BEYOND THE FOOD WASTE HIERARCHY: A QUANTITATIVE ASSESSMENT OF EMBODIED ENVIRONMENTAL IMPACTS USING A HYBRID APPROACH

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Abstract

The food waste hierarchy has been widely adopted to provide guidelines as to the preferability of food waste management options. Consequently, numerous studies have been carried out to investigate the environmental impacts associated with the different components of the hierarchy, namely prevention, redistribution, treatment and disposal. Nevertheless, the overall environmental impacts of the hierarchy have yet to be comprehensively and accurately quantified; existing studies fail to provide a holistic quantification of the environmental impacts. This could be attributed to two key factors: the high level of uncertainty as a result of truncation error – a systematic error associated with traditional evaluation methods which are largely based on process based life cycle assessment; and the tendency of existing studies to focus on treatment and disposal technologies whilst overlooking redistribution and prevention options.

This research holistically quantifies the environmental impacts of the food waste hierarchy. The present study expands conventional assessment methods in order to counter the drawbacks observed in the literature such as truncation error. A hybrid life cycle assessment (LCA) approach was developed by combining conventional process-based LCA and an input-output model, a top-down approach that was developed to describe the complex interdependencies of industries within an economy. The study also estimates the environmental benefits associated with food waste prevention using a top-down environmentally extended multi-regional input-output model. The study further includes the impact of the rebound effect: the associated environmental burdens of substitutive consumption that arises as a result of economic savings made from food waste prevention.

The study finds that food waste prevention could lead to substantial reductions in Greenhouse Gas (GHG) emissions in the order of 706 to 896 kg CO_2-eq. per tonne of food waste, with most of these savings (78%) occurring as a result of avoided food production overseas. The rebound effect may however reduce such GHG savings by up to 60%. These findings provide a deeper insight into our understanding of the environmental impacts of food waste prevention: the study demonstrates the need to adopt a holistic approach when developing food waste prevention policies in order to

mitigate the rebound effect and highlights the importance of increasing efficiency across the global food supply chain, particularly in developing countries.

The second best food waste management option identified is the conversion of food waste into animal feed. The study compared the environmental impacts of two South Korean style-animal feed production technologies (as wet and dry pig feed) with two widespread downstream treatment options: composting and anaerobic digestion (AD). Results of 14 mid-point impact categories show that the processing of food waste as wet pig feed and dry pig feed have the best and second-best scores respectively, for 13 out of 14 and 12 out of 14 impacts considered. The low impact of food waste feed stems in large part from its substitution with conventional feed, the production of which has substantial environmental and health impacts.

Considering the current status quo of processing food waste and the fact that the use of animal feed is still legally banned across Europe, the developed hybrid LCA approach was also used to evaluate the environmental impacts of existing treatment and disposal options: incineration, composting and AD. The results of the analysis reveal that composting achieved the best score for seven out of 14 mid-point environmental impacts considered, while AD scored second-best for ten impacts. Incineration had the highest environmental burdens in six impacts. Results also highlight the effectiveness of the hybrid approach in reducing truncation error and increasing the overall-captured environmental impacts of composting, AD and incineration by 26%, 10% and 11% respectively. The adoption of the hybrid model has also enabled a better inclusion of indirect activities in the analysis, in particular capital goods.

Overall, the findings of this study have provided a more comprehensive understanding of the environmental impacts associated with all stages of the food waste hierarchy. These insights have led to the provision of practical implications by which the environmental burdens of food waste may be reduced.