Sustainable food systems from a nitrogen perspective

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Abstract

Only if addressing food systems in a holistic and comprehensive way will be enable to overcome the multiple failures of high environmental impact from food production and consumption and health effect through under- or malnutrition. Sustainable food systems not only respect environmental planetary boundaries and provide sufficient, safe and healthy food for everybody; they do this also keeping high ethical standards and enabling stable food system businesses with a decent livelihood for all food system actors. Nitrogen plays a particular role in food systems: it is key ingredient for food production, nitrogen contributes to all major environmental threats, and nitrogen is a building block for amino acids essential in human diet. We argue that looking at nitrogen already includes many - albeit not all - aspects necessary for a food system approach. We review recent literature on the interface between nitrogen and food systems

Keywords: food systems, nitrogen, sustainability, health, proteins, environment

1. Introduction

Nitrogen pollution occurs through multiple N compounds and targets multiple ecosystems through multiple threats. A holistic perspective is required to avoid pollution swapping and to improve system-wide (economy-wide) improvements of nitrogen use efficiency.

Proteins are one of few macro-nutrients which are important for a healthy diet; they need to be consumed but too high consumption of protein from red meat can also lead to health problems. Excessive intake of energy, sugar, salt, fat has been associated with a number of non-communicable diseases. A correlation between an increase in animal source food and non-healthy diets has been observed (Springmann et al., 2018).

A system analysis of the relevance of nitrogen for both pollution and a healthy diet (Willett et al., 2019), based on a food system approach is therefore highly relevant yet was so far lacking.

Here, we review recents studies that assess the role of nitrogen in (sustainable) food systems looking at all stages throughout a food system, including farm production, food chain, and consumers.

2. Sustainable food systems

A sustainable food systems has been defined as “a food system that ensures food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition of future generations are not compromised” (Hight Level Panel of Experts, 2017)”.

This covers three pillars of sustainability: a healthy planet respecting planetary boundaries and not imparing the natural evnironment; a stable economic fundament for food system businesses giving a decent livelihood to all food system workers; and social well-being for citizens, providing safe, healhy and nutritous food in sufficient quantities keeping up to high ethical standards with regards to justice, equity, animal welfare (IPES-Food, 2019).

Studying food system sustainability requires a the use of various disciplines and instruments, including natural sciences, socio-economic sciences, policy sciences, and nutrition sciences.

3. Visualizing food systems

For visualizing sustainable food systems from a nitrogen perspective, we illustrate food systems with two aspects:

(i) *Elementary flow of nitrogen* between food system 'spheres' food production (see Fig. 1), food chain (including food production input industry, food processors, traders, and retailers, and food services), and consumers, as well as resources management systems (including waste management) and the environment.

(ii) *Food system functions* and the level of power actors exerting these functions currently have to induce food system transitions (see Fig. 2): policy making as most important function with the potential to set up a transformative, coherent, and inclusive food system policy; actors of the food chain determining to a large degree the external food environment consumers face; food producers and consumers as the weakest actors in food systems, albeit with the largest potential of emission reductions and being mostly affected by negative food system outcomes.

4. Conclusion

Sustainable food system requires a systemic approach and transformative changes from the current situation. While adequate supply of proteins is an important determinant of a healthy diet and crucial for growth and development, nitrogen pollution is also amongst the most important driver of environmental impacts of today's food systems. Understanding N flows provide a useful lens for improving the sustainability and public health of the global food system, so we need to look at food system policy coherence also from a N perspective.

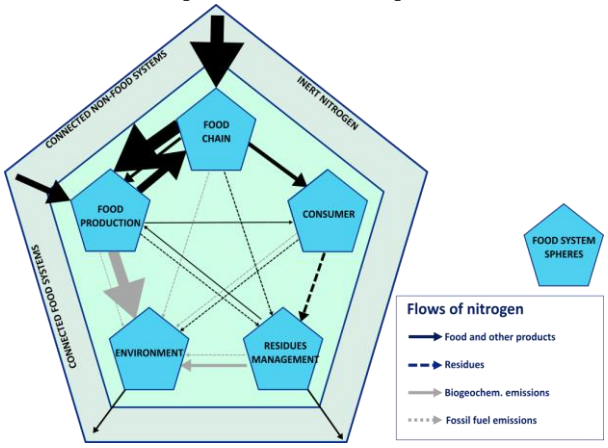

Fig. 1: Flow of nitrogen through the five nitrogen 'spheres' of food systems (Leip, Kugelberg, & Bodirsky, in preparation)

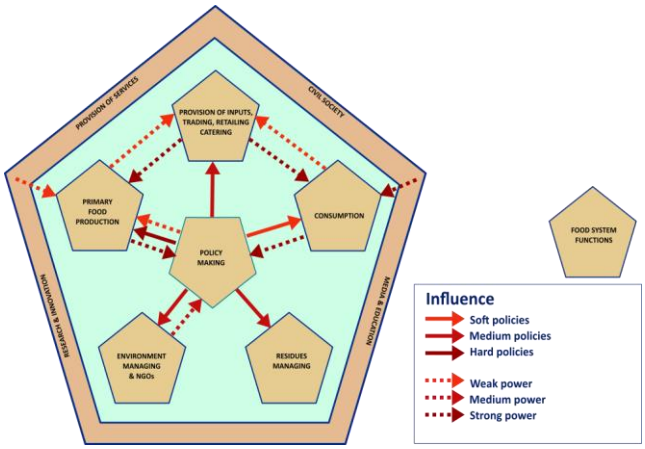

Fig. 2: Food system actors and power to induce food system transition (Leip, Kugelberg, & Bodirsky, in preparation)

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