

# Using a Fruit and Vegetable Dataset to Determine Statistically Independent Indicators for Food Production

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Life cycle assessment (LCA) describes a process for calculating the complete environmental impact of a good or a service. However, for many producers and retailers, it is not possible to perform complete LCA for every product they produce or sell. In addition, the commodity nature of most food markets makes it difficult to consistently transfer and use farm-specific LCA information. Despite these limitations, many producers and retailers are interested in using LCA tools in their business decisions and communications with customers. Because of the complexity of modern supply chains, simplified or screening are more practical than complete assessments. We describe a methodology to determine what information is needed for a simplified life cycle assessment, by examining the statistical independence of a large number of individual environmental indicators.

Although food production contributes to a range of environmental impacts, previous research using the ecoinvent database has shown that many categories of environmental impact are closely correlated. In particular, many categories of environmental impact are correlated with energy use, commonly denominated as cumulative energy demand (CED). Food production is one area where this correlation is weak, and it is desirable to test environmental indicators against a larger data set of food production systems. We describe a methodology to generate over 230 regionally-varying data sets for fruits and vegetables, based on detailed foundational data sets. For many products, detailed information is only available for certain production locations and conditions. Literature and agricultural models can be used to modify these detailed data sets to describe many different kinds and areas of production. Tools to measure the accuracy of these data set extrapolations are briefly discussed.

Using the fruit and vegetable data set, we calculate the statistical independence of over 100 separate life cycle impact assessment indicators, including the new RECIPE indicators. In addition to testing how LCIA categories, such as ozone depletion, were on average correlated with CED, we also examined how different indicators within Independence is measured by simple correlation. As the LCIA scores are not normally distributed, rank-order correlation scores are used. In addition to simple measures of correlation, more complex methods, such as principal component analysis (PCA) are discussed and applied. Preliminary results show poor correlations with CED for land use, eutrophication, and ecotoxicity. LCIA scores for freshwater use are also expectedly to be poorly correlated with CED.

As CED is very closely linked with climate change potential, discussion of the independence and importance of other environmental indicators is an especially important contribution to the discussion on food carbon footprints. Examining the correlation of indicators from different LCIA methods within indicators can also illustrate focus areas for future research. For example, the near-identical results for land use show that more than one model is needed to ensure robust accounting. By assessing the statistical independence of different indicators, one can easily determine what types of information need to be gathered for a screening LCA. This greatly helps in creating a true enterprise-wide life cycle management system.