BREAKTHROUGH AGENDA

CGIAR

Reducing emissions from fertilizer production via green ammonia

THE CHALLENGE

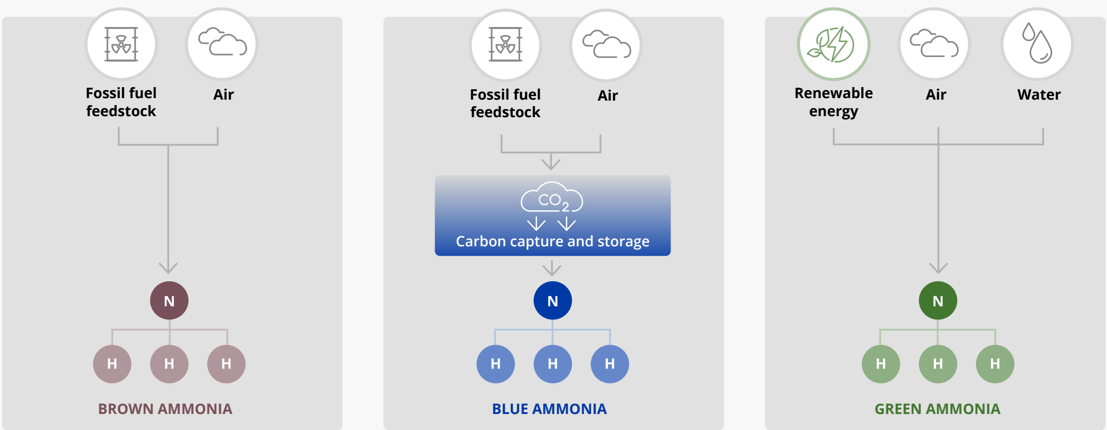
Agrifood systems account for roughly one-third of all greenhouse gas (GHG) emissions globally, when food production, transport, processing, and retailing are considered (Crippa et al. 2021; IPCC 2022; Costa Jr et al. 2022). The synthetic nitrogen (N) fertilizer supply chain is responsible for approximately 10.6% of agricultural emissions, or 2.6% of global GHG emissions (Menegat 2022). Of this, synthetic N fertilizer production accounts for 38.8% of total synthetic N fertilizer-associated emissions, while field emissions account for 58.6% and transportation accounts for the remaining 2.6% (Menegat 2022). Reducing emissions from fertilizer production can therefore contribute to climate change mitigation efforts while maintaining crop yields.

HOW DOES GREEN AMMONIA HELP US REDUCE EMISSIONS FROM FERTILIZER PRODUCTION?

Green ammonia has the potential to eliminate all carbon dioxide emissions from ammonia production. The Haber–Bosch process, invented in the early 1900s, remains the primary source of ammonia from hydrogen and nitrogen. The process is highly energy intensive: it relies on hydrocarbons as a feedstock for producing hydrogen through steam methane reforming (or coal gasification), as well as for subsequently powering the energy-intensive ammonia synthesis process, which fixes nitrogen from the air with the hydrogen obtained from steam methane reforming (called brown ammonia).

Zero carbon ammonia, called "green ammonia," uses renewable energy to power electrolysis to produce hydrogen from water (replacing the steam methane reforming process based on hydrocarbon feedstocks) and the subsequent ammonia synthesis. Figure 1 depicts the difference in production processes of three different types of ammonia. Numerous green ammonia pilot plants have been set up, and large-scale green ammonia facilities may come online in the next five years.

Startup companies have developed smaller, modular green ammonia plants, which are vastly less expensive than large plants and could facilitate decentralized ammonia production. This decentralized production would lower transportation emissions and costs and render fertilizers less prone to trade or supply shocks. Smaller-scale green ammonia could be particularly relevant in developing countries and areas where transport and storage are costly or complex, particularly landlocked countries. Moreover, smaller plants can more easily be financed than large-scale ammonia plants.



Production process of brown, blue, and green ammonia.

(Source: https://www.nature.com/articles/s44160-023-00362-y).

BARRIERS TO THE UPTAKE OF GREEN AMMONIA

The cost of producing green ammonia is still higher than for blue ammonia – although, over time, with an ongoing decrease in the price of renewable energy and electrolyzers, this barrier could be overcome.

Given that between 10 and 15% of global ammonia production is traded, countries may be hesitant to impose regulations mandating emissions reductions so as not to disadvantage their producers (noting that the EU only recently announced a plan to gradually phase out free emission allowances provided to EU fertilizer producers, but at the same time introducing carbon border tax adjustments).

As fertilizer plants can operate for more than 40 years, operators of existing plants may not feel incentivized to switch to green ammonia production, preferring instead to pursue blue ammonia because it does not require any changes to their existing plants and operations except for securing access to carbon dioxide sequestration infrastructure.

