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Resilient Agriculture on the African Continent: The Proof will be in the Soil

Recommendations on fossil fuel-based and «green» fertilizer production and use in Africa

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Resilient Agriculture on the African Continent: The Proof will be in the Soil

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Content

Introduction

The adoption of the African Union's 10-year African Fertilizer and Soil Health Action Plan (AFSHAP) is an important step in fostering more resilient and sustainable ecological and economic systems on the continent. As the document's title suggests, the plan recognizes that healthy soils are the cornerstone of productive agricultural systems, and are essential to safeguarding fresh water sources and preserving biodiversity.

This comes at an important moment. Not only is the devastating impact of climate change on the continent abundantly clear, it is accompanied by a growing recognition that global warming is not the only ecological crisis we face. In fact, it is only one of six planetary boundaries that were globally crossed in 2023.[1] Economic hardships and inequality are also growing problems, not only in low or middle-income countries, but increasingly within wealthy ones,[2] fueling political instability and polarization.

It is in this context that Africa must find pathways to provide a better life for its people, including access to healthy and sustainably produced food. The situation is dire, with sixty percent of the world's extremely poor populations living on the continent.[3] In 2022, the number of people facing hunger in Africa increased by 57 million, as compared to pre-pandemic times, consequently affecting almost twenty percent of the population.[4] As if not daunting enough, these formidable challenges will have to be resolved in increasingly volatile ecological and political climates. Tackling them will require brave choices that draw on the continent's rich indigenous knowledge and biodiversity, combined with lessons and technology from other parts of the world, while leapfrogging the destructive development models of the 20th century.

The AFSHAP does provide an opening for taking courageous action by recognizing that while fertilizer application has a role to play in increasing productivity, the global understanding of sustainable agriculture has moved beyond a narrow focus on crop productivity and profitability to take into account the broader context of social, environmental, and economic sustainability.[5]

1 See Stockholm Resilience Centre (2023): *https://www.stockholmresilience.org/research/planetary-boundaries.html*
2 See for example Council of Europe (2024): *https://www.coe.int/en/web/portal/-/germany-follow-through-with-human-rights-commitments-and-improve-access-to-social-rights*
3 See World Bank (2023): *https://blogs.worldbank.org/en/africacan/africa-still-can-call-create-more-and-better-jobs-end-poverty*
4 See FAO (2023): *https://www.fao.org/documents/card/en?details=cc3017en*
5 See African Union: *https://au.int/sites/default/files/newsevents/workingdocuments/43470-wd-2._EN_Africa_Fertilizer_and_Soil_Health_Action_Plan_VI_170523.pdf*

AFSHAP will be able to make a valuable contribution to the agricultural policy landscape only if its implementation avoids aggressively and indiscriminately pushing fertilizer uptake. To understand why, this policy brief takes a closer look at the role of synthetic fertilizers in African food systems. It argues that we urgently need to phase out fossil fuel-based nitrogen fertilizer. It also argues that while there is a role for ‹green› synthetic fertilizers (renewable hydrogen-based fertilizers) from a decarbonization perspective, their use is justified only as a means of facilitating a transition to agroecological methods[6] that improve long-term soil health and avoid the costly ecological destruction caused by excessive fertilizer use. For further details on the importance of soil health in Africa please read this *background paper*.

6 According to FAO, agroecology is «a holistic and integrated approach that simultaneously applies ecological and social concepts and principles to the design and management of sustainable agriculture and food systems». See: *https://www.fao.org/agroecology/overview/en*

1. Context: Synthetic Fertilizers in Africa

In the 20th century, the Haber-Bosch process or ammonia synthesis enabled a dramatic increase in crop yields in many parts of the world. However, artificial fertilizer use remained low on the African continent. Since the early 2000s however, the increase in the use of synthetic fertilizers in agriculture across the African continent has been a key element for implementing the so-called African green revolution. The most crucial agreement was the Abuja Declaration of 2006, in which member states of the African Union agreed to increase fertilizer use to an average of 50 kilograms per hectare. Consequently, at least 10 African countries subsidized the supply of artificial fertilizers, spending large shares of their agricultural budgets on this area of financial support for farmers. A key player in this wave of support for synthetic fertilizer use was – and still is – the Alliance for a Green Revolution in Africa (AGRA), founded by the Bill and Melinda Gates Foundation and the Rockefeller Foundation, collaborating closely both with African states and multinational agricultural corporations like the Norwegian nitrogen fertilizer producer, Yara.

