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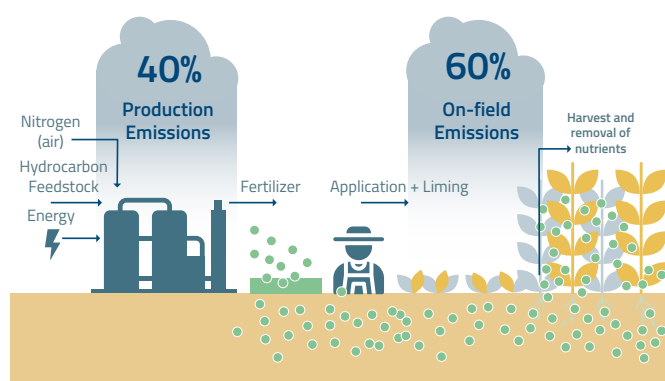
Green Hydrogen and Innovative Fertilizer Production:

Towards a Win-Win Partnership in the EU & Africa

WHY THIS MATTERS NOW

Modern agriculture is the leading consumer of fertilizers, most notably synthetic nitrogen fertilizers, which sustain crop yields that feed approximately half of the world's population. Nitrogen fertilizers are also the most emissions-intensive type of synthetic fertilizer, accounting for 2.5% of global emissions. 40% of those emissions are attributed to production, where natural gas and coal are used as feedstocks. The remaining 60% result from the release of potent greenhouse gases when these fertilizers are applied to fields (see figure 1).

Figure 1: The process for nitrogen fertilizer production and field-application, and associated emissions (Source: Gao et al. Nature Food 2023).

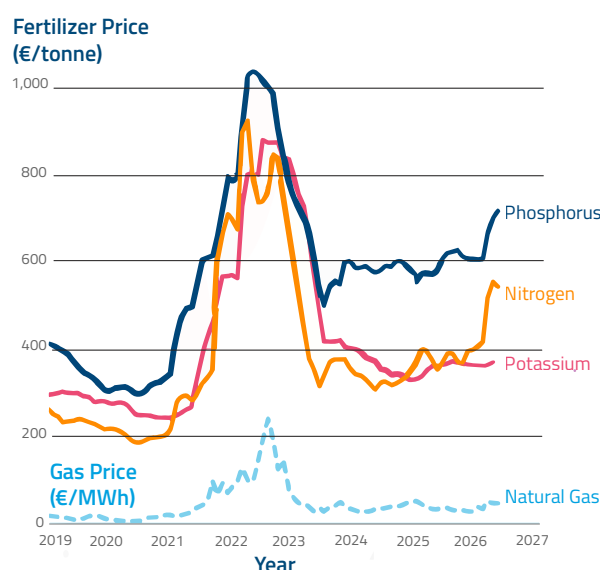


THE NATURAL GAS - FERTILIZER- FOOD NEXUS

Fertilizer and natural gas prices are closely correlated, which is unsurprising given that natural gas can account for up to 90% of the variable cost of ammonia production. Wholesale gas prices rose tenfold in 2022 and have since remained at around 40 EUR/MWh, approximately 160% above the average of 15 EUR/MWh before Russia's invasion of Ukraine (see figure 2). This has weakened fertilizer production capacity worldwide and driven up input costs for farmers.

Recent geopolitical developments have once again exposed the vulnerability of fertilizer supply chains to volatile natural gas markets. Decoupling fertilizer production from gas prices and shifting to abundant, clean, and affordable electricity is critical to food system resilience and long-term security of supply in both Europe and Africa.

Figure 2: Fertilizer and natural gas prices (Source: DG Agri Fertilizer Dashboard).



