductions in nitric acid production, with ten of these having formally included the sector in their NDCs. **Emilio Martin** concluded by emphasising that this initiative demonstrates how **strategic international collaboration** can be successfully translated into **concrete national-level action**, delivering significant **climate benefits** in a sector often overlooked in mitigation efforts.

3.3 Building on progress

1. Integration of conclusions and ways forward from the **Improved nutrient use and manure management towards sustainable and resilient agricultural systems** under the **UNFCCC**:

Dirk Nemitz, Team Lead Agriculture, Forestry and Land Use, from the UNFCCC, highlighted how sustainable nitrogen management connects with the broader UNFCCC framework. Both the **Kyoto Protocol** and the **Paris Agreement** provide the basis for **reporting anthropogenic nitrous oxide (N_2O) emissions as a potent greenhouse gas**. Under the

Paris Agreement, nitrous oxide is a mandatory reporting item for all countries, subject to capacities and data availability.

Importantly, the Paris Agreement is not limited to emission measurement. Article 4 requires parties to prepare, communicate, and maintain NDCs. Developed countries are expected to include all sectors and greenhouse gases, while developing countries follow a 'stepwise' approach. In the 2024 NDC synthesis report, 89% of parties included agriculture, forestry, and other land use (AFOLU) actions, confirming the sector's importance for both mitigation and adaptation.

Unlike most other sectors, agriculture has a dedicated negotiation track under the UNFCCC. Between 2017–2022, the Koronivia Joint Work on Agriculture (KJWA) provided an unprecedented technical analysis on the relationship between agriculture and climate change. Workshops under this work programme explored soil health, nutrient use, livestock management, socio-economic impacts, and food security. One of these workshops focused specifically on nutrient use and manure management, making nitrogen a central theme.

At COP27, the Koronivia process concluded and was replaced by the Sharm El-Sheikh Joint Work on Implementation of Climate Action on Agriculture and Food Security, which continues the agenda with a stronger focus on action and implementation.

Several conclusions emerged from the ***Improved nutrient use and manure management towards sustainable and resilient agricultural systems*** workshop:

- **Integrated, tailored approaches**: No one-size-fits-all solution exists. Effective practices combine compost, manure, and mineral fertilisers, linking crops, and livestock systems.
- **Data and MRV systems**: Reliable data on nitrogen flows and nitrous oxide emissions are critical for inventories, NDCs, and access to climate finance. Cost-effective, locally adapted MRV systems are essential.
- **Capacity building and inclusiveness**: Technical and financial assistance is needed, especially for developing countries. Smallholders, women, youth, and Indigenous peoples should be recognised as key actors in decision-making and implementation.
- **Multiple co-benefits**: Improved nutrient management reduces greenhouse gas emissions while enhancing soil health, water quality, biodiversity, food security, and energy efficiency.

- **Finance and policy alignment**: Nutrient management strategies must align with NDCs, and adaptation plans to unlock climate finance and scale up effective practices.

The Sharm El-Sheikh mandate (Decision 3/CP.27) now provides the most comprehensive COP-level framework for agriculture and climate. It calls for holistic, multi-level approaches; stronger coordination among parties and institutions; and recognition of local and traditional knowledge.

Looking ahead, the implementation challenge is to translate knowledge into scalable action. More efficient nitrogen use offers a 'triple win': climate mitigation, reduced pollution, and improved farm efficiency, while also creating synergies with the SDGs, biodiversity, and desertification conventions.

To support this, the COP has requested the UNFCCC Secretariat to establish an online platform for sharing projects, initiatives, and policies related to agriculture, food security, and nitrogen management. Submissions from countries and organisations will feed into future synthesis reports and inform negotiations, including discussions at COP31.

Dirk Nemitz finished his presentation by highlighting that the in-session workshop on systemic and holistic approaches to agriculture and food security (June 2025) could provide a new opportunity to embed key nitrogen management messages into the UNFCCC process.

2. Follow up on the implementation of **UNEA** resolutions on **Sustainable Nitrogen Management**:

Dr. Ning Liu, Programme Management Officer at UNEP's Ecosystems Division, presented an update on the implementation of the United Nations Environment Assembly (UNEA) resolutions on sustainable nitrogen management, highlighting progress made since the first resolution was adopted in 2019. The 2019 resolution (**Colombo Declaration**) marked a milestone by calling for improved coordination of nitrogen management policies at national, regional, and global levels. It encouraged countries to explore how better management of the global nitrogen cycle could contribute to achieving the Sustainable Development Goals (SDGs). This included sharing methodologies for nitrogen assessment, best practices, guidance documents, emerging technologies, and improving the coordination of existing platforms to assess the environmental, food, and health benefits of more sustainable nitrogen use.