Terminology

Organic fertilizers are based on living organic matter, including manure (from cows, sheep, poultry or horses), bonemeal, bloodmeal, compost and green manures.

Biofertilizers are organic fertilizers from biological animal or plant sources that contain micro-organisms which improve the soil fertility by fixing atmospheric nitrogen, solubilizing phosphorus or decomposing organic wastes.

Inorganic fertilizers are made from non-living sources. They can be divided into *mineral fertilizers* based on mineral resources like rock phosphate or potassium salt and *synthetic, chemical or artificial fertilizers* that are produced synthetically. An example for the latter would be synthetic nitrogen fertilizer manufactured by combining fossil gas with nitrogen from the air.

Please note: The African Fertilizer and Soil Health Action Plan seems to include fossil fuel-based synthetic fertilizer in its definition of «organic fertilizer». This is in contradiction with the widespread use of the term and should be corrected.

2. Fossil Fuel-Based Synthetic Fertilizers: Not compatible with net zero by 2050

As efforts to mitigate climate change intensify, the fertilizer industry, and particularly nitrogen fertilizer producers, have come under increasing pressure to take accountability for the carbon footprint of their product. The life cycle of nitrogen fertilizer production accounts for more than 2 percent of global greenhouse gas emissions.[7] This is due to the energy intensive Haber-Bosch process; the methane emissions associated with extracting, processing, and transporting the fossil gas that is the primary feedstock for fertilizer production; as well as the emission of nitrous oxide during and after application. Investment in fossil fuel-based fertilizer production on the continent will exacerbate climate change – to which the African continent is the most vulnerable – while contributing to the expansion of oil and gas extraction, which has proven devastating to ecosystems, in particular soil health.

In response, the fertilizer industry is investing in the development of so-called ‹green fertilizer›, where renewable energy is used to generate ‹green› or ‹renewable hydrogen›, which in turn is used to produce ‹green› ammonia. Yara claims these fertilizers have a 75-90 percent lower carbon footprint, in comparison to the same fertilizers made with fossil gas.[8] Donor countries have already begun investing in initiatives to produce ‹green hydrogen›-based fertilizer in Africa. For example, the German Federal Ministry for Economic Affairs and Climate Action is supporting an international hub in Kenya to explore the potential of the industrial production of «hydrogen as a commodity to produce ammonia-based fertilizers».[9] Such investments are being seen not only as an opportunity for the continent to become more self-sustaining in terms of fertilizer access, but also as opportunities for ‹moving up› value chains based on the continent's renewable energy resources, and the implied job creation associated with it.

However, so called ‹green fertilizers› also pose major risks and challenges. These cannot be ignored if the continent intends on taking a path that recognises the importance of looking beyond short-term gains in order to achieve resilient and sustainable agriculture systems.

