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Promote sustainable nitrogen management in the livestock sector

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I. Introduction

1. Nitrogen (N) makes up 78 percent of the Earth's atmosphere. It plays a crucial role in the natural environment, cycling through air, soil and water, and forming essential compounds for plants, animals and microorganisms. While some plants can access atmospheric N through biological fixation, most others depend on nitrogen availability in soils. The use of synthetic N fertilizer, produced through the Haber-Bosch process by converting atmospheric N_2 into plant-usable forms, has complemented these natural processes.[1] This significantly increased crop yields and contributed to food security and nutrition for a growing world population.

2. The demand for food and feed commodities has led to an over 900 percent increase in N fertilizer use compared to 1961.[2] Excess use of N has caused negative impacts on both people and the planet.

[1] Erisman, J.W., Sutton, M.A., Galloway, J., Klimont, Z. & Winiwarter, W. 2008. How a century of ammonia synthesis changed the world. *Nature geoscience*, 1(10), 636-639. https://doi.org/10.1038/ngeo325

[2] https://www.fao.org/faostat/en/#home

Ammonia and nitrogen oxide emissions have led to air pollution, nitrate loads in water bodies have caused eutrophication and harmed aquatic ecosystems and biodiversity, and emissions of nitrous oxide, a potent greenhouse gas, contribute to climate change.[3] Conversely, many low-income countries still face challenges in accessing fertilizers, leading to soil health degradation and crop yields well below their potential. Urgent action is needed to address nitrogen imbalance and pollution.

3. The global livestock sector has undergone significant changes, driven by increased demand for feed and terrestrial animal source food. Small-scale farms have transitioned to medium and large operations due to economic and institutional factors, globalization and trade liberalization.[4] This shift has led to extended and international systems, causing a local disconnection between feed and livestock production. In some high-density livestock regions, excessive manure production is not effectively recycled and discharged into the environment.[5] Additionally, the application of organic and inorganic fertilizer, and the transport of N-rich products, such as feed, food and manure, contribute to global N flows and losses.

4. Total N losses from livestock supply chains are estimated at 65 Tg of N per year, equivalent to one-third of human-induced N emissions.[6] Therefore, efficient N management is necessary to reduce the contribution of livestock to the triple planetary crisis: climate change, pollution and biodiversity loss,[7] while fostering the sustainable use of N, both in regions with N depletion and N surplus.

II. Opportunities to increase nitrogen use efficiency in livestock systems

5. Farmers are taking measures to improve N use efficiency in livestock and agrifood systems. These efforts include adopting best practices for fertilizer and manure application, enhancing soil health, closing crop yield gaps, boosting grassland and livestock productivity, optimizing diet protein content and recycling manure.[8] Solutions involve agroecological practices and circular bioeconomy approaches, such as reusing food leftovers and crop residues as livestock feed.[9]

III. FAO and UN work on sustainable nitrogen management

6. FAO develops and fosters the implementation of relevant tools and guidelines, such as the guidelines developed by the FAO Livestock Environmental Assessment and Performance (LEAP) Partnership for the assessment of nutrient flows and associated environmental impacts in livestock supply chains.[10] FAO has also developed the International Code of Conduct for the Sustainable Use and

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[3] Sutton, M.A., Bleeker, A., Howard, C.M., Erisman, J.W., Abrol, Y.P., Bekunda, M., Datta. A. *et al*. 2013. *Our nutrient world. The challenge to produce more food and energy with less pollution*. https://wedocs.unep.org/20.500.11822/10747

[4] Gerber, P.J., Robinson, T., Wassenaar, T. & Steinfeld, H. 2010. *Livestock in geographical transition*. In: Livestock in a changing landscape: Drivers, consequences and responses. 1(1), 51-66. Washington, DC, Island Press.

[5] Bai, Z.H., Ma, L., Qin, W., Chen, Q., Oenema, O. & Zhang, F.S. 2014. Changes in pig production in China and their effects on nitrogen and phosphorus use and losses. *Environmental science & technology*, 48(21), 12742-12749. https://doi.org/10.1021/es502160v

[6] Uwizeye, A., de Boer, I.J., Opio, C.I., Schulte, R.P., Falcucci, A., Tempio, G., Teillard, F. *et al*. 2020. Nitrogen emissions along global livestock supply chains. *Nature Food,* 1(7), 437-446. https://doi.org/10.1038/s43016-020-0113-y