In 2022, UNEA adopted a second resolution on sustainable nitrogen management (**Resolution 5/2**), which further strengthened commitments by urging Member States to accelerate actions to significantly reduce nitrogen waste globally by 2030 and

beyond. The resolution tasked UNEP with providing support to countries in developing national nitrogen action plans for **sustainable nitrogen management (National Nitrogen Action Plans or NNAPs)[2].** To help achieve this, UNEP established a dedicated Working Group on Nitrogen, which has since held six meetings, with a seventh planned for July 2025. These meetings have focused on exploring policy coordination mechanisms, developing action plans, and fostering synergies between international partners and UN agencies. In 2023, UNEP organised a Nexus Dialogue on sustainable nitrogen management and mapped out UN mandates to better align activities related to nitrogen use and pollution control. UNEP is also preparing to publish guidance on legal, policy, and regulatory frameworks that aim to reduce nitrogen footprints across sectors through integrated approaches.

Over the past year, UNEP has received requests from thirteen countries seeking technical support for drafting NNAPs. Online consultations have already been held with seven countries, while Sri Lanka and Trinidad and Tobago have received technical and financial assistance to finalise their plans, both of which are expected to be submitted for cabinet approval in 2025. UNEP has also been active in awareness-raising efforts, hosting side events at major international forums, including COP29, the New York High-Level Political Forum, and the Bonn Climate Conference, along with co-partners including Compassion in World Farming, to keep sustainable nitrogen management high on the global environmental agenda.

Looking ahead, UNEA-7, scheduled for December 2025, will be a key milestone for advancing sustainable nutrient management. UNEP has released a report identifying priority actions for building a more resilient planet, with nutrient pollution highlighted as one of the top concerns for UNEA-7. Dr. Liu concluded by encouraging Member States to consider establishing an ad hoc open-ended working group to provide future guidance on sustainable nutrient management and to create a dedicated platform for collaborative actions, knowledge sharing, and best practices. This would help drive coordinated global efforts to reduce nitrogen pollution while supporting environmental sustainability, food security, and human health.

3. Activities of the **UNEP Working Group on Nitrogen**:

Mihai Constantinescu, co-chair of the UNEP Working Group on Nitrogen and representative of the government of Romania, provided an overview of the group's activities, challenges, and future priorities in implementing the UNEA resolutions on sustainable nitrogen management. He highlighted that the working group represents the highest level of collaboration between Member States on nitrogen issues and operates within the

framework established by UNEA decisions. Its mandate includes preparing a roadmap for implementation and supporting global efforts to significantly reduce nitrogen waste by 2030 and beyond. While some progress has been made, **Mihai Constantinescu** emphasised that **significant gaps remain**, particularly in providing concrete technical and policy recommendations to accelerate action on **nitrogen management** globally.

One of the key achievements of the working group has been the development of a template for NNAPs. As UNEP previously highlighted, thirteen countries have requested UNEP's support in preparing their plans, and Japan has already published and begun implementing its own. However, it was noted that many countries still require substantial scientific and technical assistance. This includes developing robust monitoring and implementation systems, establishing harmonised indicators to track progress, and facilitating knowledge transfer across regions. He suggested that **regional workshops and webinars** that bring together countries facing similar challenges could be useful mechanisms for **building capacity and facilitating the sharing of best practices.**

Mihai Constantinescu further outlined ongoing activities, including conducting a global analysis of nitrogen management actions, providing a platform for information sharing through the working group as well as the Global Partnership on Nutrient Management (GPNM), and participating in expert meetings and policy dialogues. However, he stressed that key challenges persist, particularly in raising awareness of **nitrogen waste as a major environmental issue** despite its significant contribution to the **'triple planetary crisis'** of **climate change, pollution, and biodiversity loss.** Balancing the need to increase fertiliser access for food production while minimising nitrogen losses remains a significant difficulty in many parts of the world. Moreover, there is a pressing need for **greater scientific support, technology transfer, and stronger collaboration** between developed and developing Member States to address these gaps.

