Carbon Footprint and Labelling of Dairy Products – Challenges and opportunities

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Abstract
In the present paper, milk and dairy products are used to illustrate the challenges and opportunities of carbon footprint (CF) analysis in the context of CF labelling of foods. Due to uncertainties regarding methodological aspects and data quality, solid and valid CF analysis is associated with several challenges. Milk is one of the food items, which most frequent has been investigated using life cycle assessment (LCA). In the present presentation previous studies are used to demonstrate some of the above-mentioned challenges associated with the calculation of CF, namely dependence of 1) handling of co-products, 2) emission factors (e.g. for nitrous oxide from application of nitrogen fertiliser), and 3) variation between different farms. Moreover, the method of how the dairy company Arla Foods work with CF (aiming of initially to reduce their Green House Gas (GHG) emissions with 25% by 2020) will be presented together with the some of the obtained results. Finally, the potentials in using CF in business communication will be discussed shortly.

Key words
carbon footprint, CF, milk, dairy products, lifecycle assessment, LCA, uncertainties

1. Background and method

The rising concern about humans' contribution to global warming has put a pressure on industry, politicians and other stakeholders to act. Consequently, there has during the last couple of years there been a tremendous focus on food and its contribution to global warming. Food production is one of the major contributors to green house gas (GHG) emissions, and the livestock sector is especially important, as it represents approximately eighteen percent of the anthropogenic global warming (Steinfeld *et al* 2006). As a result, carbon footprint[1] (CF) and carbon labelling have been presented as potential tools to document and inform about the emissions of greenhouse gases from products and hereby provide the information needed for the consumers to choose products that give rise to reduced GHG emissions.

In the following, previous performed life cycle assessment (LCA)/CF studies on milk and dairy products are used to illustrate the complexity of such assessments. This to demonstrate many of the challenges associated with CF analysis and carbon labelling, and to discuss the opportunities on how CF can be applied and the obtained knowledge can be used. Initially CF and its challenges are discussed. This is done through three examples, which represent various difficulties related to methodological issues. The opportunities are then addressed, on basis of work conducted at the dairy company Arla Foods. Moreover, both the challenges and opportunities in carbon labelling are investigated, followed by discussion and conclusion of the overall findings.

2. Carbon Footprint (CF) methodology

Lifecycle assessment (LCA) has since the beginning of the nineties been used to evaluate the environmental impact (where contribution to global warming is one impact category) from products, using a lifecycle perspective. The ongoing discussion about carbon labelling has already resulted in the development of standards and guidelines, specifically designed for calculating the CF of products. As one of the first, PAS 2050 (2008), prepared by British Standard Institute (BSI), is a specification developed for assessing the life cycle GHG emissions of goods and services. The PAS 2050 is to large extend based on the ISO 14040 (ISO 2006a) and ISO 14044 (ISO 2006b) standards, but in some areas it is more specific in how to calculate the CF. However, despite being more specific, it still gives room for interpretations, as is the case with the ISO standards. Consequently, it is important to discuss how various prerequisites influence the final result. Analysing the contribution to global warming from food products might often be even more difficult than for the other sectors (e.g. electricity, energy, transport), which also dominate the overall emission of GHG. This is due to the fact that agricultural systems are of biological origin, which include complex processes why the calculations often will include large uncertainties.

[1] carbon footprint (CF) accounts for all GHG emissions, i.e. also nitrous oxide (N_2O) (which is especially important for agricultural products), and not only those consisting of carbon, as the name implies.

2.1. Challenges in CF analysis

When performing an LCA or CF analysis there are a lot of uncertainties to consider. These are mainly related to methodological issues and data quality. Initially, many decisions have to be taken regarding methodological considerations, e.g. type of overall modelling approach to be used (e.g. attributional LCA vs consequential LCA), how to handle co-products (e.g. system expansion, economic allocation, mass allocation) and how system boundaries should be determined (e.g. should capital goods be included, emissions from deforestation occurring to make more land available for food production etc.). In the comparison of results from different studies it is urgent to beware of these prerequisites, as these will influence the final result significantly. Likewise, the quality of data needs to be considered to be able to make comparisons. Both the ISO standard (ISO 14044:2006) and PAS 2050 (2008) identifies a number of issues regarding the data quality, such as time-related coverage, geographical specificity, technology coverage, accuracy (PAS 2050 only), precision, completeness, representativeness (ISO 14044 only) consistency, reproducibility, data sources and uncertainty of the information (ISO 14044 only). Hence, while it is important to obtain data with as high quality as possible, it is, however, also important to remember that some data, e.g. emissions from biological processes, can have a high "inherent uncertainty", because the complexity of the process, lack of measurement methods and natural variations making it extremely complicated to come up with "one true figure". Moreover, there are also differences between farms, depending on management practices, which influence the final result of the CF analysis of milk. This also makes it a challenge to perform CF analysis of products, since it is at present not possible to get the CF for each specific farm producing/delivering milk.

