

Fertilizer nutrient imbalance to limit food production in Africa

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Underuse of phosphorus-based fertilizers in Africa currently contributes to a growing yield gap—the difference between how much crops could produce in ideal circumstances compared to actual yields. This phosphorus-specific yield gap currently lies at around 10% for subsistence farmers, but will grow to 27% by 2050 if current trends continue, according to a study published today in the journal *Global Change Biology*.

"This research shows that the imbalance between nitrogen and phosphorus applications has the potential to further limit food production for a growing population in Africa" says Marijn van der Velde, a researcher now at the Joint Research Centre of the European Commission, who led the study while working at IIASA.

While nitrogen-based fertilizers can be produced by a process that extracts the element from the air, phosphorus must be mined from rock—and reserves are limited. That makes phosphorus fertilizers expensive, especially in the longer term.

"Farmers with limited money are more likely to buy and have access to cheaper nitrogen-based fertilizers," says van der Velde. "While this might work in the short term, in the longer term it has a negative effect on crop growth as soil nutrients become more imbalanced."

As farmers use fertilizers for their [crops](#), nutrients such as nitrogen and phosphorus build up in the soil, providing a reserve of nutrients that plants need to grow. But fertilizer use remains very low in Africa, and to increase crop production, it is widely recognized that farmers must increase their fertilizer use. And while nitrogen-based fertilizer usage has begun to increase in Africa in the last 10 years, the application of phosphorus to cropland has not kept pace, leading to a growing imbalance between nitrogen and phosphorus levels in soil. The new study shows that increases in nitrogen and phosphorus inputs must happen in

a way that provides crops with the balanced nutrient input they need.

The study used data from Food and Agriculture Organization (FAO) crop trials as well as an established EPIC large-scale crop model to estimate how the imbalance affects current and future crop yields.

"Previous research has looked at these effects on a field and local scale, but this is the first study to do so at the continental scale," says IIASA researcher Christian Folberth, who also worked on the study.

In order to make optimal use of current nitrogen inputs, the researchers estimated that phosphorus applications would need to increase 2.3-fold. To close yield gaps nitrogen applications would have to increase 5-fold. Phosphorus applications would have to increase nearly 12-fold from 2.2 to 25.9 kg per hectare.

But because of the cost of phosphorus, that remains a challenge. "While much of the remaining phosphorus reserves are found in Morocco, on the African continent, we need to find better ways for African farmers to access this precious resource" says van der Velde.

The global phosphorus cycle is, besides nitrogen, also increasingly growing out of balance with carbon, the subject of another recent paper by the same group of researchers and a new European Research Council grant for continued research by IIASA and an international team of scientists.

"The change in the stoichiometry of [nitrogen](#) and carbon from rising atmospheric CO₂ concentrations relative to [phosphorus](#) has no equivalent in the Earth's history and the impacts will go beyond the agricultural sector." says van der Velde.

More information: Van der Velde M, Folberth C, et. al. (2013). African crop yield reductions due to

increasingly unbalanced Nitrogen and Phosphorus consumption. *Global Change Biology* DOI: [10.1111/gcb.12481](https://doi.org/10.1111/gcb.12481)

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