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The consumers' contribution to the product carbon footprint of asparagus

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The consumers' contribution to the product carbon footprint of asparagus

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1. Introduction, Knowledge, Objectives

Since the issue of global warming has become an important topic for the whole society, concepts to judge products regarding their climate change impact like Product Carbon Footprints (PCF) reached also the horticultural industry. Many studies were conducted e.g. analyzing tomatoes (Theurl, 2008), ornamental tree production (Kendall and McPherson, 2012), strawberries (Breloh and Priess, 2009), bananas (Luske, 2010), apples (Blanke, 2012) and also for cut-roses (Williams, 2007), just to mention a few. These studies cover the production side of the products' life cycle, but mostly leave out an important part: the shopping and use phase, which is completely in the hand of the consumer. However Buschmann (2009) stresses out, that the consumer plays an important role influencing the total Product Carbon Footprint. Few studies gathered empiric data for the use phase in a Carbon Footprint calculation e.g. Sima et al. (2012) for the grocery shopping trip, Weber and Matthews (2008) for American household Carbon Footprints or Page et al. (2012) for fresh tomato production. Studies like those from Dierks (2008), Bergmann (2009) or Kauppinen et al., (2010) which include or focus on the consumer phase, used secondary data in combination with estimated scenarios. Based on the state of the author's knowledge, empiric data of the use phase of horticultural products has not been collected yet. Therefore the general objective of this work is to calculate the Product Carbon Footprint of the consumer side on an empirical basis using the example of asparagus and furthermore give insight into of the main emission drivers.

2. Material and Methods

Data collection

In order to collect valid empiric data for the PCF-calculation, a consumer panel with 168 participants was set up starting on April 1st and lasting to July 30rd. Finally 420 acts of purchase of asparagus and associated usage data have been taken into consideration. A product questionnaire contained questions, which were relevant to calculate the Carbon Footprint on the consumer side. Especially three phases were underdetermined within the survey: the shopping trip, the use/cooking phase and the end of life stage, whereas the first two of these phases mark our system boundary for this paper as seen in Figure 1.

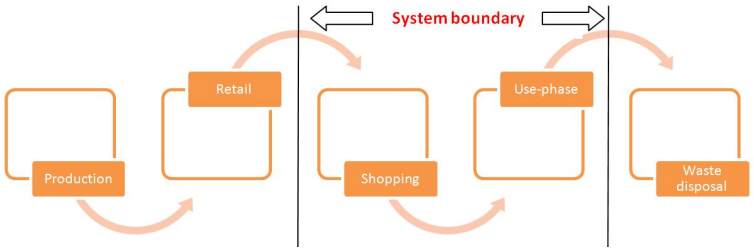

Figure 1: System boundary

Within this boundary, several factors have to be considered for the actual PCF calculation as seen in Figure 2.

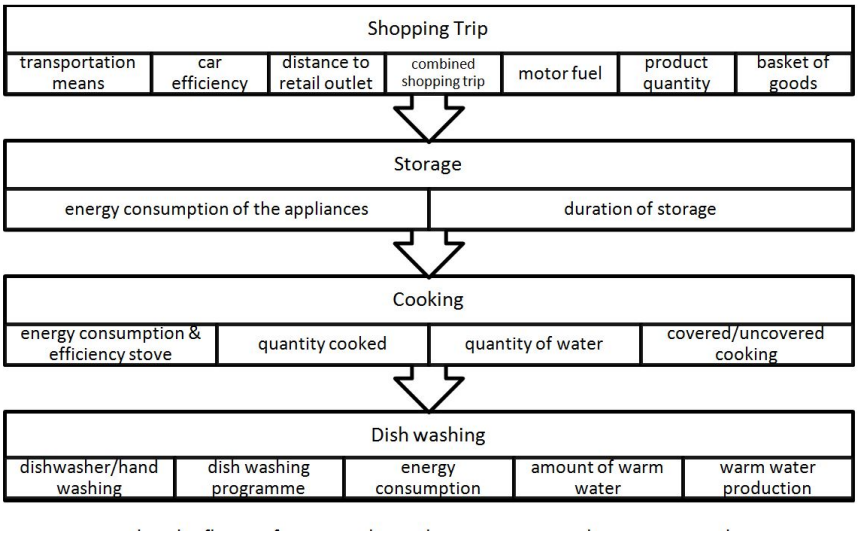

Figure 2: Considered influence factors to the Carbon Footprint on the consumer side