The challenges with CF analysis will in the present discussion only focus on 1) handling of co-products (which is one of the more important methodological issues), 2) emission factors for nitrous oxide (to illustrate its importance for the data quality) and 3) variations between farm systems (demonstrating the difficulty to obtain "average data").

Handling of co-products

The focus here is to illustrate how the handling of co-products from milk production influences the final result of an LCA/CF study. In the analysis of CF of milk production, the handling of co-products is a critical issue to take into consideration, i.e. how to distribute the GHG emissions between the milk and the other outputs from the dairy farm (meat from slaughtered animals and calves). In Cederberg & Stadig (2003), three different ways to handle co-products from milk production were analysed, i) system expansion, ii) physical cause-effect allocation and iii) economic allocation. As seen in Figure 1, there is a significant difference in the results depending on the method chosen. Economic allocation, physical cause-effect allocation and system expansion gave 91%, 85% and 63% respectively of the GHG emissions compared to when 100% of the GHG emissions are allocated to the milk (Figure 1).

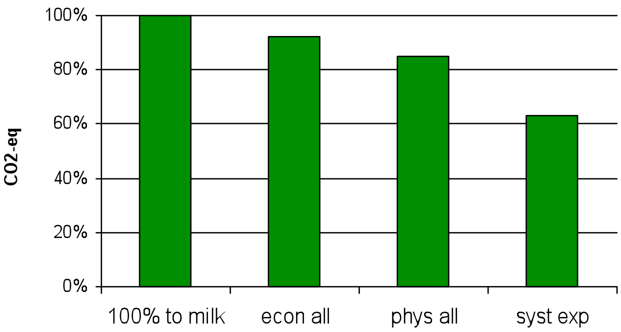

Figure 1: GHG emissions from milk production; comparison between 100% allocation to milk, economic allocation, physical cause-effect allocation and system expansion (based on figures in table 3 in Cederberg and Stadig, 2003).

It is obvious, that using system expansion give a significantly lower result compared with allocation. This is partly because that meat from the culled dairy cow is assumed to replace beef meat produced from a "pure" beef production system (so called suckler cow-calf system), but most important, surplus calves (mostly bulls) from the dairy production are assumed to substitute calf production in suckler cow-calf systems. In these production systems, a suckler cow produces approximately one calf per year; hence, the environmental impact from the calf is not only from the calf itself, but also from holding a suckler cow one year.

Also Hospido (2005) came to similar conclusions applying system expansion for the Galician milk production system in Spain, resulting in 72% of the GHG emissions attributed to the milk. The study by Cederberg & Stadig (2003) was performed for a Swedish system and over the past 30 years, the Swedish dairy cow population has decreased by 30 % (resulting from the increase of milk production per cow). Parallel with this, beef production from suckler cow-calf systems has increased to compensate for the loss of meat production from the dairy cow population, supporting system expansion methodology in assessing the environmental impact of milk. However, the result depends on the assumptions concerning substitution of products and it may be questioned, if meat from dairy cattle in fact substitutes meat from beef cattle. Hence, it is not obvious how by-products from the dairy system should be credited, and, moreover, there may also be variations between countries in how they interpretate the value of beef from dairy cattle.

Further down in the product chain, there are also challenges on how the GHG emissions should be distributed between various dairy products (e.g. milk, yoghurt, cheese, butter, whey, butter milk). Feitz *et al* (2007) made a comparison of different allocation methods for raw milk to various products. The different allocation methods compared base their allocation on: milk solids, economic value, mass, process energy, fat and protein. Depending on the allocation method, the amount of raw milk to market milk varies between 6.2% (process energy) and 51.3% (mass). For butter the corresponding figures are between 0.3% (protein) and 42.2% (fat) while they for cheese are between 4.5% (process energy) and 23.5% (fat). However, it can be discussed whether all these allocation methods are relevant, and the authors suggests a physico-chemical allocation based on milk solids. This seems to be valid approach, as there is no clear main product – by-product relationship and since the utilization of milk solids for different products to a wide extent is interchangeable.

