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Applying multi-nutrient functional units

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When looking for solutions to reduce the environmental impact of food, the integration of nutritional and environmental aspects becomes especially important; sustainability should be achieved in a way that human nutrition would not suffer when environmental impacts are reduced. Due to several environmental and health impacts, a transition to more plant-based diets in the Western countries is desirable, one manifestation of which is the replacement of animal-source products to plant-based alternatives. It requires a product-specific information and understanding on the substitution impact that integrates both environmental and nutritional perspectives. At the end of last year, FAO published a report on the best practices for integrating nutrition in LCA of food items, providing general guidelines for nutritional LCA (nLCA) methodology (McLaren et al. 2021). However, the methodological approaches remain varying because, as in any LCA, the methodological choices are dependent on the goal and scope of the study, ie a context of the assessment and intended usage of the results. Still, the use of nutritional functional units (nFUs) is a key solution for integrating nutrition into the LCA as it seeks to incorporate food functionality into the FU. This method has been developed over the last years (Saarinen et al. 2017; McAuliffe et al. 2020; Green et al. 2021).

The practical implementation of nLCA through product group specific nFUs is studied in NEPGa project led by Natural Resources Institute Finland. The project develops scientifically valid methodologies for combining nutritional factors with environmental impacts of food products in various product groups. The project's development work takes place in a Finnish context, but the scientific procedures can be implemented also elsewhere. In the project the methodological integration of nutritional quality into environmental assessment is developed in the multidisciplinary project team including food, environment and nutrition scientists from leading Finnish research institutes and universities. The work has been carried out as iterative development process in close collaboration, through discussions and test assessments. Workshops and seminars with stakeholders have been organized to collect feedback on views on usability of the methodology and communication of nLCA results to consumers. Indeed, in addition to methodological development, the NEPGa project aim to building a basis for a product labelling that integrates nutrition aspects to life-cycle-based environmental information.

In this study, we present the methodological framework for **the product group specific nLCA with nFU**. First, we describe the procedure for selecting suitable nutrients to be included in the nFU for protein rich foods in a national context, considering the Finnish nutrition and food recommendations, as well as the population's dietary habits and nutrient intake. We highlight the unresolved concerns involving the shift in diets toward plant-based foods and the resulting change in nutrient intake, and the sensitivities and uncertainties associated with nFUs. Since the use of nFU affects the other choices made in LCA modeling (e.g., system boundaries, allocations), we also discuss the challenges associated with nFU implementation in LCA. The methodological framework with practical implementation and discussion is described in detail in Kyttä et al. (2022, unpublished).

For product group specific nFUs, the grouping of foods is an important step - it needs to be broad enough to cover variety of foods that are substitutable with each other but narrow enough to differentiate the foods with different functions. Therefore, in this study the grouping was based on the plate model presented in the national food recommendations of Finland (VRN, 2014). As a result, the foods that are consumed similarly, and thus are substitutable, are grouped together. For proper usage of nFU, it is crucial to identify the nutrients that are derived from the product group under study. First, the nutrients that are currently obtained from sources of protein were identified. This was done based on the National FinDiet Surveys (Kaartinen et al. 2020) that monitor the dietary habits and nutrient intake of the adult population in Finland. According to the survey, in current diets the main sources of protein are meat and dairy products. Because our approach is based on the substitution effect of products, we mapped out all the nutrients that meat and dairy products are significant sources of in current diets. These criteria resulted to the following beneficial nutrients being included to the nutrient index of protein rich foods; calcium (Ca), iron (Fe), selenium (Se), zinc (Zn), vitamin B6, vitamin B12, niacin, riboflavin, and thiamine. Because the index is based on relation of nutrient content of food and the national daily intake recommendation of nutrient, the index was calculated separately for all population groups with different nutrition recommendations. The index was used directly as a FU for protein rich foods by dividing the environmental impacts by the index score. The sensitivity of climate impacts to the choice of nutrients in the index and system boundaries in LCA were tested with further analyses.

The results show that using nutrient index instead of mass as FU decreases the difference between animal source foods and plant-based foods. Due to high climate impacts of beef per 100 grams, also the climate impact per index score was the highest, and consequently, the high index scores of fish foods lead to low climate impacts per index. The results are sensitive to the choice of nutrients in the index, the type of food assessed and the system boundaries of assessment. The more detailed results are presented at the conference and in the scientific publication with methodological focus.

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