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# Environmental impact assessment of dietary scenarios:
## a comparison of methodological aspects

## Background

Dietary patterns have manifold impacts on the environment.

- However, studies that assess dietary patterns operate with varying methodological approaches and underlying assumptions, which evoke different, and occasionally even contradicting, results.
- This leads to uncertainty regarding what should or should not be eaten, especially with regard to animal-source food (ASF) and production types (e.g. conventional or organic).
- Therefore, to adequately interpret results, it is necessary to interpret these in the context of the respective methods used and assumptions made.

## Research Question

Which methodological aspects cause differences in results when assessing environmental impacts of dietary scenarios?

## Results

Based on the literature reviewed, a range of methodological aspects has been identified that influences the results:

| **Well-known aspects:** | **New aspects:** |
|---|---|
| Temporal and geographical scope | Level of the FU |
| System boundaries | Production units |
| Functional unit (FU) | Food system-wide consequences |

The influence of the newer aspects on results will be investigated here by employing two illustrative examples.

1. Tilman and Clark (2014): assess dietary scenarios by compiling footprint studies of single food items
2. Muller et al. (2017): assess dietary scenarios by employing a food systems modelling approach

Both studies conduct global impact assessments of predefined dietary scenarios for the year 2050 (cf. Figures 1a and 1b). However, in the newer aspects mentioned above, the studies differ considerably.

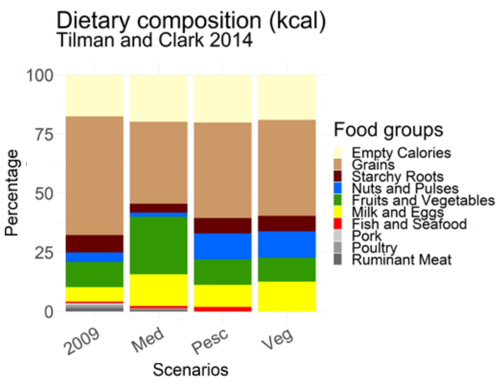


**Figure 1a:** The dietary composition in calories assessed by Tilman and Clark (2014) for the reference (year 2009), and the scenarios (year 2050; Mediterranean (Med), Pescetarian (Pesc), Vegetarian (Veg)).

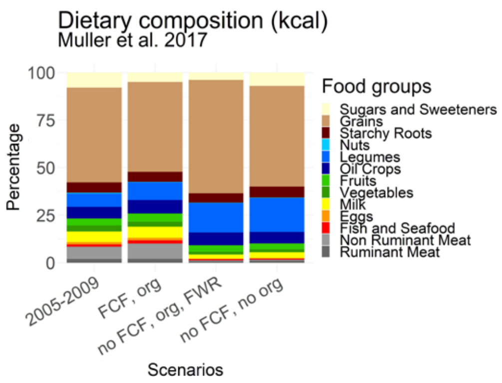


**Figure 1b.** The dietary composition in calories assessed by Muller et al. (2017) for the reference (years 2005-2009), and the scenarios (year 2050); food-competing feed (FCF) and 100% organic production (org), no FCF and 100% org and 50% food waste reduction (FWR), no FCF and no org.

### Level of the FU

**Tilman and Clark (2014):** FU on product level, impacts are derived for individual production chains and are then aggregated to represent impacts of global dietary patterns.

**Muller et al. (2017):** food systems approach on a global scale which does not depend on a product-based FU, as the full systemic connections throughout all calculations are covered.

### Production units

Production units describe ensembles of products with a linked production scheme, such as milk and meat, or crop rotations.

**Tilman and Clark (2014):** products that are linked like milk and meat are separated based on mass or economic values. As a result, the vegetarian scenario results in a relatively lower impact, because part of the impact of dairy production is allocated to meat, which is not included in the scenario.

**Muller et al. (2017):** products from production units are coupled throughout the calculations, which can be seen in the resulting dietary composition (cf. Figure 1b).

### Food system-wide consequences

**Tilman and Clark (2014):** environmental impacts are fixed values that represent the current state (→ fixed impact assessment).

If global dietary patterns change, then production patterns are likely to adapt and change as well.

**Muller et al. (2017):** environmental impacts are calculated for changed food system states (→ systemic consequences analysis).

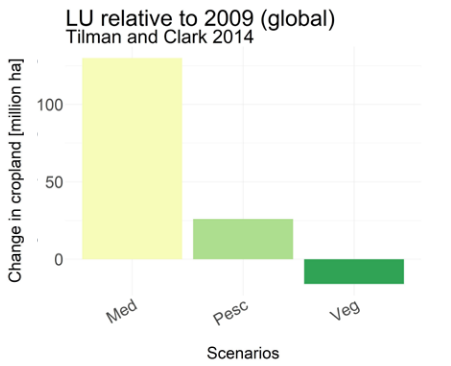


**Figure 2a:** Land use of the different scenarios relative to the reference year assessed by Tilman and Clark (2014).

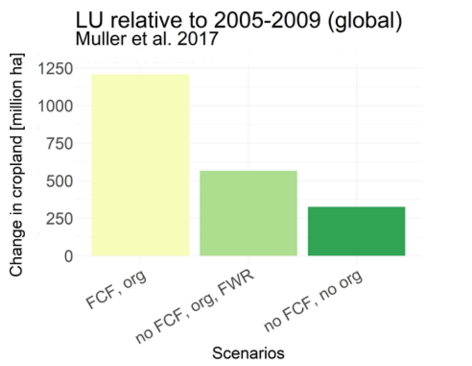


**Figure 2b:** Land use of the different scenarios relative to the reference year assessed by Muller et al. (2017).

### Identified option spaces

**Tilman and Clark (2014):** vegetarian and pescetarian diets are identified as desirable outcome (cf. Figure 2a).

**Muller et al. (2017):** a small amount of ASF that can be sustained without food-competing feed (animals are not fed with products that humans can also eat) and complementary strategies such as food waste reduction and organic agriculture are proposed (cf. Figure 2b).

## Conclusions

The **methodological aspects** discussed above **influence** both the shaping of the assessments – e.g. a vegetarian scenario vs. a scenario without food-competing feed – and the resulting option spaces.

To assess **dietary patterns for the current situation**, fixed impact assessment with a FU on product level can be applied.

To get **insights into the consequences of dietary changes**, a systemic consequences analysis which considers production units and food system-wide consequences is needed.

**References**
Muller, A., Schader, C., Scialabba, N. E.-H., Bruggemann, J., Isensee, A., Erb, K.-H., Smith, P., Klocke, P., Leiber, F., Stolze, M., et al. (2017). Strategies for feeding the world more sustainably with organic agriculture. Nature communications, 8(1):1290.
Tilman, D. and Clark, M. (2014). Global diets link environmental sustainability and human health. Nature, 515(7528):518-22.`



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