7 See Menegat, S. / Ledo, A. / Tirado, R. (2022): *https://www.nature.com/articles/s41598-022-18773-w*

8 See Yara (2024): *https://www.yara.com/sustainability/transforming-food-system/green-fertilizers*

9 See PtX Hub (2024): *https://ptx-hub.org/kenya*

3. ‹Green› Fertilizer: The Risks

3.1 Threats to existing rural livelihoods

Before producing ‹green ammonia› and ‹green fertilizer›, ‹green hydrogen› needs to be produced. The main problem regarding the production of ‹green hydrogen› is that it requires large areas of land – for example, for photovoltaic systems or wind farms – and a large quantity of water. As the AFSHAP recognizes, insecure land tenure is one of the drivers of insufficient soil protection, as farmers are dis-incentivized from considering long-term sustainability. The AFSHAP directly calls for strengthening security of land use rights and tenure, to encourage land users to adopt soil health restoration practices.[10] Insecure access to water has similar impacts. It is a challenge faced by many food producers across the continent and is likely to worsen as climate change accelerates. While ‹green hydrogen› production could rely on desalination, thereby protecting existing freshwater sources from increasing competition, the concentrated brine that results from the process, can harm marine life if dumped back into the sea in an unregulated manner. In other words, if the production of ‹green hydrogen›, ammonia and fertilizer are not properly managed, and lead to land and fresh water grabs or aquatic ‹dead-zones›, they could threaten the livelihoods of farmers, pastoralists and fisher folk. While these threats can all be managed, their regulation requires strong governance institutions, which may not be operational in many of the countries and regions on the continent.

3.2 Excess nitrogen, climate change and algal blooms

When nitrogen fertilizer – whether it be fossil fuel-based or ‹green› fertilizer – is applied to agricultural fields, usually only some of the nitrogen is fixed in the plants and soil. A portion of the excess nitrogen is emitted as nitrous oxide – a greenhouse gas 300 times more potent than CO_2. Nitrous oxide can also be emitted when applying organic fertilizer, such as animal manure.[11]

Excess nitrogen can also cause overstimulation of growth in aquatic plants and algae (known as algal blooms), which in turn, can clog water inlets, use up oxygen while

10 See African Union (2023): *https://au.int/sites/default/files/newsevents/workingdocuments/43470-wd-2._EN_Africa_Fertilizer_and_Soil_Health_Action_Plan_VI_170523.pdf*

11 A recent meta-analysis came to the conclusion that using organic fertilizers instead of chemical fertilizers significantly decreases nitrous oxide emissions but, on the other hand, increases global warming potential by enhancing methane and carbon dioxide emissions, particularly in the case of paddy fields. See Zijian et al. (2023): *https://www.sciencedirect.com/science/article/abs/pii/S0048969723055420* decomposing, and block light to deeper waters. Excessive nitrogen in drinking water can cause cancers, reproductive problems, hypothyroidism and other serious conditions.

In 2023, leading environmental scientists studied different planetary boundaries, nitrogen being one of them. They concluded that nitrogen is one of the six (out of nine) planetary boundaries that have already been transgressed globally, meaning that more nitrogen is applied to the agricultural system than plants and soils can absorb. The level of transgression in the case of nitrogen is already in the high-risk zone.[12]

Many experts are rightly concerned that in soils with nitrogen deficiency, crops are taking up too much nitrogen from soils, causing or accelerating soil degradation. Therefore, their response is to advocate for increasing synthetic fertilizer use. However, given the various risks outlined in this brief, we argue that ‹green› synthetic fertilizers should only be used for an interim measure in situations where nitrogen is deficient and where no organic options are available. If ‹green› fertilizer is used, it must be embedded in a long-term soil health and nitrogen use strategy, avoiding lock-ins and dependencies, whether agricultural or economic.

While the AFSHAP emphasizes the importance of efficient and sustainable use of mineral and organic fertilizers, there is a real risk that those aspects of the plan will not be financed, while the production of synthetic fertilizer – ‹green› or otherwise – will be supported, given its hypothetical profitability. Moreover, much of the fertilizer management actions proposed in the AFSHAP would require significant capital investment in high tech tools. It is neither clear how small-scale farmers would have access to this technology, nor how African governments would finance them.

3.3 Long term soil health

Synthetic nitrogen fertilizers based on ammonia dramatically accelerate soil acidification. Among other problems, soils that are particularly acidic are less able to absorb phosphorus. This poses a major problem because phosphorus is a critical and non-substitutable resource. Regarding soil biodiversity, it has been proven that intensive fertilization and the use of chemical pesticides result in a decrease in the diversity and number of soil microorganisms. Without a healthy microbial community, plants are unable to access essential nutrients, resulting in increased risk of pests and diseases, and the production of poor quality fruit and vegetables. For more detailed information on the long-term effects of mineral fertilizer application on soils please read our *background paper*.