Looking ahead, Mihai Constantinescu emphasised the importance of building a stronger scientific foundation for the working group's efforts. Plans include the establishment of a global database of scientists to provide technical guidance, developing more detailed and practical guidance documents to complement **NNAP**s templates, and working towards harmonised indicators that could support an agreed implementation calendar for monitoring progress. He concluded by underlining the need for deeper collaboration with other multilateral agreements, including the **UNFCCC**, and securing adequate funding, without which meaningful progress on sustainable nitrogen management will remain limited.

4. **Case study:** Pakistan

Dr. Tariq Aziz, Regional Director for South Asia at the International Nitrogen Initiative (INI) and Professor of Soil Science at the University of Agriculture, Faisalabad (UAF), presented Pakistan as a case study, highlighting its active role in global efforts towards sustainable nitrogen management. He began by situating Pakistan within the broader context of South Asian, a region that hosts 25% of the global population but occupies less than 5% of the world's landmass. This high population density, coupled with increasing energy and food demands over recent decades, has placed significant pressure on ecosystems.

Despite Pakistan contributing less than 1% to GHG emissions, the country ranks among the most climate-vulnerable worldwide. The devastating floods of 2020, which destroyed millions of homes and caused an estimated $15 billion in damages, underscored the urgent need for resilience-building measures. Nitrogen emissions have surged significantly, exacerbating nitrous oxide emissions. Dr. Aziz noted that with adequate technical and financial support, emission reductions of at least 15% are achievable.

Pakistan has emerged as a leading advocate for sustainable nitrogen management within South Asia and on the global stage. Through the South Asian Nitrogen Hub project, supported by UK Research and Innovation (UKRI), the region has developed datasets, emission inventories, and policy reports to better understand nitrogen flows and inform action.

Pakistan has actively contributed to UNEA resolutions, participated in the Colombo Declaration, and co-hosted side events at UN forums such as COP26, COP29, and UNEA-6, demonstrating its commitment to advancing nitrogen management globally. While government transitions prevented the planned submission of a third nitrogen resolution at UNEA-6, renewed negotiations are underway domestically under a National Consultative Workshop aimed at integrating nitrogen management into climate, biodiversity, and pollution policies. The plan is to submit a resolution for UNEA-7.

Dr. Aziz also addressed ongoing challenges, including the volatility of global fertiliser prices, which have intensified food security concerns and highlighted the importance of reducing nitrogen waste to avoid economic losses. He pointed to emerging issues such as the potential environmental risks of using ammonia as a fuel in decarbonisation strategies, which require further scientific research and policy guidance. Looking ahead to 2030, he stressed the need for clearer **international priorities and reporting mechanisms beyond UNEA-6,** suggesting that UNEA-7 should establish a framework for monitoring progress towards nitrogen waste reduction targets.

Future resolutions, he argued, must institutionalise **intergovernmental coordination on nitrogen, foster innovation in the nitrogen circular economy, address knowledge**

gaps, and secure financing commitments for developing nations to ensure equitable and effective action on sustainable nitrogen management.

4. The discussions

Participants shared national experiences and perspectives on advancing sustainable nitrogen management, emphasising the importance of addressing key challenges and barriers.

Canada highlighted its voluntary emissions reduction target of 30% by 2030, introduced in 2020. Initial misunderstandings among farmers (believing it mandated a 30% cut in fertiliser use) raised concerns about food production impacts. This led to extensive consultations, the creation of farmer working groups, and monthly policy dialogues to build trust and clarify objectives. The initiative spurred investment in beneficial management practices, research and development (R&D), and knowledge transfer, focusing on more efficient fertiliser application. Canada stressed that **clear communication and transparency** are key to fostering collaboration and achieving emissions reductions over time.

Brazil shared its experience with the sectoral plan for climate change mitigation in agriculture (ABC Plan), which adopts incentive-based policies. Tools such as dedicated credit lines and technical support for farmers in adopting sustainable technologies were put in place. Rather than framing policies as fertiliser reductions, which farmers can perceive negatively, the focus is on offering solutions that cut costs, improve soil health, and enhance production, with the key benefit of lowering nitrous oxide emissions. Brazil emphasised that **scientific language must be translated into practical, business-oriented terms** that resonate with farmers. Incentive-based approaches have proven more effective than regulatory measures, which face greater resistance.

Mark Sutton reinforced the need for a positive narrative around sustainable nitrogen management. Whether in regions facing excess nitrogen or nitrogen scarcity, reducing waste delivers environmental and food security benefits. He noted that fear, particularly among countries concerned about insufficient nutrient availability, can hinder ambition. Reframing the **discussion around 'win-win' solutions** can build confidence and encourage broader action. Farmer involvement and stakeholder engagement emerged as a recurring theme.

