# Modelling effects of food loss and waste mitigation measures on GHG emissions

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## Background

Food losses and waste are estimated at one-third of all food produced for human consumption (FAO and others). These represent substantial environmental impacts, estimated at around 7 percent of anthropogenic greenhouse gas emissions (Vermeulen et al. 2012). It is considered essential to significantly reduce these inefficiencies for minimizing environmental impacts of food production and for securing expected increasing demands for food, feed and biobased non-food uses.

Food losses and waste generate emissions not only through the waste handling processes (like rotting in landfilling, composting, bio-digestion, etc.), but also have an even more substantial impact through indirect contribution via the embedded emissions in primary production, processing, distribution, and refrigeration of the wasted food itself.

A variety of food loss and waste preventing measures can be implemented in the post-harvest chain, contributing to the reduction of product quality decay and losses, including (FAO, 2011):

- developing processing facilities;
- improving storage facilities;
- establishing/improving cold chain;
- using packaging for fresh products.

These preventive measures require investments and cause greenhouse gas emissions, thus adding to climate change rather than solely reducing it (James & James, 2010). This research analyses net effects (comparing embedded GHG emissions reductions to added emissions).

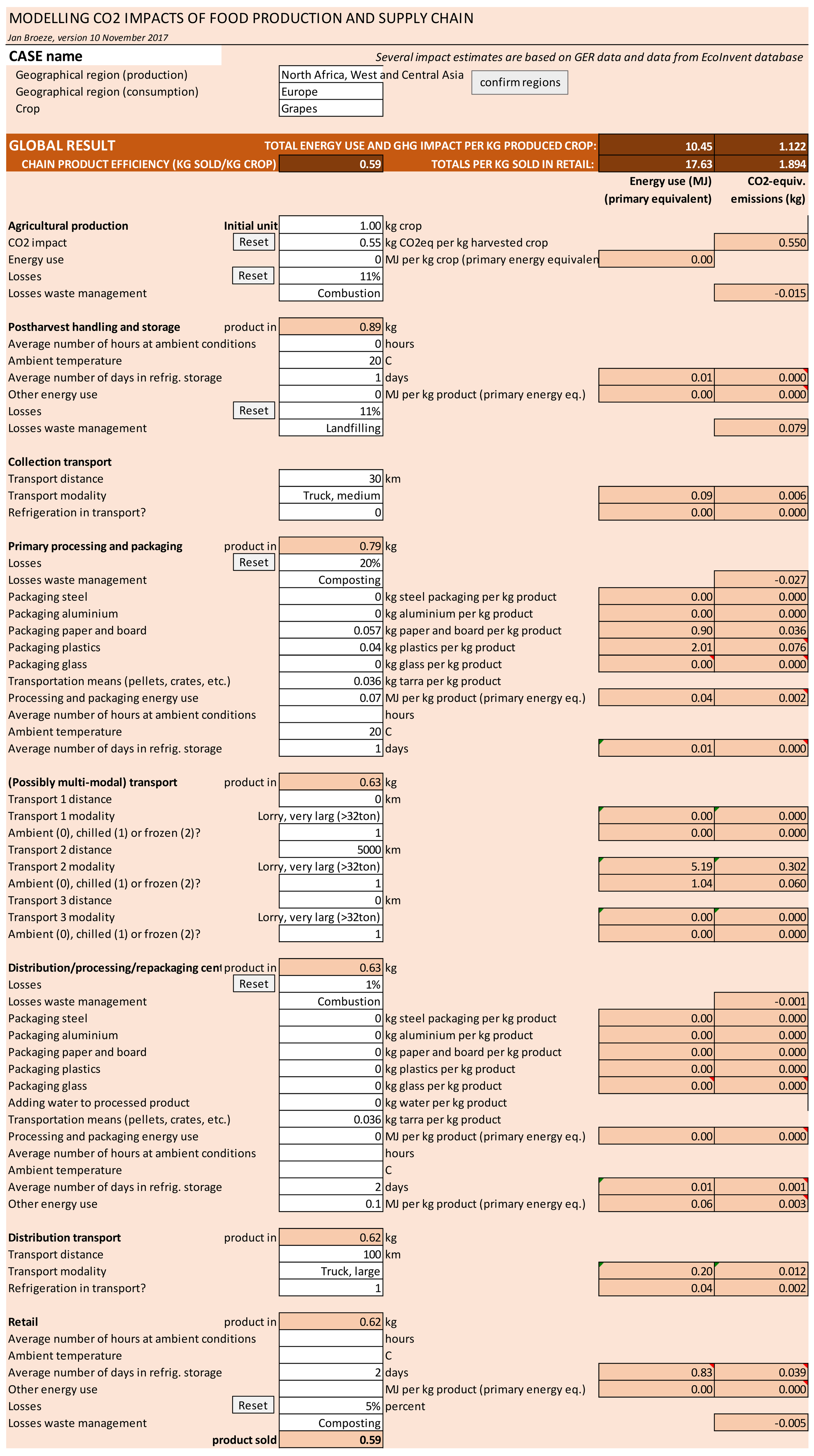
**Table 1.** Integrated modelling approach

| Modelled stages along the supply chain | Sustainability effects | Complication | Sources for data |
|---|---|---|---|
| Agricultural production | $CO_2$ emissions associated with agricultural production | Distinction between crops (categories) and production regions | FAO and Porter *et al.* (2016) |
| Transportation | $CO_2$ emissions related to fuel use | Distinction between transport modalities | GER data, EcoInvent |
| Food processing | $CO_2$ emissions due to processing | Product and process specific | Expert estimations + practical data |
| Refrigerated storage | $CO_2$ emissions related to energy use and use of refrigerants | Results largely depend on technology level and refrigerant type | Reference examples of refrigerated warehouses |
| Retail shelf | $CO_2$ emissions related to energy use for cooling and use of refrigerants | Results largely depend on technology level and refrigerant type | Reference examples |
| Food losses (applies at each stage of the supply chain) | Due to losses, cumulative effects are allocated to a reduced volume of food. Effects of food waste handling process. | Losses largely vary amongst product categories and production and consumption regions. Large differences of impacts amongst food waste handling options. | FAO and Porter *et al.* (2016) give global overview of food losses per stage in food supply chains for the main food product categories, differentiated for production regions. Effects of waste processes are estimated from various information sources. |

## Approach

For assessing net effects of food losses reduction scenarios, cumulative direct and indirect sustainability effects must be estimated. For that, appropriate data for effects of agricultural production and post-harvest handling must be combined in an integrated model (Table 1).

**Figure 1. C**hain impact modelling user-interface.




## Conclusions

A modelling approach for calculate cumulative GHG impacts of food supply along the supply chain has been formulated. This will be used to calculate sustainability cost-benefit of improvement opportunities.

Finding appropriate performance and sustainability data as explained in Table 1 is essential for validity of the outcomes. Preliminary comparisons of calculations based on these data and on industry-supplied data gave noticeably similar outcomes. Thus, using secondary data as explained in this table seems a good basis for practical relevant conclusions.

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