12 See Katherine Richardson et al. (2023): *https://www.science.org/doi/10.1126/sciadv.adh2458?adobe_mc=MCMID%3D80764956213155347304590268907628024714%7CMCORGID%3D242B6472541199F70A4C98A6%2540AdobeOrg%7CTS%3D1694526267*

4. Questioning the Correlation Between Nitrogen Fertilizer Application and Food Security

A key ambition of the AFSHAP is to reduce hunger and malnutrition. However, it should be noted that the correlation between nitrogen fertilizer application and food security is not clear cut. In 10 out of 13 AGRA countries in which the use of synthetic fertilizers was promoted particularly strongly since 2006, the number of undernourished people actually increased between 2004-2006 and 2016-2018 – from a total of 100.5 million to 131.3 million people.[13] The reason is that higher agricultural productivity in certain crops does not automatically result in improved access to food – political conflict, food waste, food affordability, and other factors are critically important in addressing hunger and malnutrition.

The political economy of food systems, i.e. who has access to land and water, what food is produced, and for whom, significantly impacts food security, as shown by ongoing hunger in regions that grow food for export. Zambia, for example, has the highest fertilizer use in Sub-Saharan Africa, with a five-year average of 65 kilograms per hectare,[14] and is one of the six African countries with the highest per-hectare yields for cereals.[15] Nevertheless, Zambia ranks at the bottom of the 2022 Global Hunger Index and malnutrition is considered a major problem in the country.[16] The industrial cultivation of maize and soy in Zambia does not contribute to food security, in part, because development policies often follow a commercial value chain approach, particularly by promoting soybean cultivation as a flexible crop with multiple (also non-food) uses, instead of strengthening local markets and alternative supply chains.

There are other reasons that increasing yield productivity is important – economic development is one. However, again, it should be noted that the enormous agricultural productivity increases seen in Asia as a result of the ‹green revolution› would not have happened in the absence of well established irrigation systems and transport infrastructure such as India's railway lines. While it is important that these are developed on the continent, the intensification of fertilizer use without these critical infrastructures is unlikely to yield similar results, and may result only in overuse of fertilizer.

13 See BIBA Kenya et al. (2020): *https://www.rosalux.de/fileadmin/rls_uploads/pdfs/Studien/False_Promises_AGRA_en.pdf*

14 See FAO (2020): *https://data.apps.fao.org/catalog/dataset/fertilizer-consumption*

15 See The Global Economy / FAO (2021): *https://de.theglobaleconomy.com/rankings/cereal_yield*

16 See Welthungerhilfe (2022): *www.welthungerhilfe.de/aktuelles/publikation/detail/welthunger-index-2022*

5. Recommendations for Strengthening Soil Health on the Continent

As noted above, the AFSHAP is an important step in restoring and building healthy soils and resilient food systems on the continent. However, if it is to achieve its goals and avoid the costly ecological mistakes of the 20th century, the plan must ensure that:

a. Fossil fuel-based nitrogen fertilizers are completely phased out. Investments in fossil fuel-based fertilizer production on the continent should be strongly discouraged.

b. ‹Green hydrogen›-based nitrogen fertilizers should only be used for limited periods in nitrogen deficient situations, if at all, with the aim of avoiding the lock-ins and dependencies that result from synthetic fertilizer use. Investments in ‹green fertilizer› production must adhere to strict sustainability criteria that prevent land-grabbing, irresponsible disposal of brine and detrimental impact on water-stressed regions. Moreover, ‹green hydrogen› investments should not be based on the assumption that synthetic fertilizer use will underpin the continent's future agricultural systems.

