Policy Pathway Brief

Promoting Efficient Use and Greener Production of Fertilizers

AGRICULTURE POLICY DIALOGUE

Foreign, Commonwealth & Development Office

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Just Rural Transition

In brief

Agriculture and food systems are both drivers and victims of escalating climate and nature crises, in turn increasing the risks to healthy diets, livelihoods and economies. Public policies can set incentives for farming and market practices that further exacerbate these trends, but they can also play a role in reversing them. The global Agriculture Policy Dialogue on Transition to Sustainable Agriculture is a peer-to-peer platform to share experience, facilitate partnerships and catalyse policy leadership to accelerate the transition to sustainable agriculture and food systems that benefit people, prosperity and the planet.

Policy Pathway Briefs provide an overview of emerging experiences and lessons on policy approaches that contribute to this transition, covering a series of topics requested by Policy Dialogue members, to support peer leaning and knowledge exchange. The briefing notes are in no way exhaustive. The options facing governments will be context specific and look different across and within countries. The notes aim to act as a discussion starter and to facilitate exchanges between countries engaged in the Agriculture Policy Dialogue and with other global initiatives, drawing on the experiences presented by members and examples identified through further research.

This brief focuses on fertilizers and provides guidance on policy actions that can incentivize efficient and more sustainable use and production of synthetic fertilizers.

Key messages

- Synthetic fertilizers have played an important role in improving global food security: increased use of fertilizers has enabled crop yields to grow by 30–50%, supported by government policies to increase the availability and use of fertilizers, often through input subsidies.
- However, fertilizer use varies considerably across – and within – countries, with both underuse and overuse of synthetic nutrients. In some countries, inefficient fertilizer use has created negative climate and environmental impacts for farmers and other users of affected ecosystems, threatening further improvements in food security.
- This has been facilitated by government policy that tends to focus on fertilizer subsidies without policies that simultaneously encourage the other complementary interventions required to boost yields and reduce emissions and negative environmental effects.
- There are a range of technological and agroecological solutions that can be pursued to improve fertilizer use efficiency and decarbonize fertilizer supply, some of which are supported by long-standing practices, others which are more recent.
- These can be supported by repurposing public expenditure on agriculture away from blanket subsidies on fertilizer use and towards more targeted support that: rewards a shift towards more efficient fertilizer use and complementary agricultural practices; increases investment in research and extension services to support farmers; helps to decarbonize fertilizer production; and strengthens global cooperation on fertilizer use efficiency and environmental standards to reduce emissions and pollution without reducing yields.

Background

Increased use of synthetic fertilizers[i] has played a key role in improving food security over the past 100 years by rapidly increasing crop yields. By improving nutrient availability in soils, fertilizers have contributed to a 30–50% increase in crop yields, improving food security for billions (Stewart et al., 2005; Smil, 1999). Estimates show that almost half of the global population is sustained through increased production enabled using inorganic nitrogen fertilizers (Erisman et al., 2008). By 2050, worldwide use of synthetic nitrogen fertilizers is expected to increase by 50% from 2012 levels (FAO, 2017).

Government support for increasing fertilizer availability and use – including nutrient-specific subsidies – has enabled the use of such fertilizers. Input subsidy programmes have been a popular mechanism used by many governments to intensify fertilizer application to improve food security.

However, continuing current patterns of fertilizer use faces several challenges:

