Fostering a sustainable use of phosphorus

July 28 2020

Credit: CC0 Public Domain

Phosphorus is critical to food security, ecosystem functioning, and human activities. Urbanization and dietary changes, and in particular industrial use of P for chemical fertilizer production, have led to a declining trend, especially in recent decades. A study published in *Nature Food* provides some suggestions on how to address this critical

issue while protecting food security.

Approximately 90% of global phosphate rock demand is for food production. Access to P is put under pressure by population growth, limited P recycling and reuse, and finite P mining resources. In addition to access, the network resilience of P cycling (that is, a system attribute that ensures continuous access of P within the network and is critical for sustainable P management) is vulnerable to socio-environmental shocks and disturbances. To eradicate hunger and achieve food security, it is essential to better understand the metabolic network of P flows.

A study recently published on *Nature Food* evaluates the evolution of the resilience of the P cycling network in China over four centuries (1600-2012), as well as its underlying determinants. "Our results reveal that, in the most recent decades, the network resilience of the P cycling in China has declined," says Ali Kharrazi, CMCC researcher at the Economic Analysis of Climate Impacts and Policy Division. Dr. Kharrazi is a Marie Curie Research Fellow at Ca' Foscari University and CMCC Foundation Euro-Mediterranean Center on Climate Change in Venice, Italy; his research focuses on examining the resilience of food trade networks under climate change.

He says, "The key factors underlying this trend include the growth of food demand and the changes of the food structure from a modest, mostly vegetarian-based diet to a more complex diet (that is, more animal-based foods with higher P content). This is because after the year 2000, urbanization accelerated in China and higher living standards were adopted. Should this trend persist, China's food security shall be increasingly vulnerable to P availability under socio-environmental shocks and disturbances to its P cycling network. Moreover, the P declining trend observed in China it's definitely a global trend."

The resilience of the P cycling network is influenced by human food

demand/fertilizer P proportion: to meet this demand, the animal husbandry and aquaculture sectors expanded their production, subsequently increasing the demand for agricultural products such as grains and beans and P fertilizer use in the cultivation sector.

So, how can food systems satisfy the increasing food demand and guarantee sustainable development? The authors tried to give some suggestions to increase the resilience of the P cycling network while guaranteeing food security.

The first suggestion is to reduce food loss and food waste. The second one, to improve the farm-to-fork efficiency (that is, P productivity) in food supply chains. Possible measures in this avenue include setting guidance limits and standards for P fertilizer use, promoting advanced technologies to reduce food loss during food processing, and reducing food waste through education and public awareness campaigns.

The third suggestion is to reduce fertilizer use. A potential measure to achieve this is developing technologies to enhance fertilizer use efficiency.

Approaches to increase fertilizer use efficiency range from high-tech solutions (for example, precision agriculture like hydroponics) to organic farming techniques aimed at optimizing soil conditions to increase the P availability of soil. Other approaches focus on the addition of microbial inoculants to increase the P availability of soil. An obstacle in spreading these approaches is the fact that poorest countries in the world may be not able to adopt these options because they don't have the necessary know-how.

An alternative for decreasing the proportion of mineral P fertilizer use is to increase the P recycling rate: there are lots of other measures to recover and reuse P, such as plowing crop residues back into the soil;

composting food waste; and P recovery from sewage sludge, steelmaking slags and wastewater.

"P geographical distribution and availability is very limited," Kharrazi explains. "It is, in fact, located in few countries, such as Morocco, Australia and China; other countries, and especially European countries, don't have great stocks of P and import this key chemical element from other countries. Another problem is that P is not adequately recycled: We use an increasing amount of fertilizers in the agricultural sector, but all the data indicate that the current P cycling network is actually a one-way journey, where the majority of the P is directly deposited in the soil or discharged in solid wastes and water bodies, causing critical environmental problems such as algae blooms and eutrophication. We should not only rely on P rocks to maintain the high efficiency of P cycling, but also improve the network resilience through P recycling and P productivity improvement in food supply chains. In our study, we proposed some ideas to solve this well-known, critical issue."

More information: Sai Liang et al, Network resilience of phosphorus cycling in China has shifted by natural flows, fertilizer use and dietary transitions between 1600 and 2012, *Nature Food* (2020). DOI: 10.1038/s43016-020-0098-6

Provided by Euro-Mediterranean Center on Climate Change