PCF calculation

Different approaches to estimate the PCF in the consumer stage are described in the two most respected standards (GHG Protocol, PAS 2050). Therefore, the authors decided to use the methodology applied in the PCF Pilot Project Germany, which is based on the ISO-Standards 14040 and 14044 for Life Cycle Assessment (Priess, 2009). A few adaptations had to be made in the case of the shopping trip to accommodate combined car rides. These were handled according to the work of Sima (2012), who suggest to divide the trip distance with the number of stops. As we did not collect the number of stops, we decided to divide the whole shopping trip distance (roundtrip) in two peaces, if the shopping trip was combined. This has been similarly done also by Deinert and Pape (2011). In order to calculate the PCF, the energy consumption of the single phases were evaluated on the basis of the data. Having done that, the consumed energy was converted in CO_2-emissions with the help of specific emission factors taken from well-respected databases like EcoInvent or ProBas. Allocation of the emissions within the basket of goods was done physically, as it is the preferred method in all major standards (GHG Protocol, 2011), (BSI, 2011). At last, all calculated emissions were converted to 1 kg asparagus.

Statistical analysis

In order to identify the individual emission drivers of the PCF, statistical analysis was done using the software program SPSS (Statistical Package for the Social Science). Thereby descriptive statistics and comparison of means performing an analysis of variance (ANOVA) were used.

3. Results

The PCF on the consumer side of asparagus sums up to 408 g CO_{2e} (CO_{2e}=considering all relevant greenhouse gases calculated into CO_2-equivalences). As seen in Figure 3, the phases of the highest share on the PCF are the shopping trip and especially the cooking-phase. Those two phases are further analyzed within the following section.

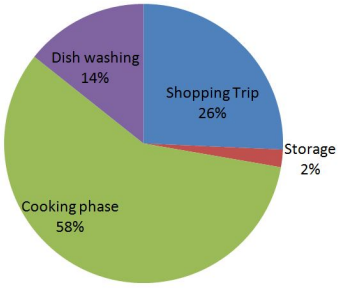

Figure 3: Average PCF on the consumer side of asparagus (n=365)

Shopping is been mostly done by car in 60 % of all asparagus purchases, followed by bike (18 %) and walking (15 %). Less important are public transportation with a share of 5 % and motorbike with just 1 %. But there is a significant difference between urban and rural population. In urban areas our panel participants take advantage of the car in 31 % of the cases, which means half of the car use of rural inhabitants and about 10 % of the total car use. The lesser car use is compensated to the same extent by the use of public transportation.

However, this higher proportion of public transport, results not in a significant (p=0.05) reduction of the PCF within the shopping phase, although it is a bit lower in tendence (27 g). This has several reasons: Firstly, the distances to the retail outlet are not significantly different. Secondly the quantity of asparagus bought at one purchase act is significantly (p=0.05) smaller (0.86 kg) in the case of the usage of public transport than when using a car (1.28 kg). In general, the average quantity which was bought, was 1.23 kg of asparagus, with also no significant differences between urban and rural residency, gender or number of children living in the household.

As mentioned above, the cooking phase is even more important than the shopping trip for the amount of the PCF. Within that phase, the quantity of asparagus and the quantity of water used for cooking at once are the important factors. Thus it can be summerized that the more you cook simultaneously and with little water, the lower is the PCF in the cooking phase.

4. Discussion

The results show rather high emissions caused by the consumer in the case of asparagus. Comparing that with production side, which accounts for about 500 g CO_{2e} (local and seasonal grown) (Berners-Lee, 2010), a 45 % share of the emissions arise at the consumer stage. This phase is primarily influenced by the shopping-trip and the cooking-process. The results show, that there is a wide range how to manage these phases. That there is no significant advantage of living in the city concerning the PCF of the shopping trip is due to several reasons.
One reason for this might be found in the methodology: The figures for public transportation were taken from a study for buses in public transportation (Oeko-Institut, 2005), where the Carbon Footprint is higher as it would be for a system with subways etc. But nevertheless, for a significant lower PCF in urban areas, the usage of cars must be much lower, than it is proven in our data. Asparagus outlets seem to be as closely spaced in the city as in rural areas, otherwise the share of people walking or biking to the outlets in rural areas would be expected to be lower what they are obviously not. Outside our system boundary and thus disregarded in this study, the disposal phase takes place. It is treated in a separate paper by the author throughout the whole value chain. Other environmental impacts like water-use are not included in the study but should not be neglected when they are supposed to have a significant influence on the product's environmental performance. In this case it would be more suitable to apply an a Product Environmental Footprint (PEF) calculation using the methodology of the European Commission, which was just recently published.

5. Conclusions

The study shows that when applying a Carbon Footprint calculation without considering the consumer phase it can lead to incomplete results and eventually wrong recommendations to decrease the PCF of a product. As shown, the consumer can have a massive impact on the overall PCF. To gain more data on the consumer influence, more empirical research needs to be done considering other horticultural or food products. In order to get a standard of comparison for future research regarding PCF on the consumer side, certain rules should especially be developed for that purpose (analogue to Product Category Rules on the production side) and system boundaries should be determined consistently.

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