- The **uneven distribution of fertilizer use and need across the world:** some countries are applying fertilizers beyond the optimal amount and can therefore reduce fertilizer use without compromising on farmer incomes and food production.
    - Without more tailored use of appropriate nutrient blends or other measures to support soil health, using increasingly large amounts of fertilizers do not necessarily translate into a proportionate increase in yield over a sustained period (Damania et al., 2023). Long-term evidence from Malawi, for example, shows a substantial decline in maize yield response to fertilizers over time, as blanket subsidies did not incentivize efficient and tailored use of appropriate nutrients or provide complementary measures (Burke et al., 2022).
    - On the other hand, many poor countries are underusing fertilizers, which does not compensate for the loss of nutrients due to agricultural production and soil degradation. This keeps productivity low, undermines soil health and encourages expansion of the area under cultivation to produce more food (Ritchie et al. 2022).
- **Negative environmental impacts:** a combination of poorly targeted government subsidies, a lack of technical knowledge on proper use and insufficient access to technical advisory services encourages overuse or unbalanced application of fertilizers. Less than half of the 109 million tons of synthetic nitrogen applied to fields each year is absorbed by crops (Peoples et al., 2019). This leads to a series of negative environmental impacts:
    - **Soil degradation** and reduced soil health more broadly,[ii] which further diminishes the response rate of fertilizers and the ability of farmers to use them profitably.
    - **Deterioration of water quality** as excess fertilizer runs into rivers or leaches into water tables; and
    - **Greenhouse gas (GHG) emissions** from fertilizer production and low nutrient use efficiency in the field: fertilizer production and use account for around 5% of total global GHG emissions, around half of which are caused by direct and indirect nitrogen dioxide emissions from fields (IPCC, 2022), and one-third from production (Menegat et al., 2022; Gao and Serrenho, 2023; Naess-Schmidt, 2015).
- Recent shocks over the past few years, particularly the rises in oil prices and the war in Ukraine, have highlighted that **fertilizer production is highly concentrated**, making users vulnerable to short-term price and supply shocks.

Options to improve efficient and sustainable production and use of fertilizers

Across-the-board cuts in fertilizer application are neither feasible nor efficient and fertilizers have a role to play in bolstering food security. Without more access to and use of tailored blends of fertilizers, certain countries and regions, particularly in sub-Saharan Africa, will opt to increase agricultural production by expanding cropland, often leading to deforestation, or mining the soil beyond its regenerative capacity, causing degradation (Ritchie et al., 2022).

However, there are significant opportunities to incentivize fertilizer use efficiency, incorporate alternative sources of soil nutrition and decarbonize the fertilizer supply chain. This could help move farmers to a more sustainable trajectory of agricultural production, contributing to climate, nature and social goals.

Technical solutions

Improving nutrient use efficiency

There are a variety of readily available measures to enhance nutrient use efficiency, both long-standing and emerging, all of which need to be underpinned by information and technical support to farmers to change fertilizer application practices:

- Improve the precision of fertilizer application through the application of the 4 Rs (Johnstone and Bruulsema, 2014) – the right source of nutrients, at the right rate, at the right time and in the right place – or a site-specific nutrient management approach (Chivenge et al., 2022).
- Apply an integrated soil fertility management approach, including through digital tools (i.e., precision farming, soil maps and soil testing) such as integrated soil fertility management.[iii]
- Use of enhanced efficiency fertilizer technologies, such as nitrification inhibitors to reduce the risk of nitrogen loss through leaching and slow- and controlled-release fertilizer (Janke and Bell, 2023).
- A more circular approach focused on biological nitrogen fixation in the soil through intercropping or single planting with leguminous crops, and upscaling the use of organic fertilizers and biochar (Mukherji et al., 2023).

Decarbonizing fertilizer supply

Several approaches to decarbonizing fertilizer production are being considered (Batool and Wetzels, 2019; Ouikhalfan et al., 2022) focused on technological improvements or increasing the use of organic fertilizers and a circular economy approach between livestock and crop production:

