

First-of-its-kind database tracks agricultural phosphorus use world-wide

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Researchers from the University of Maryland Center for Environmental Science have released a first-of-its-kind study quantifying cropland phosphorus budgets around the world, which will help in identifying

nutrient management gaps in different regions in food production and consumption systems. This new database will help countries and regions to evaluate their performances in addressing phosphorus pollution and scarcity challenges, and guide actions towards a more sustainable future.

"To address these management challenges, it is critical to use [phosphorus](#) more efficiently in agriculture," said lead study author Tan Zou.

"Knowing these gaps and potential drivers can help to guide the development and implementation of best management practices, such as soil testing and specialized fertilizers that are better absorbed by crops."

Phosphorus is an essential nutrient for crops and living organisms, but excess phosphorus running off of [agricultural fields](#) and into bodies of water has led to harmful algal blooms and low oxygen zones that are detrimental to aquatic ecosystems. Poor nutrient management can lead to nutrient waste, loss, or shortage, resulting in social and [environmental problems](#) such as [environmental pollution](#) and crop yield reduction.

"The dominant global challenge is to enhance crop yield while bringing human disturbance of phosphorus cycles back to the planetary boundary," said Zou. "This could be achieved by developing and implementing more efficient nutrient management practices and allocating production and input resources to regions with higher phosphorus use efficiency levels."

While many efforts have been devoted to improving nutrient management practices on farms, few studies have examined the historical trends of phosphorus use efficiency (PUE) and their socioeconomic and agronomic drivers on a national scale. This is the first study to present a unique database of agricultural phosphorus budgets and phosphorus use efficiency by country, year, and crop type, examining the significant contribution of several socioeconomic drivers and discussing phosphorus management challenges and opportunities in

croplands by country.

Phosphorus management challenges and opportunities in croplands vary widely among [countries](#) and are related to multiple socioeconomic and agronomic factors, such as economic development stage, nitrogen use efficiency, and farm size. Recent levels of phosphorus loss from cropland have exceeded a proposed planetary boundary, highlighting the need for more efficient use of phosphorus fertilizer in order to reduce the environmental damage of phosphorus while securing future food supplies. To meet the predicted food demand in 2050, while bringing the phosphorus surplus level below the planetary boundary, global phosphorus use efficiency needs to be improved to about 70-80%.

"While nutrient management practices are typically carried out on farms, decisions by stakeholders along the food supply chain largely determine which crops are being produced and how much is lost from the farm to the fork," said co-author and UMCES Professor Eric Davidson.

The challenge of phosphorus scarcity is more concerning for countries that have very limited reserves, such as India and Mexico. All countries that rely upon imported fertilizers need to consider their vulnerability to geopolitical events, such as those in Ukraine today, that could affect fertilizer and food trade and identify alternative sources.

"The price of phosphorus and nitrogen fertilizer is at an all-time high, potentially exacerbating the 'too much, too little' dilemma. While part of the world is applying 'too much' nutrient fertilizers causing pollution, the other part of the world is struggling with the lack of accessible and affordable fertilizer to support the production of basic nutrition needs by the population. Addressing such dilemma is essential for achieving Sustainable Development Goals and requires collaboration across countries," said co-author and UMCES Associate Professor Xin Zhang.

By examining historical trajectories of phosphorus budgets for crop production by country and crop type in the past five decades, this work demonstrates a common trajectory of phosphorus use efficiency as countries develop their economies and intensify crop production. This study fills those research gaps in phosphorus use efficiency studies to inform policymaking for tackling the challenges that come with [phosphorus pollution](#) and scarcity.

"Global Trends of Cropland Phosphorus Use and Sustainability Challenges" was published in *Nature* by Tan Zou, Xin Zhang, and Eric Davidson of the University of Maryland Center for Environmental Science.

More information: Xin Zhang, Global trends of cropland phosphorus use and sustainability challenges, *Nature* (2022). [DOI: 10.1038/s41586-022-05220-z](#).
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