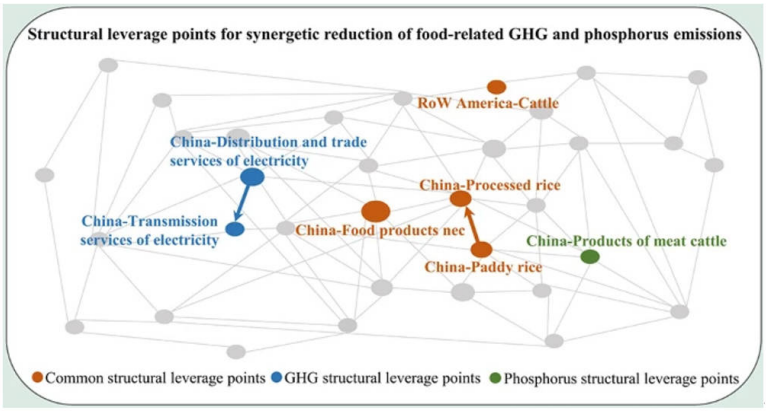
Food supply chains hold hidden leverage for cutting greenhouse gas and phosphorus together

GA, UNITED STATES, September 11, 2026 /EINPresswire.com/ -- Rising global food demand is loading the planet with two very different pollutants: greenhouse gases that warm the climate and phosphorus that chokes rivers and oceans with algal blooms. New research shows that the most powerful lever to cut both may sit right in the middle of the supply chain — not on farms or at dinner tables, but inside food processing plants. By mapping how these emissions travel through global economic networks, the study pinpoints specific sectors where a single efficiency upgrade could simultaneously reduce both climate-forcing gases and phosphorus runoff. The findings offer a practical, coordinated path to tackling two environmental crises at once.



Structural leverage points in food supply chains

Food systems produce roughly one-third of human-caused greenhouse gas emissions and consume almost 90% of all extracted phosphorus — most of which ends up as fertilizer, washing off fields into lakes and coastal waters. These two problems are tightly linked: growing demand for meat and processed foods drives both livestock methane and phosphorus losses from feed crops and manure. Yet most mitigation efforts have focused on either the farm (better fertiliser use, improved animal feed) or the consumer (dietary shifts). The crucial middle stage — where raw commodities are turned into packaged products — has remained largely unexplored. Because of this oversight, there is an urgent need to examine the transmission nodes within supply chains that could enable synergetic reductions.

Researchers from Guangdong University of Technology in Guangzhou, China, published (DOI: 10.1007/s11783-026-2258-x) the work on September 8, 2026, in ENGINEERING Environment. Using an environmentally extended multi-regional input-output model, they traced greenhouse gas and phosphorus emissions embodied in China's food consumption from 1995 to 2022, following how these pollutants flow through domestic and international supply chains. Their analysis identified critical sectors, transactions, and supply-chain paths where efficiency

improvements could deliver the biggest synergetic impact.

The numbers are striking. China's food-related greenhouse gas footprint grew from 919 million tonnes to 2 billion tonnes between 1995 and 2022, while phosphorus emissions to water bodies jumped from 73 to 258 kilotonnes. Even more telling: the share of emissions originating abroad rose from under 1% to more than 10% for greenhouse gases, and from 0.3% to over 15% for phosphorus — a clear sign that China's food system is now deeply entangled in global trade.

The team discovered that food processing sectors — especially "Food products nec" (a miscellaneous category covering many processed foods) and "Processed rice" — act as critical hubs for both pollutants. They sit at the crossroads, taking inputs from agriculture and energy and turning them into final goods. Improving their production efficiency would cut demand for upstream electricity and fertilisers, creating ripple effects that reduce emissions all along the chain.

But the study also uncovered an important asymmetry: the leverage points for greenhouse gases are much broader than those for phosphorus. Non-food sectors — notably electricity distribution and transmission services — also rank high as transmission hubs for greenhouse gases. That means policies designed to cut greenhouse gases at these nodes would automatically bring down phosphorus emissions through the shared food-processing bottlenecks. Meanwhile, international beef-related sectors in South America and Brazil have emerged as significant transboundary channels, pointing to a growing need for cross-border cooperation.

"People usually think about fixing food's environmental problems either at the source — the farm — or at the end — what we choose to eat," the authors said. "But our work shows that the real leverage lies in the middle. A modest efficiency gain in a food processing plant can ripple backward, reducing the embodied emissions from electricity, fertilisers and packaging that feed into it. And because these processing sectors sit at the intersection of both greenhouse gas and phosphorus flows, improving them gives us a two-for-one opportunity — cutting climate pollution while also protecting our lakes and rivers from nutrient overload."

The findings give policymakers and industry leaders a clear target. For food processors, that means investing in energy-efficient milling, waste-to-energy systems that turn rice husks into power, and water-recycling technologies. For governments, prioritising greenhouse gas mitigation as the primary policy lever could automatically deliver phosphorus reductions as a co-benefit, making climate action an efficient entry point for tackling multiple environmental goals. On the international front, the rising role of foreign supply chains — particularly beef from South America — calls for trade agreements and sustainability standards that address emissions beyond national borders. The research directly supports several Sustainable Development Goals, including Zero Hunger (SDG 2), Responsible Consumption and Production (SDG 12), Climate Action (SDG 13), and Life Below Water (SDG 14).

References
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