There are important safety and security considerations in the ammonia production process, storage, and transport, as well as at the level of on-farm application of fertilizers. Anhydrous ammonia, the end product of green ammonia plants, requires careful handling and specialized equipment for transportation and application at the farm level. Ammonia codes of practice and government regulations can mitigate against such risks, as can proper equipment, but this implies additional costs for value chain players, including farmers. This can be particularly significant for smallholder producers.

Balanced fertilization is important for agricultural productivity, soil health, and sustainability, and further processing would be required to produce multinutrient fertilizers (nitrogen, phosphorous, potassium, and other micronutrients). These considerations imply that setting up green ammonia plants alone is not sufficient, and additional processes and costs would be required to provide fertilizer products that farmers prefer and that provide for more balanced plant nutrition.

CALL TO ACTION

A1. Increased international climate finance should be directed toward unlocking the potential of agricultural technologies and approaches with proven effectiveness

- Include green ammonia in Climate Bonds Initiative (CBI) Agriculture Criteria – under efforts to reduce GHG emissions, where the science has been proven – so that they are eligible for green finance. This in turn should be used to include green ammonia in country- and regional-level taxonomies, e.g., the EU taxonomy of permissible activities for green finance.
- Set emissions reduction targets for the green ammonia industry under the Science-based Target Initiatives (SbTI). This will further spur investments in this technology, because green ammonia enables emissions reductions.
- Seek and obtain international consensus on "repurposing" the more than US$600 billion spent annually by governments on agricultural support. Considering that much of the support provided to agriculture is market-distorting and incentivizes unsustainable production, public support should be reformed. One of the most promising shifts in such investments would be an increase in funding for R&D dedicated to productivity-enhancing and emissions-reducing technologies.

A2. Promote international sharing of knowledge on policy and implementation to facilitate faster uptake of proven technologies

- Encourage governments to sign Nitrogen Use Efficiency (NUE) Pledge on lines of the methane pledge. Such a NUE pledge will help reduce nitrous oxide emissions, as nitrogenous fertilizer is the top source of nitrous oxide emissions. A pledge to reach a global NUE of 70% by 2030 is ambitious but feasible with appropriate policies and financial support.
- Countries should take advantage of existing platforms such as the World Bank and FCDO facilitated Global Agriculture Policy Dialogues to engage with countries and private sector for exchanging best practices and barriers to a quicker transition to green ammonia.

A3. Develop common metrics and indicators to track the adoption of sustainable agricultural solutions

- Fertilizer companies must be encouraged to expand their GHG accounting to include the GHG emitted as a result of fertilizer application in the field (so-called Scope 3 emissions). Greater scrutiny of Scope 3 emissions can incentivize greater efforts to reduce nitrous oxide emissions from fertilizer application and enhance NUE.
- Governments could set deployment targets for existing and planned ammonia facilities. Examples of such targets could be: 30% of existing ammonia production facilities to install carbon capture and storage (CCS) infrastructure for capturing carbon dioxide by 2030; mandate all new ammonia plants set up hence forward to produce green ammonia.
- Governments should also set a target of deploying 80GW of new renewables-powered electrolysers, of which Green Hydrogen Catapult members have already committed 45GW. To further stimulate increased low-carbon ammonia production, the industry should undertake a complete reporting structure or certification mechanism that will report the full production carbon dioxide equivalent footprint and the captured carbon of an associated ton.
- Countries should come together and develop "Codex Planetarius" on the lines of Codex Alimentarius which develops internationally agreed food safety standards. 'Codex Planetarius' can set forth criteria for crops and animal-derived products (that is, end products for consumption) to be certified as compatible with international climate targets, which will then incentivise all actors in the value chain, such as fertilizer and livestock producers, to adopt low emissions and climate compatible technologies.

A4. Increase support for food system research, development, and demonstration to support the uptake and scaling of promising technologies and approaches

- Strengthen global knowledge exchange on green ammonia by expanding and strengthening the Nutrient Management Network of the Global Research Alliance on Agricultural Greenhouse Gases.
- Fertilizer industry must be mandated by the governments to report on R&D spending and commit to higher spending levels on green innovations, since it is increasingly evident that increased spending on R&D underpins innovation. Currently, there are no estimates of R&D spending by the fertilizer industry.

A5. International efforts should work toward enabling the private sector to scale up solutions through global markets

- Revive moribund WTO Agreement on Environmental Goods and Services. Plurilateral negotiations for an Environmental Goods Agreement were started in 2014 to promote trade in essential environmental products, i.e., solar panels and wind turbines. In future negotiations, the list of green goods and services should include low-carbon fertilizers like green ammonia, among other emissions-reducing technologies. This would involve advocating for harmonized standards, certifications, and accounting methodologies with multilateral organizations such as WTO and various UN agencies.

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For more information see:

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