[7] https://unfccc.int/blog/what-is-the-triple-planetary-crisis

[8] Bittman, S., Dědina, M., Howard, C.M., Oenema, O. & Sutton, M.A. 2014. *Options for ammonia mitigation: Guidance from the UNECE Task Force on Reactive Nitrogen*. Centre for Ecology & Hydrology. Edinburgh, UK. https://nora.nerc.ac.uk/id/eprint/510206/1/N510206CR.pdf

[9] Uwizeye, A., Gerber, P.J., Opio, C.I., Tempio, G., Mottet, A., Makkar, H.P., Falcucci, A., Steinfeld, H. & De Boer, I.J. 2019. Nitrogen flows in global pork supply chains and potential improvement from feeding swill to pigs. *Resources, Conservation and Recycling*, 146, pp.168-179. https://doi.org/10.1016/j.resconrec.2019.03.032

[10] FAO. 2018. *Nutrient flows and associated environmental impacts in livestock supply chains: Guidelines for assessment (Version 1)*. Rome. https://openknowledge.fao.org/handle/20.500.14283/ca1328en

Management of Fertilizers,[11] which was endorsed by the FAO Conference at its 41st Session in June 2019. It was the result of a broad and intensive consultation process initiated in December 2017.

7. FAO also hosts knowledge sharing platforms, such as the International Network on Soil Fertility and Fertilizers[12] (INSOILFER), which aims to adopt and implement sustainable soil fertility management, avoid the underuse, misuse and overuse of fertilizers, and reduce the environmental and health impacts of unsustainable fertilizer use.

8. FAO also provides global statistics on N fertilizer use and nitrous oxide emissions through FAOSTAT[13] and has produced statistical reports on N inputs from livestock manure.[14] The Global Livestock Environmental Assessment Model[15] has also been updated to assess N emissions and adaptation and mitigation options.

9. FAO co-led the nexus dialogue organized by the UN Environment Management Group to pave the way for a system-wide approach to sustainable N management, bringing different perspectives and strengths of UN entities, and looking at synergies and policy coherence.[16]

10. The UN Environment Programme has established the Global Partnership on Nutrient Management as a response to reduce nitrogen and phosphorus pollution in the environment.[17]

IV. Relevant UN policy decisions supporting sustainable nitrogen management

11. The Paris Agreement[18] is a legally binding international treaty on climate change. It was adopted by 196 Parties at the UN Climate Change Conference in 2015. Countries committed to take actions to mitigate climate change, including the reduction of nitrous oxide emissions.

12. The Kunming-Montreal Global Biodiversity Framework,[19] adopted in 2022 by the Conference of the Parties to the Convention on Biological Diversity, aims to catalyse, enable and galvanise urgent and transformative action by governments to halt and reverse biodiversity loss. Its targets 7 and 8 address the reduction of N pollution.

13. The United Nations Environment Assembly has adopted two resolutions in 2019 and 2022 on 'Sustainable nitrogen management' to accelerate actions to reduce N losses.[20,21]

V. Conclusion and way forward

[11] FAO. 2019. *The international Code of Conduct for the sustainable use and management of fertilizers*. Rome. https://openknowledge.fao.org/handle/20.500.14283/ca5253en
[12] https://www.fao.org/global-soil-partnership/global-soil-partnershipinsoilferen/en/
[13] https://www.fao.org/faostat/en/#data/GT
[14] FAO. 2018. *Nitrogen inputs to agricultural soils from livestock manure. New statistics*. https://openknowledge.fao.org/handle/20.500.14283/i8153en
[15] https://www.fao.org/gleam/en/
[16] https://unemg.org/nexus-dialogue-sustainable-nitrogen-management/
[17] https://www.unep.org/explore-topics/oceans-seas/global-partnership-nutrient-management
[18] https://unfccc.int/process-and-meetings/the-paris-agreement
[19] CBD/COP/DEC/15/4. *Kunming-Montreal Global Biodiversity Framework*. https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf
[20] UNEP/EA.4/Res.14 Sustainable Nitrogen Management. https://www.unep.org/resources/resolutions-treaties-and-decisions/UN-Environment-Assembly-4
[21] UNEP/EA.5/Res.2. Sustainable Nitrogen Management. https://www.unep.org/environmentassembly/unea5/unea-5.2/outcomes-resumed-session-unea-5-unea-5.2

14. FAO will continue to provide technical knowledge on opportunities and challenges for sustainable N use in agrifood systems.[22]

15. FAO can support Members in mainstreaming sustainable N management across livestock development programmes and action plans, as well as provide policy recommendations to enhance N use efficiency in agrifood systems at global, regional and national levels.

[22] COAG/2022/2. Table 4. https://openknowledge.fao.org/handle/20.500.14283/nj001en