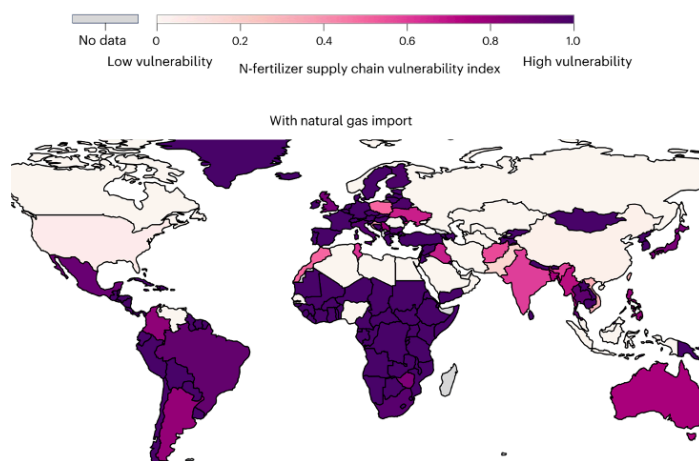
FERTILIZER TRADE BETWEEN AFRICA AND EUROPE

Currently, roughly 30% of nitrogen fertilizer consumption in the EU is imported. Approximately 70% of these imports come from three countries: Egypt (~30%), Russia (~30%) and Algeria (~10%). Most African countries also rely on fertilizer imports. Overall, African countries import over 60% of their fertilizers. This means that both the EU and Africa rank highly on "fertilizer vulnerability" indices (see figure 3), but the nature of their vulnerability differs: much of Africa lacks production capacity, while Europe retains production capacity but relies on imported natural gas.

- ▶ Africa faces a triple challenge: energy poverty (600 + million people lacking access to electricity); fertilizer dependency and price volatility; and growing food insecurity linked to climate change
- ▶ Food security impacts: Fertilizer price spikes directly reduce smallholder farmers' productivity
- ▶ Europe faces decarbonization pressures, high energy prices, energy security concerns, fertilizer production curtailment, and strategic supply chain vulnerabilities

Figure 3: Fertilizer vulnerability (Mingolla and Rosa, Nature Food 2025).

In both cases, clean fertilizer production depends on low-emission fertilizer production in regions with abundant, low-cost, clean electricity. This includes building domestic capacity and establishing partnerships with African countries that offer such production conditions. Several African countries, including Egypt, Namibia and South Africa, already have green hydrogen and green ammonia projects underway, with large-scale commercial production expected from around 2030.



LOW-EMISSION PRODUCTION METHODS

The incumbent pathways produce thousands of metric tons of nitrogen fertilizer per day in capital-intensive, long-lived plants. These facilities operate continuously, consuming natural gas (or coal) as both a feedstock and a heat source. Ammonia and nitric acid are the building blocks from which all synthetic nitrogen fertilizers are derived. Low-emission production hinges on producing these molecules sustainably through four broad routes:

► **Renewable hydrogen with flexible Haber-Bosch:** Hydrogen produced through water electrolysis is synthesized with nitrogen from the air in the Haber-Bosch process to form ammonia (Haber-Bosch is a high-temperature, high-pressure industrial process used to produce most of the world's ammonia).

► **Plasma-based route:** An electrically powered plasma fixes nitrogen from the air directly into nitric acid, bypassing the ammonia step entirely.

► **Electrochemical ammonia synthesis:** Nitrogen and water react directly in an electrochemical cell to produce ammonia, bypassing both hydrogen production and the Haber-Bosch step.

► **Carbon capture and storage:** Natural gas remains the feedstock, but electricity supplies the heat required for steam reforming, and the concentrated process carbon dioxide (CO₂) stream is captured.

AFRICA'S OPPORTUNITIES

► **Renewable resources, geography and cost:** Abundant solar (the Sahel, North Africa, Southern Africa); strong wind corridors (Horn of Africa, coastal regions); proximity to Europe; and existing port infrastructure in countries such as Morocco, Namibia, and Egypt. Low-cost solar could enable competitive green hydrogen production, with long-term potential to undercut fossil-based ammonia.

► **Green hydrogen and innovative fertilizers production can connect renewable energy with agricultural productivity,** making them strategic tools for advancing both energy access and food security.

RISKS AND REALITIES FOR AFRICA

► **Risk 1 - Export-only model:** Risk of repeating extractive patterns, with local communities excluded from value chains.

► **Risk 2 - Water stress:** Water demand from electrolysis and the need for desalination or careful basin management.

► **Risk 3 - Governance and equity:** Land use conflicts and infrastructure concentration near ports.

EUROPE'S OPPORTUNITIES

► **Technology transfer and joint innovation:** European leadership in electrolysis, low-emission fertilizer technologies, and plant engineering can drive partnerships and open new markets.