Aimable Uwizeye stressed that mitigation solutions cannot be effectively designed or implemented without **including farmers and broader agri-food stakeholders**. Policies implemented without proper engagement face resistance, as farmers fear potential economic losses or being driven out of business. Ensuring their perspectives are integrated from the outset and providing clear, tangible incentives are critical to securing their willingness to adopt sustainable practices.

Brazil further emphasised the need to frame policies as solutions. Drawing on discussions linked to the upcoming COP30, Brazil highlighted the opportunity to make this an 'implementation COP'. Brazil suggested moving away from messages focused solely on planetary boundaries. Brazil believes that without economic gains or lasting market competitiveness, **temporary subsidies or incentives are unlikely to drive long-term behavioural change**.

Uruguay identified a major technical barrier: weak MRV systems for nitrogen fertiliser use. Unlike methane emissions from livestock, where more robust data exist, fertiliser use is largely estimated from sales figures. This approach overlooks on-farm realities, such as fertilisers being stored for future use, and lacks detail on the types of fertilisers and practices applied. Without accurate data, it is difficult to design effective incentives and track emission reductions.

Canada echoed Uruguay's concerns, noting that the absence of data on beneficial management practices, including on-farm, activity-based data, can make it difficult to estimate actual emissions. Canada recommended advancing research and improving MRV systems to better reflect 'real-world' nitrogen use and its environmental impacts.

Brazil agreed, stating that current fertiliser monitoring relies heavily on sales data, which is an imperfect proxy for actual on-farm use. Variability between purchase and application years makes this method unreliable, similar to the challenge with pesticide tracking. Brazil further underscored the need to move toward more accurate Tier 2 MRV systems that can distinguish between fertiliser types, such as urea and sulphates, which have different environmental impacts.

Aimable Uwizeye stressed the importance of integrating nitrogen governance into national policy frameworks. Many countries lack comprehensive fertiliser policies or mechanisms to manage nitrogen sustainably. The FAO's voluntary Fertiliser Code provides guidance to governments, industry, and other stakeholders on improving fertiliser use efficiency while addressing pollution and food security concerns. However, a lack of direct incentives and investments, particularly in developing countries, remains a major barrier. Few countries, such as India, subsidise pollution-reducing inhibitors, leaving most farmers without support to adopt sustainable practices.

Mark Sutton responded to a *chat-box* question from a participant from Palestine regarding the use of dung as fertiliser in livestock systems. He emphasised that dung is highly beneficial for soil health, providing a slow-release nitrogen source, adding carbon, improving water retention, and supporting microbial life. However, urine is more volatile, prone to nitrogen losses as ammonia emissions. Good practice involves solid-liquid

segregation at the source and incorporating manure carefully into the soil to minimise emissions.

Australia raised the need for long-term policy reform to phase out harmful subsidies. While **some subsidies or tariffs aim to support farmers**, they can **unintentionally lead to overuse of fertilisers, causing environmental harm**. Drawing from international experiences such as South Korea, Australia highlighted that the gradual removal of fertiliser subsidies, combined with complementary measures (e.g., improved rice cultivation practices), can reduce emissions without compromising food security. Over time, such reforms allow farmers to see **economic and environmental benefits, supporting the 'win-win'** approach advocated throughout the workshop.

Botswana highlighted several challenges, including a **lack of awareness among stakeholders, fragmented legislation,** and the **absence of specific policies addressing nitrogen use**. Despite having scientific capacity within relevant sectors such as agriculture, environment, water, and sanitation, persistent data gaps remain due to limited funding. These challenges hinder the development and implementation of effective nitrogen management strategies.

Tariq Aziz highlighted that **governance and policy on nitrogen management remain severely fragmented**, particularly in developing countries, where disconnected policies across agriculture, environment, water, and climate sectors result in inefficiencies and missed opportunities. He emphasised a growing **recognition of the need for cross-sectoral coordination** at both national and international levels to **manage nitrogen in a more integrated and holistic manner**. Dr. Aziz called for the inclusion of nitrogen-focused coordination mechanisms, which convene all relevant ministries to shape policy decisions for NNAPs. He also addressed the widespread lack of awareness among farmers, especially in developing nations, who are generally well-informed about production yields and profits, but often unaware of the environmental costs of nitrogen losses, such as air pollution, eutrophication, and nitrous oxide emissions. Dr. Aziz pointed to the absence of standardised systems for tracking nitrogen flows and emissions, citing Pakistan's reliance on Tier 1 emissions estimates while they work toward Tier 2. In many lower and middle-income countries, crucial data on nitrogen is often missing or outdated. Strengthening MRV systems must be a top priority moving forward.

