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132 Nutritional life cycle assessment for sustainable diets and agri-food production: A regionally-explicit global case study

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Accounting for the multi-functionality of food

Optimizing food systems from both a production and consumption perspective requires the inclusion of nutritional, health, and environmental sustainability dimensions. However, to accomplish this, we need innovative methods; one such option is nutritional life cycle assessment, which is the integration of nutrition and health into environmental life cycle analysis (Green et al. 2020). In this assessment, we explored the applications of nutritional life cycle assessment with a case study that covered over 200 countries and food items, in addition to identifying methodological and data challenges. Specifically, we focused on nutritionally-invested environmental footprints because our food system is not only responsible for environmental impacts like climate change and freshwater scarcity but also for hidden hunger and noncommunicable diseases like diabetes (Green et al. 2021). However, currently, most life cycle assessment studies are measured using a mass-based functional unit, which does not holistically reflect the multi-functionality of food.

Methods

For this study, we used regionally-explicit nutritional (Smith et al. 2016) and environmental data (Poore and Nemecek 2018; Poore 2018) to calculate trade-weighted nutritional metrics of food supply and food products and their associated environmental impacts. We analyzed six impact areas; namely, greenhouse gas emissions, water use, land use, arable land use, pasture land use, and eutrophication. For nutritional metrics, we calculated novel and existing nutrient indices, which measure nutritional adequacy for food products and food supply, as well as nutrient diversity metrics that assess how diverse a national food supply is on a nutritional basis. For this, we accounted for 23 nutrients relevant to food consumption and human health.

Results and Discussion

Overall, we found that using nutritionally-invested environmental impacts revealed new insights and trade-offs and that methodological choice influenced results. One main case study result was that the relative rankings of environmental footprints change when considering the nutritional value of the food product or national food supply. For example, for the greenhouse gas emissions impact category, 67 percent of food groups changed ranking spots. In such cases, a food item that has an environmentally-friendly water footprint when measured on a kg basis may have a relatively higher footprint compared to other food items when accounting for nutrient density. We also saw that these trends, for the same food group, varied depending on the region. The relevance of these findings varied according to country-specific emission intensities and current nutrient adequacy ratios; we saw that of the 23 nutrients examined only the requirements of five nutrients were met in all countries. Methodological challenges that we identified and addressed included the use of disqualifying nutrients, energy standardization, capping nutrient scores, and a lack of harmonized LCA data. The choice of how and when to apply these methods altered the final nutritionally-invested environmental impact results.

Conclusions

Overall, our results have implications for how money should be allocated when designing sustainable food systems. Consequently, more research should explore the area of combined nutritional and environmental analyses via nutritional life cycle assessment.

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