The 6th International Conference on Life Cycle Management in Gothenburg 2013

# FOOD WASTE IN THE SUPPLY CHAIN – IMPACTS ON THE PRODUCT CARBON FOOTPRINT

*Eveli Soode*, Paul Lampert, Gabriele Weber-Blaschke. *Munich Wood Research Institute, Winzererstraße 45, 80797 München, Germany, soode@wzw.tum.de*

*Keywords: product carbon footprint, asparagus.*

## ABSTRACT

Product carbon footprint (PCF) of food products does not directly reflect the amount of produced food ending as waste. Current research aims to determine the impact of the food waste in the asparagus supply chain on the PCF. Data on asparagus cultivation in a conventional production system was collected. Up to 40% of the harvested asparagus is sorted out at the production site and up to 15% of the vegetable is disposed of by the consumer, leaving 45% of the harvested vegetable for consumption. If customers accept asparagus with visually lower quality, reduce energy for shopping trips and cooking, the waste occurring in the asparagus supply chain can be reduced as well as the total PCF.

## INTRODUCTION

One-third of food produced for human consumption is lost or wasted globally (van Jenny Gustavsson, 2011). This means that huge amounts of the resources used in food production and the greenhouse gas emissions caused by the production are in vain (van Jenny Gustavsson, 2011). In medium- and high-income countries significant amounts of food waste occurs at the consumption stage and early in the food supply chains (van Jenny Gustavsson, 2011).

In the recent years customers have become more aware of the environmental problems and have shown interest in the environmental impact of food products. This has initiated the more frequent use of a simplified life cycle analysis methodology in a form of carbon, water or environmental footprint. PCF has risen as one of the most common tools to be used due to its clear connection to the climate harmful greenhouse gases and a clear numeric result. PCF is the sum of GHG emissions and removals in a product system, expressed as carbon dioxide equivalent ($CO_2e$) and based on a life cycle assessment (Draft International Standard 14067). The obvious limitation of using PCF is that it does not reflect the wide spectrum of influence on the environment caused by the production and consumption of the product. Another limitation is that the PCF does not directly reflect the amount of food products which do not reach customer because of inefficient production system, product quality requirements and losses during the transport. Also, only little information is available about the use phase PCF of products.

In Germany, asparagus was the most widely cultivated vegetable in 2012, covering 20% of the total land used for growing vegetables (Statistisches Bundesamt, 2013). Also, it is a

vegetable which is to a great extent being sold directly at the farm shop (Dirksmeyer, 2009) or at the sales stalls within the neighbourhood of the farm. In Germany, the asparagus season starts in April and ends on the 24th of June. Asparagus is first and foremost enjoyed freshly cooked within a few days after the harvest.

With using asparagus as a case study the aim of the research is to determine

1) the impact of the customer on the PCF;
2) the impact of the amount of food wasted in the supply chain on the PCF.

## METHODS

To achieve the goal of the study life cycle, inventory was gathered about each life cycle stage of the product. It includes transporting the seedlings to the farm, planting the seedlings, yearly soil cultivation, application of agricultural chemicals, harvesting, sorting and packaging, supply chain from the farm to the marketer, centre of distribution and supermarket, customer shopping trip, product preparation at customer's home, and waste occurring at the customer life cycle stage.

Data about the asparagus seedlings, cultivation and transport to the marketer was gathered during an interview in a conventional asparagus farm in Germany for the cultivation in 2010-2012. The asparagus is grown on a field under a thermo-foil with no additional heating. Except for harvesting, all other operations in the field are done with agricultural machines. Since the fields have been in use for agricultural land for a long time no impacts caused by land use change were taken into account.

The marketer prodived data about further transportation of asparagus until the arrival at the central distribution storage. Since no primary data was available for the processes at the central distribution storage or supermarket these stages were modelled as scenario.

User phase data was gathered as a panel questioning during three month. In total 168 customers sent back 420 questionnaires with data about their spargel shopping trip and cooking. After eliminating the extreme values, an average value for each data point was used for the user phase PCF calculations.

Throughout the study, the manufacture and construction of all buildings and infrastructures were omitted. Since no data was available for specific agricultural chemicals, generic data sets for herbicides, pesticides and insecticides were used. For asparagus transport in all stages a truck use was calulated although occasionally asparagus was transported to the marketer by a transporter bus.

The functional unit was defined as 1 kg of product at the point of sale. The PCF was calculated with life cycle assessment calculation programme GaBi 6 as total greenhouse gas emissions 100-year global warming potential.

## RESULTS

The results are summarised in Table 1. According to the asparagus producer, only approximately 60% of the asparagus harvested from the field is transported further for sale.