A participant from the **GIZ** observed that while MRV is important, waiting for perfect data before acting risks delaying progress. Instead, countries should focus on promoting context-specific 'best bets' for sustainable nitrogen practices that are known to work, even without complete measurement systems, to generate faster impacts.

Brazil highlighted that awareness alone is insufficient to change farming practices; strong and continuous technical advisory services are needed to support farmers in implementing solutions on the ground. Brazil mentioned that they currently lack a dedicated nitrogen pollution policy, but established a National Fertiliser Plan five years ago. In parallel, a National Biological Inputs Program was introduced to fast-track approval processes for biological fertilisers, allow farmers to produce these products on-farm, and promote low-cost inoculants for nitrogen fixation. These measures have led to rapid market growth of biological inputs (20–30% annually).

Switzerland presented its nutrient reduction pathway, which includes nitrogen. This has resulted in the introduction of additional subsidies for agricultural practices that reduce nutrient losses, as well as stricter requirements regarding balanced nutrient management plans, which farmers must provide in order to receive direct payments. Measures to increase transparency in the use of mineral fertilisers and animal feed on farms are also being implemented. While these measures have contributed to reductions, nitrogen inputs into sensitive ecosystems remain well above sustainable limits, and further reductions are necessary to achieve climate targets. The stricter requirements have not been well received by the agricultural sector and are being contested politically. Future progress will depend on more farms participating in the subsidy scheme and overcoming political barriers**.**

Germany shared its experience with the Humus Climate Network, a program involving one hundred and fifty model farms demonstrating sustainable soil management practices to build soil organic matter, improve nitrogen retention, and, therefore, mitigate GHG emissions. **This approach leverages farmer-to-farmer learning, which has proven highly effective in encouraging wider adoption of sustainable nitrogen management techniques**.

On the topic of biological nitrogen fixation and inoculants, **Mark Sutton** welcomed innovations in legume inoculants, noting that they offer slow-release nitrogen, matching crop demand and reducing losses. He stressed the importance of experimental field trials and farmer demonstration pilots to validate efficacy and build trust. **He emphasised that the goal is to reduce nitrogen pollution, not oppose fertiliser usage per se**. Though he saw value in intercropping nitrogen-fixing crops with non-fixers as a promising strategy, he cautioned that green manure systems, where legumes are ploughed into soil, can produce risks: nitrogen mineralisation can lead to elevated nitrous oxide emissions if not properly managed. Regarding fertiliser subsidy reform, **Prof. Sutton** acknowledged the lack of comprehensive international data on the proportion of global fertiliser use supported by subsidies, though he suspected it was substantial. He highlighted the political sensitivities around subsidy reform. To address this, he proposed showcasing South Korea as a real-world example of a country that has successfully and gradually phased out fertiliser subsidies, providing a model for other nations to follow.

Japan highlighted that under **Target 18 of the Convention on Biological Diversity (CBD)** Target 18, countries should not only **identify and reform harmful subsidies** across all sectors - not just agriculture – but also **enhance positive subsidies**. Japan stressed the importance of recognising that the environmental impact of agricultural subsidies varies depending on national agricultural conditions. Some subsidies can have beneficial effects, while others may have serious consequences for food security and farmers' livelihoods. Therefore, Japan views as a crucial challenge to identify negative subsidies and reforming them into positive ones that can be helpful to achieve sustainable nitrogen management.

Canada described Alberta's experience with a nitrous oxide emissions reduction protocol introduced roughly ten years ago. The Agricultural Nitrous Oxide Emissions Reduction Protocol (NERP) aimed to incentivise improved nitrogen management practices. Canada further noted that Fertiliser Canada's 4R certification program, the principles of which provide an example of how working directly with farmers can support improvements in nutrient management that support the dual objectives of reducing greenhouse gas emissions and enhancing productivity and profitability.

Tariq Aziz emphasised the need to mainstream nitrogen management within climate and agricultural financing. He noted that sustainable nitrogen management offers considerable mitigation potential at comparatively low cost due to reduced emissions and increased productivity. Integrating nitrogen strategies into established climate finance instruments, such as the Green Climate Fund (GCF) or the Global Environment Facility (GEF), could unlock resources for innovation, capacity building, MRV systems, and awareness-raising campaigns.