- **Technological improvements**: substituting natural gas for hydrogen; improving energy efficiency in production plants; using carbon capture and storage for carbon dioxide emissions; and reducing nitrous oxide emissions during the production process by installing catalyst technology in existing and new nitric acid facilities (EPA, 2010). Several green ammonia production facilities are being planned or under construction, e.g., in Peru, South Africa, Egypt, Brazil and Australia. However, to be commercially viable, large quantities of cheap renewable energy supply must be available and the production of greener fertilizers is still very costly compared to conventional production using hydrocarbons.
- **Agroecological and circular approaches**, using locally produced, composted or fermented animal manure to complement synthetic fertilizer (Wellspring, 2023) or by increasing the use of by-products of fertilizer production, such as waste heat and

carbon dioxide for agricultural greenhouses, or biogas from fermented manure as a feedstock. A full-chain nitrogen use efficiency approach (Kanter et al., 2020) can impact nitrogen losses beyond the farm by including fertilizer producers and wastewater treatment companies. Biological products[iv] can supplement synthetic and organic fertilizers, and in some cases, can partially or fully replace them (Wellspring, 2023).

Policy solutions

While technical solutions are available to improve fertilizer use efficiency, government policies need to be aligned with this goal rather than incentivizing overuse and inequitable distribution. National governments can work domestically and internationally in five main areas to do this and improve both social and environmental outcomes:

- **Repurpose government support that encourages inefficient use of fertilizers:** government subsidies on fertilizers often result in overusing fertilizers or applying fertilizers that are not suited to specific soil conditions and are fiscally unsustainable in the long run, particularly if they are not combined with other interventions to underpin improved crop yields and boost crop responsiveness to fertilizer. To rectify this, governments can implement two complimentary interventions:
    - **Replace blanket subsidies on fertilizers with targeted support** via direct transfers that reward results, such as more sustainable agricultural practices and fertilizer use, soil health, etc.[v] In **Malawi,** the government is reforming the Agricultural Inputs Program to reduce funding on inorganic fertilizer subsidies and discussions are ongoing as how to redirect finance to rewarding farmers for soil health outcomes (Campbell et al., forthcoming).
    - **Increase investment in complementary public goods and services** to generate the necessary research and technology and then disseminate it to farmers through extension services. Starting with identifying areas with overuse and underuse of fertilizer, and soil types and conditions in specific areas, fertilizer support can be bundled with the necessary advisory services for tailored blends are appropriate to the soils and their effective use, improving soil testing systems to allow precision farming, improving the digital infrastructure to improve the extension system, and investing in infrastructure to improve access and reduce costs of fertilizers. Governments can also increase investment in research and development and field-testing of potential alternatives to current synthetic fertilizers, including slow-release and “smart” fertilizers, biologicals and microbials, and green ammonia production. This would address the significant gap in research and development that currently exists.
- **Scale up initiatives to increase access to and use of organic fertilizers, and a circular economy approach between livestock and crop production**, using locally produced, composted or fermented animal manure to complement synthetic fertilizer. The government of **Ghana** has intensified efforts to increase domestic production and uptake of organic fertilizer, using a combination of information (organic fertilizer guidelines, extension material and a repository of information for investors), financial support (negotiating with the EXIM Bank of India for funds to establish organic fertilizer plants) and communications to encourage farmers to use more organic fertilizer (online and radio programmes) (UN Sustainable Development Group, 2023; Nangara, 2022). The **European Union (EU)** promotes a circular economy and organic fertilizer through regulatory tools by incorporating organic fertilizers into existing guidelines on fertilizers, establishing product safety and quality requirements (European Parliament and Council, 2019); and funding via Horizon Europe (Horizon Europe, 2023), the EU’s key funding programme for research and innovation, which includes a focus on increasing

the availability and use of “non-contentious inputs” in organic farming, including manure and recycled nutrients.

