

Reducing Household Food Waste by Dietary Meal Planning

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Abstract

This research aims to reduce food waste at the household level by formulating menu plans. One-third of global food production is lost or wasted. Food waste is a significant contributor to climate change, as food waste is estimated to generate 8% of global greenhouse gasses. Of the total food waste in Europe, about 50% is caused by households. Planning is identified as one of the main drivers of food waste. Poor planning leads to the wastage of food because of, among others, difficulties consumers face with inappropriate packaging sizes and managing leftovers. Diet modelling has proven to be an effective method for solving food planning problems. It has mainly been used to find nutritious and affordable diets using mathematical optimization techniques. However, diet modelling has not yet been considered for reducing household food waste. In this research, food waste is defined according to the EU definition: “any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be ingested by humans”. Currently, in literature, food waste is frequently expressed in weight. However, if the purpose of reducing food waste is to mitigate climate change, other units of measure might be more appropriate. For instance, environmental impact indicators such as greenhouse gas emissions (GHGE), land use, and water use. A dietary meal planning model based on mixed-integer programming is developed to estimate to what extent food waste can be reduced at the household level when planning is optimized. The model formulates menu plans by selecting optimal combinations of recipes while taking package sizes, perishability, and nutritional value into account. Multiple conflicting objectives, such as costs, overall environmental impact, and food waste are considered. It is assumed that grocery shopping is done on the first day of the menu plan. Perishable foods not finished by the end of the menu plan are considered waste. The Netherlands is taken as a case study, the Dutch National Institute for Public Health and the Environment and a large Dutch supermarket chain are the main data sources for dietary reference values, recipes, and package data. The model is used to formulate dinner menu plans for an average Dutch family of 4 persons for 5 days. The results show that menu plans can be formulated to minimize waste (0 g waste), environmental impact (15681 g GHGE), and costs (€33.11), respectively. Trade-offs in the results show that, for instance, the menu plan with minimum waste has relatively high GHGE (21118 g GHGE) and cost (€52.12). Furthermore, the cheapest menu plan

suggests large package sizes, which leads to more waste (1028 g waste). It is possible to formulate healthy, affordable menu plans and corresponding shopping lists that result in neglectable waste. Moreover, our analysis suggests that environmental impact is more suitable than weight as the unit of measurement for food waste. This study shows that optimizing menu plans is a promising way to reduce household food waste and the environmental impact of diets.

Keywords: mixed-integer linear programming, food waste, carbon footprint, recipes, menu plan

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