► **Affordable green ammonia:** Access to global markets and African producers with abundant renewable energy can help diversify supply away from volatile natural gas markets and support the decarbonization of European fertilizer production.

► **Developing a new fertilizer industry in the EU:** A diversified, resilient supply system could draw on multiple low-carbon nitrogen production pathways, including hydrogen-based ammonia and directly electrified solutions such as plasma-based fertilizer production.

► **Integrated clean fertilizer value chains:** Cooperation between Africa and Europe can combine local, low-cost renewable energy with clean fertilizer production technologies, investments, and markets, creating value chains that strengthen resilience in both regions, and incentivize trade in agricultural products.

RISKS AND REALITIES FOR EUROPE

► **Fragmented supply chain:** Dependence on imported ammonia or other critical inputs could create new vulnerabilities if supply chains are not diversified.

► **Scale-up risk and valley of death:** Without supportive regulation, new cleantech, such as innovative fertilizer production technologies, could face long development cycles, high capital expenditure (CAPEX), and financing difficulties due to limited commercial track records.

► **Cost gap:** Clean fertilizer remains more expensive than conventional production where clean electricity is costly.

POLICY RECOMMENDATIONS

Low-carbon production technologies are complementary rather than competing, and all depend on abundant, affordable, and clean electricity.

► **Accelerate the build-out of and access to affordable, clean, and reliable electricity:** Expand renewable generation, strengthen grids, increase storage, and ensure timely grid connections for early pilots.

► **Support innovation for clean and flexible synthetic nitrogen fertilizer production:** Provide dedicated R&D funding for new electrified production pathways, support pilot plants, and prioritize clean hydrogen for existing feedstock uses.

► **Create demand for low-carbon fertilizers:** In the short and medium term, low-carbon fertilizers will likely cost more than the fossil-based alternatives. Demand-side measures such as labeling low-carbon products, paired with incentives for end users, are therefore essential to help early projects reach commercial scale.

► **Move beyond offtake agreements:** Support local fertilizer production, provide blended finance for domestic value chains, and develop agro-industrial clusters and regional fertilizer hubs.

► **De-risk early investments:** Provide guarantees from the European Investment Bank, support for regulatory harmonization, and align standards for green certification.

► **Promote “dual-use” infrastructure and embed food security objectives in EU-Africa hydrogen partnerships:** Develop infrastructure that can support both hydrogen production and rural electrification, upgrade ports to serve local economies, and prioritize capacity-building and African institutional leadership.

► **Take a system-level view of nitrogen fertilizers:** Evaluate each lever (decarbonize and abate production; improve nutrient management and retain nitrogen and carbon in soils; reduce and shift demand; recover and substitute nutrient and carbon) at regional, national, and international levels, and sequence the levers so they reinforce each other.

Green hydrogen and innovative fertilizer production in Africa can either become a new extractive export sector or a catalyst for energy access, fertilizer sovereignty, and food security. In Europe, green hydrogen and innovative fertilizer production pathways can decouple agriculture from volatile markets and catalyze a new fertilizer industry. These outcomes will be shaped by policy choices made now – in Brussels, in African capitals, and between continents.

About the **UNU Vice-Rectorate in Europe (UNU-VIE)**

Since its foundation in 2007, UNU-VIE has actively engaged in UN processes, advocating science-based policy decision-making in key international events and fora and supporting UN priorities through cooperation with the Global South. Its frontier research spans foci such as the water-energy-food nexus, green innovation, digitalization/technology, and entrepreneurship. Acknowledging that collaboration and capacity development are central to fostering innovative solutions, UNU-VIE spearheads new initiatives and ideas that contribute to setting agenda, positively impacting humanity, and ensuring that no one is left behind. <http://unu.edu/vie>



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About **Future Cleantech Architects**

We are a climate innovation think tank dedicated to closing the innovation gaps in hard-to-abate sectors through research and development, and policy and advocacy. To this end, our experts conduct comprehensive, science-based analyses and modelling of these sectors and drive high-level research consortia on critical technologies. We advocate for policymakers to prioritize and incentivize research and development to accelerate technological solutions for transitioning to a sustainable net-zero future.



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