Mark Sutton agreed with Aziz's point, but he preferred the term 'investment' over 'support'. He argued that framing interventions as investments- highlighting economic returns rather than perpetual aid- could be more appealing to governments.

5. Key messages

- Nitrogen is unique, affecting climate, water quality, biodiversity, soil health, and air quality, through its various forms, including nitrous oxide, ammonia, nitrate, and nitrogen oxides. This makes its management crucial compared to other nutrients.

- Implementing sustainable nitrogen management has multiple co-benefits: better nitrogen management reduces nitrous oxide emissions (which is good for the climate), ammonia emissions (which is good for air quality), and nitrate runoff (which is good

for water quality, biodiversity and soil health), moving towards a circular nitrogen economy and supporting food security.

- Nitrous oxide has been largely overlooked in climate discussions, despite it being a potent greenhouse gas that should be more explicitly included in NDCs under the UNFCCC and the Paris agreement. Awareness raising is still needed, but immediate action and effective implementation is fundamental.

- Most anthropogenic emissions come from agriculture, driven by fertiliser use and livestock production. Industrial sources, particularly nitric and adipic acid production, offer quick and cost-effective opportunities for immediate reductions.

- Livestock plays a particularly important role in nitrogen flows within agrifood systems, Solutions include more efficient fertiliser application, dietary shifts where needed, best practices in manure management, promoting integrated farming systems and reducing food waste.

- Policy action is urgent, with countries encouraged to create incentives for farmers and other stakeholders in the broader food system to improve nitrogen use efficiency. Capacity building, knowledge sharing, and financing will be essential to ensure the effective adoption of sustainable practices.

- Effectively communicating the benefits of a sustainable nitrogen management approach (e.g. reducing emissions and pollution, increasing yields, lowering costs) is essential to avoid policy reform opposition. Farmer-to-farmer learning could encourage wider adoption of sustainable approaches.

- The lack of appropriate data and MRV systems remain a significant barrier. However, ‘waiting for perfect data’ before implementing measures risks delaying progress. One way to address this could be promoting context-specific ‘best bets’ for sustainable nitrogen practices.

- Reforming or repurposing harmful subsidies and enhancing positive ones is essential to achieve long-term policy reform that advances sustainable nitrogen management. The impacts of agricultural subsidies vary depending on regions and national realities. However, sharing country experiences could help identify effective pathways for subsidy reform.

- A central message was that sustainable nitrogen management offers a ‘win-win’ scenario, since it is not only beneficial for the environment, climate and food security, but also lowers production costs and brings economic benefits. Countries should thus see it as an investment and embrace its implementation.

- With nitrogen's multifaceted relevance, it is fundamental to break policy silos both at national and global levels. Coordinated global action should be strengthened, and synergies should be fostered between the work under UNEP, the Rio Conventions (climate, biodiversity and desertification) and the Montreal Protocol. COP 30, UNEA-7 and Bonn 2026, represent clear opportunities to continue advancing sustainable nitrogen management.
- Further efforts are needed to integrate sustainable nitrogen management into NDCs (going further, into national transition plans) and biodiversity strategies; as well as to help countries develop National Nitrogen Action Plans (NNAPs), under the Colombo Declaration and UNEA resolutions 5/2 and 4/14.

6. Next steps

Participants expressed keen interest to continue exploring synergies and identifying practical pathways to advance sustainable nitrogen management. Country-level experiences were welcomed, and the need for more spaces for knowledge sharing was highlighted.

We believe that there are clear opportunities to build and develop the work started in this workshop by expanding on the discussions held. In the future, we could hold a similar version of this workshop and adjust considering participants' feedback and the key messages described in this document. For example, we could further explore how to advance sustainable nitrogen management from commitments under multilateral processes to advancements at a national level.

We aim to continue bridging the work under UNEP with the UNFCCC and to expand the collaboration with key stakeholders of the Biodiversity and Desertification Conventions (CBD and UNCCD), as well as the Montreal Protocol. Strengthening these synergies is essential to advance coordinated global action on sustainable nitrogen management.

Our key aim was to facilitate knowledge sharing and Member State discussions on ways forward, and we believe this objective was achieved. We will continue to seek to facilitate much-needed spaces that can lead to global policy action and concrete implementation.