- **Strengthen policy and regulatory frameworks to establish baseline expectations** to accelerate transformation of agricultural practices and ensure that quality parameters of fertilizer are defined and met. In **India**, the government made coating of urea with neem oil mandatory to slow nutrient release and improve its efficiency; although the technology had been available for many decades, the introduction of government regulation catalysed its uptake at farm level (Srinivasarao, 2021).
- **Boost efforts to decarbonize fertilizer production**, particularly through supporting energy efficiency in industrial production and promoting the use of more carbon-neutral sources of energy in the production process. Governments could also investigate the feasibility of supporting investment in smaller-scale, modular and localized green ammonia production presents various opportunities, particularly in areas that face challenges accessing traditional mineral fertilizer supply chains, provided that there is access to ample and reliable renewable energy and water (Wellspring, 2023).
- **Strengthen global cooperation on fertilizer-use efficiency and environmental standards** to reduce emissions and pollution without impacting on crop yields. If polluting countries increased their nitrogen use efficiency, nitrogen pollution could be reduced by around 35%, while increasing yield gaps[vi] by only 1% (Wuepper, 2020; Ritchie et al., 2022). As emissions from synthetic nitrogen fertilizers and pollution are highly concentrated in certain geographic areas (Menegat et al., 2022),[vii] attention could be focused on these countries, backed by financial support from the global community, as well as using existing international guidelines on effective fertilizer use, such as the International Code of Conduct for the Sustainable Use and Management of Fertilizers (FAO, 2019).

China's experience of promoting efficient fertilizer use

China’s experience (Ritchie et al., 2022; Cui et al., 2018) demonstrates that providing general services support tailored to specific site conditions can reduce inefficient fertilizer use without compromising yields. Between 2005 and 2015, researchers developed enhanced management practices for rice, wheat and maize, tailored to different agroecological zones in China, using an integrated soil–crop system programme. Researchers trained extension staff and agribusiness personnel to work participatively with farmers through field trials and created a national programme to transmit and monitor recommended practices. This provided high quality inputs and strengthened the technical and organizational capacity of farmers. As a result, nearly 21 million farmers adopted enhanced management practices, reducing nitrogen application by up to 18% and nitrogen losses by almost 35% while average yields rose by up to 11.5%, and grain output expanded by 33 million tons, generating additional farmer income of $12.2 billion, compared to direct programme costs of $454 million. GHG emissions from nitrogen use, manufacture and transport, and diesel use in farming operations fell by up to 13.2%.

Process considerations

Policymakers would need to assess conditions for accelerating and scaling up initiatives to increase fertilizer use efficiency or reduce synthetic fertilizer use by using alternatives in each context, and the time needed to set up systems, establish infrastructure, understand incentives and manage the transition. The experience of Sri Lanka's decision to rapidly ban imports of synthetic fertilizers stands as a cautionary tale.

Policy Dialogue discussions acknowledge that a transition to low-emission, climate-resilient agriculture practices needs to centre on people and engage stakeholders at all stages. This recognizes that stakeholders have vested interests, may have a significant stake in existing agriculture production systems or stand to lose from changes in the short term. It is important to engage stakeholders in policy design – rather than imposing policy on them – to ensure that proposals are feasible, take account of risk appetite and support equitable change through the transition to more sustainable practices that benefit everyone.

In fertilizer production and use, the key stakeholders that need to be engaged by governments are farmers, fertilizer companies and civil society. There are strong and entrenched positions both for and against synthetic fertilizer use across these groups which need to be navigated.

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Endnotes

[i] Also called inorganic or mineral fertilizers. In the rest of the brief, we refer simply to “fertilizers” for synthetic fertilizers.

[ii] See Soil Health Policy Brief for more information.

[iii] See Integrated Soil Fertility Management (IFDC).

[iv] Naturally derived substances and living organisms that can help optimize nutrient uptake and use (Wellspring, 2023).

[v] See Policy Brief on Payment for Ecosystem Services for more information on how this can work.

[vi] The amount that yields could be increased with better management of nutrients.

[vii] In terms of total volumes, the biggest emitters are China, India, North America and Europe. On a per capita basis, the biggest emitters are the major agricultural export countries of North America, South America, Europe and Australia and New Zealand (Menegat et al., 2022).

Please contact jrt@merid.org with any questions about this brief.