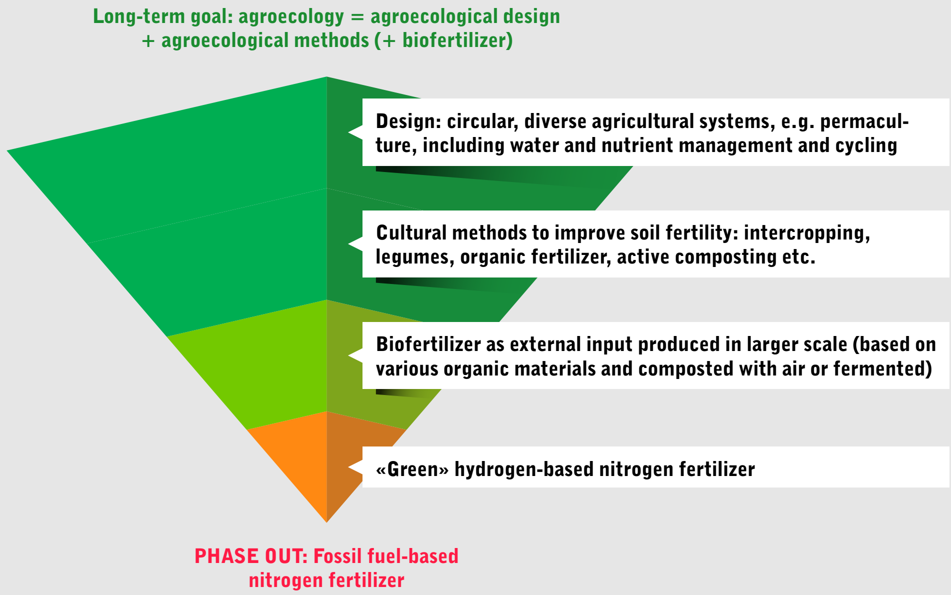
c. The use of biofertilizers and cultural methods to improve soil fertility must be prioritized.

d. In the medium-term, agricultural design must shift towards diversified agricultural systems.

While biofertilizers and agroecological cultural methods can and should be implemented immediately, including on conventional farms, the long-term goal should be agroecological farming as a holistic concept, meaning the combination of circular design and agroecological methods.

A visual representation of the continent's path towards soil health:
The foundations of a sustainable agricultural system are the methods at the base of the pyramid, while methods higher up should be limited or phased out completely.

Fig. 1: The role of «green» fertilizer on the path towards resilient agriculture



Source: Own illustration

5.1 Recommendations for African Union members:

a. If the AFSHAP is serious about mitigating agriculture- and fertilizer-related contributions to climate change› and facilitating climate adaptation, it must focus on phasing out fossil fuel-based fertilizers, rather than condoning the continuation or expansion of these products.

b. Phase out subsidies for synthetic fertilizer and use farm input subsidy programs (FISP) and similar subsidy systems to improve knowledge and local production, as well as access to agroecological practices and organic inputs.

c. Invest in training and infrastructure to support local production of biofertilizers based on locally available organic matter and locally sourced micro-organisms, including mycorrhizal fungi, algae and bacteria.

d. Encourage and demand chemical fertilizer companies to pursue and diversify into production of biofertilizers, investing in long-term soil health. End partnerships with those companies that refuse to do so.

e. Support extension services that promote agroecological methods. These should include approaches that improve soil health by designing diverse agricultural systems, such as including intercropping and integration of legumes.

f. Revise the AFSHAP so that it clearly differentiates between organic and synthetic fertilizers (see box above).

g. Revise the AFSHAP to prioritize and incentivize the use of organic fertilizer alongside agroecological design and other agroecological practices (see illustration). Recommended approaches should be geared towards long-term soil health, as well as farmers› independence from external inputs, which are often expensive.

5.2 Recommendations for donors:

a. In development cooperation initiatives, prioritize research on locally adapted agroecological methods to improve soil health, and extension services that promote agroecological and indigenous agricultural methods.

b. End partnerships with chemical fertilizer companies that pursue the goal of increasing synthetic fertilizer use, thereby disrupting long-term soil health.

c. Limit support to ‹green hydrogen›-based ammonia or fertilizer to specific and well defined conditions of high nitrogen deficiencies where no organic options are available.

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