Nutrient-extended input–output analysis for food nitrogen footprint

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Abstract

Nitrogen (N) inputs to agro-food systems are ultimately lost to the environment and threaten human and ecosystem health. We developed and applied a novel approach—the nutrient-extended input–output (NutrIO) analysis—to evaluate the N footprint. The method sums N inputs through supply chains by linking a material flow analysis (MFA) of N and economic transactions. The estimated N footprint of Japan in 2011 was 21.8 kg-N capita^{-1} year^{-1} (16.7 kg-N capita^{-1} year^{-1} sourced from agriculture and fisheries and 5.1 from non-fertilizer chemical industries)**.** The analysis provides a better understanding of N use in complex agro-food systems.

Keywords: agro-food systems, supply chains, material flow analysis

1. Introduction

Substantial N inputs are required to meet today's food demands through agro-food systems. The amount of N inputs is ultimately equivalent to the N footprint of food as the inputs are eventually lost to the environment, thus causing pollution (Shindo et al., 2021). Since N flows along supply chains are often long and complicated (Oita et al., 2016), integrated management of N sources is a key challenge. In this study, we developed an integrated tool, the NutrIO model, and assessed the N footprint of Japan in 2011 focusing on food.

2. Methods

The NutrIO model linked the physical amount of N input data based on the MFA of N and economic transactions shown on an input–output table. As the N sources, chemical fertilizers, other chemical N (industrial N), organic fertilizers, biological fixation, and wild fish were considered. The detailed MFA used crop cultivation data for each of 47 prefectures in Japan and other literature.

3. Results and discussion

Of the total N footprint, the food-related sectors (edible crop cultivation, livestock, fisheries, manufacturing of foods and beverages, hotels, and eating and drinking services) accounted for 72%, or 15.7 kg-N capita^{-1} year^{-1}. The 3.9% of the food N footprint consisted of industrial N. The "wheat and barley" sector had the highest N input per economic output (N intensity), at 1.50 kg-N per 1000 JPY (12.5 USD in 2011) due to high N input per unit production and subsidies lowering their prices. In contrast, the N intensity of rice sector was relatively low (0.12 kg-N per 1000 JPY).

4. Conclusion

The integrated assessment of N footprint demonstrated contribution of industrial N to the food supply chains in complex agro-food systems. Subsidies could be effective measures to promote better nitrogen management for sectors with high N intensity. The NutrIO approach is a useful tool for efficient nitrogen use through supply chains.

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References

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