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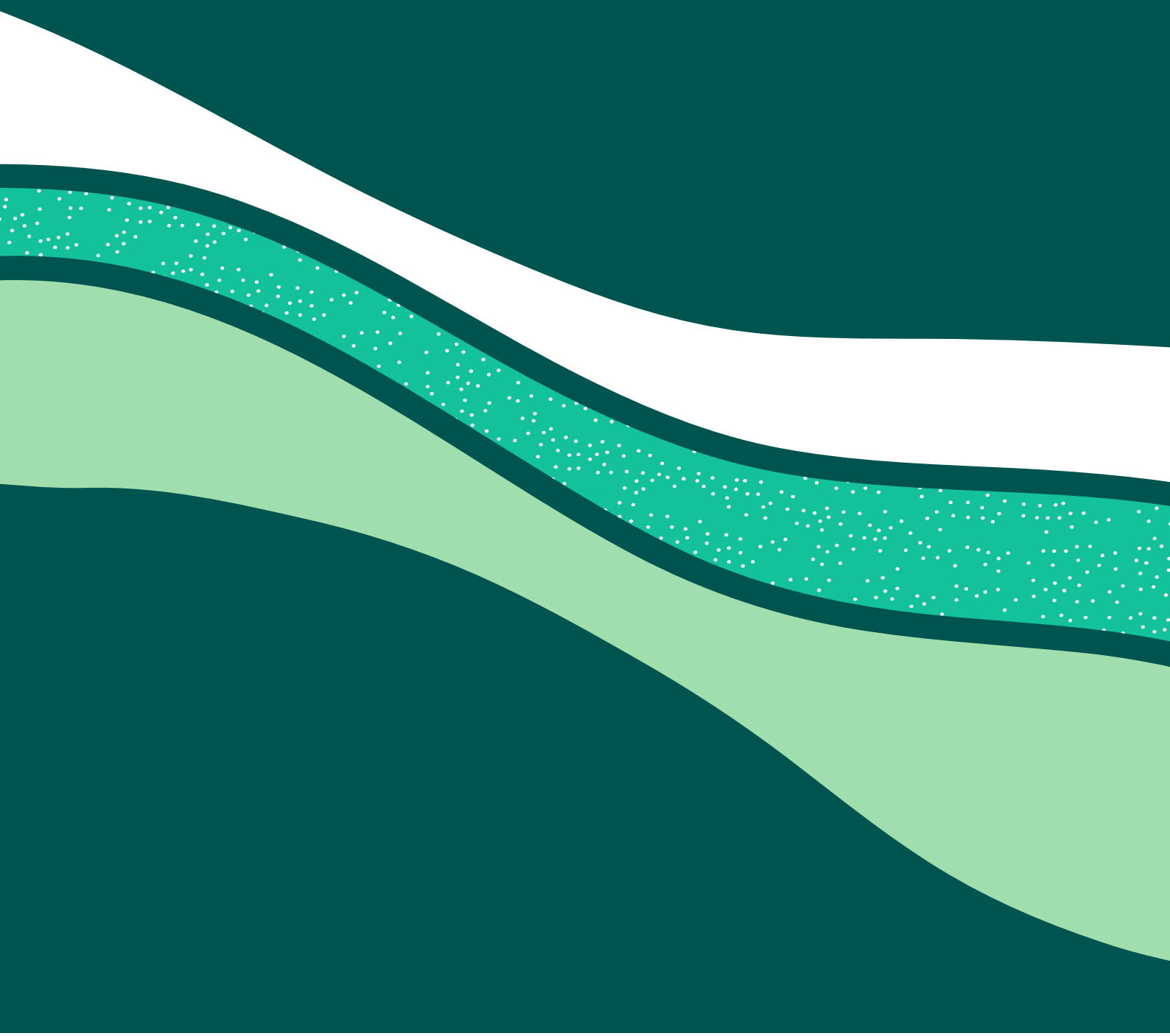

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