The 40% loss occurs mainly during sorting, where the asparagus stems are cut to the same length, and crooked, stained and purple stems are excluded. The customers estimated that on average at least 10% of purchased asparagus is disposed of as peelings and cuttings of the dried stem ends. However, a few customers who actually weighted the peels and stem ends reported about values up to 25%. If losses in the supply chain are kept below 5%, then only between 43% and 54% of the asparagus harvested from the field gets consumed as food. If no asparagus would be wasted throughout the production and supply chain, the total PCF could be reduced up to 47%.

Table 1. PCF results and the impact of waste on the final PCF*

| Life cycle stage | kg CO2 e | Relative contribution | Occurring asparagus waste | Left of harvested asparagus | Effect on the total PCF |
|---|---|---|---|---|---|
| Pre-farm and farm | 0.24 | 33.3% | 40% | 60% | up to -40% |
| From farm "gate" to the point of sale | 0.11 | 15.2% | 0-3% | 57-60% | 0 to -0.8% |
| From the customer shopping trip to the end-of-life | 0.36 | 51.5% | 6-15% | 43-54% | -2.6 to - 6.3% |
| Total | 0.71 | 100% | - | 43-54% | -42.6 to -47.1% |

*At the moment of writing current paper the results have not been verified and adjustments in the future may occur.

In the farm stage the asparagus waste occurs just before the end of that life cycle stage, i.e. before asparagus is transported to the marketer. From the farm gate to the point of sale the waste can occur at the distribution storage while repacking the asparagus. In both stages the total amount of greenhouse gas emissions could be divided by more kilograms of asparagus if no waste occurred. In the customer phase the difference in the amount of asparagus waste would only affect the emissions at the end-of-life stage, in the current case study when the asparagus peels and stem ends are composted.

## DISCUSSION

The asparagus waste mainly occurs in the sorting and packaging process at the farm and at the customer stage. This waste cannot be completely avoided because in case of natural products there are always some asparagus stems which cannot be sold because of insufficient quality. In case of asparagus also visual signs have an imporant impact: when asparagus stems have "rost" stains or purple heads the vegetable cannot be delivered to the supermarket due to unsufficient quality. When the producer assesses also the potential price he could receive at the local sales stall too low, the stems will be excluded from further sale completely and regarded as waste. These visual flaws do not affect the taste and the asparagus with purple heads have even higher nutritional value in contrast to white ones.

Waste cannot be avoided at the customer stage. Each asparagus stem must be peeled and if they are not kept cold and moist the stems dry up in a few hours and must be shortened up to a few centimetres. Short storing time and proper storing conditions help to avoid drying and reduce the waste. Thereby, the PCF can be reduced only minimally. Since the customer stage

sums up to a half of the total PCF, customer shopping trip, storing, asparagus cooking and dish washing have higher potential to reduce the total PCF. Similarly, Schäfer and Blanke (2012) emphasise that the largest PCF reduction potential is the customer responsibility.

## CONCLUSIONS

The study revealed that asparagus waste cannot be avoided, but if customers would accept asparagus stems with minor visual flaws the amount of asparagus waste at the farm stage could be reduced. Waste at the customer stage can be reduced minimally. The farm stage waste reduction would theoretically reduce the PCF up to 40%. The customer stage waste minimisation only up to 6%. Neither of these theoretical reduction potentials are realistic. Since the customer stage contributes half of total PCF it entails a relevant greenhouse gas reduction potential through more energy efficient shopping trips and cooking practices.

## REFERENCES

Dirksmeyer, W. (2009). *Status quo und Perspektiven des deutschen Produktionsgartenbaus*. Retrieved from http://www.bfafh.de/bibl/lbf-pdf/landbauforschung-sh/lbf_sh330.pdf

Draft International Standard 14067 (2012). Geneva: International Organization for Standardization.

Schäfer, F., & Blanke, M. (2012). Farming and marketing system affects carbon and water footprint – a case study using Hokaido pumpkin. *Journal of Cleaner Production*, *28*, 113–119. doi:10.1016/j.jclepro.2011.08.019

Statistisches Bundesamt. (2013). *Wirtschaftsbereiche - Obst, Gemüse, Gartenbau - Spargel das am häufigsten angebaute Gemüse 2012*. Retrieved from https://www.destatis.de/DE/ZahlenFakten/Wirtschaftsbereiche/LandForstwirtschaftFischerei/ObstGemueseGartenbau/AktuellGemuese.html

van Jenny Gustavsson, C. C. U. S. R. O. A. M. (2011). *Global food losses and food waste*. Retrieved from http://www.fao.org/docrep/014/mb060e/mb060e00.pdf