Emissions factors (EF)

For many data it is possible to obtain a high quality (i.e. a high degree of certainty), while some has a high degree of “inherent uncertainty”, i.e. emissions from biological processes such as methane (CH_4) and nitrous oxide (N_2O). In the present we only focuses only on the uncertainties related to nitrous oxide to illustrate some of the challenges in obtaining robust and reliable emission data. GHG emissions from milk production (ex farm gate) consist of 45-65% methane and 20-35% nitrous oxide. A simple sensitivity analysis on the EF used for calculating nitrous oxide from fertiliser application shows the uncertainty and consequently the importance for the results of these emissions. Using data from one of the farms in Cederberg *et al* (2007) where the results are recalculated using the most recent characterisation factors for carbon dioxide equivalents (CO2-eq) from IPCC (2007) (i.e. methane 25 and nitrous oxide 298 kg CO2-eq per kg). According to IPCC guidelines (2006) the default emissions factor for direct nitrous oxide emissions from nitrogen applied as synthetic fertilisers is 0.01, with uncertainty range of 0.003-0.03. In Figure 2 below the emissions factor is changed from 0.01 to 0.02 and 0.03, which result in a total increase of GHG emissions of 11% and 25% respectively.

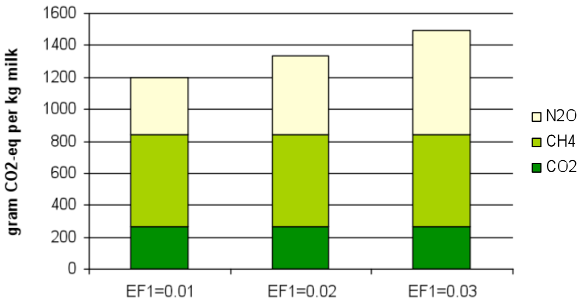

Figure 2: Increase of nitrous oxide emissions from synthetic fertilisers applied on field (based on one farm in Cederberg et al, 2007).

In the example above only one emission factor is changed and even though the uncertainty ranges might be extreme, the performed calculations still gives a good indication of how these emissions include large “inherent uncertainty” that needs to be accounted.

Variations between systems

There are obvious variations between farms. Consequently, different farms produce milk in various ways (i.e. uses different feeds and other inputs), which means that milk from different farms give rise to different amount of GHG emissions (Cederberg *et al* 2007, Cederberg & Flysjö 2004). This is a challenge, e.g. when a dairy company wants to calculate the CF of their products. Is it necessary to include the specific CF for the milk from each farm who delivers milk, or is a sample of farms enough? This is not really clarified in, for example, PAS 2050 (2008). Figure 3 shows the variation of GHG emissions between dairy farms, based on a study analysing the environmental impact from 23 dairy farms in Northern Sweden (Cederberg *et al* 2007), using updated characterisation factors (IPCC, 2007) for methane (from 21 to 25 gram CO2-eq per gram methane) and nitrous oxide (from 310 to 298 gram CO2-eq per gram nitrous oxide). Similar results are also obtained from other studies, i.e. Cederberg & Flysjö, 2004, where the environmental impact from 23 dairy farms in South-Western Sweden were analysed, (not shown).

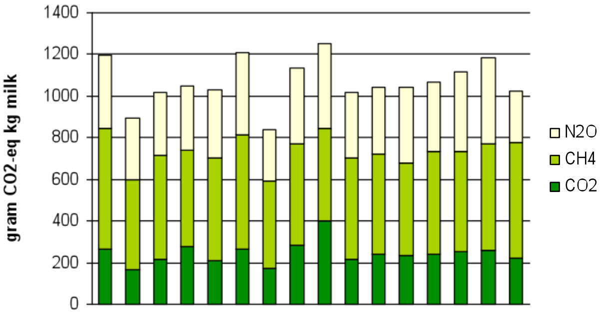

Figure 3: Variation of GHG emissions from different dairy farms in Northern Sweden, expressed as CO2-eq (based on Cederberg et al, 2007).

As can be seen from above data, there is a potential to reduce GHG emissions on farm level by improving management practices. The results presented in Figure 3 are calculated using the same method, but it would be of interest to perform a sensitivity assessment of the results, e.g. applying system expansion instead of allocation and analysing EF for methane and nitrous oxide for example. This will assess the robustness of the results. An important finding in the study Cederberg et al. (2007) and Cederberg & Flysjö (2004) is that there are significant variations between farms. The variations between farms with similar production system within the same country can be in the same magnitude as comparing results from different LCA studies on milk (e.g. Haas *et al* 2000, Hospido 2005, Hospido 2008, Williams 2006, Casey & Holden 2004, Thomasen *et al* 2008, Basset-Mens *et al* 2007, Cederberg & Flysjö 2004, Cederberg et al 2007). Hence, it can be difficult to tell whether a difference is due to an actual difference of GHG emissions or because of a difference in the calculation methods.

2.2. Opportunities in CF – case study of the dairy company Arla Foods

At the dairy company Arla Foods, the energy use and its related GHG emissions has been reported for more than ten years. For 2005 and onwards the total GHG emissions have been calculated (i.e. the total CF), from "cradle to gate" (including milk production, all inputs to the dairy, transports and delivery to store). This is a first step in the company's goal to reduce their GHG emissions by 25% by 2020 (compared to 2005 year's level). The reduction goal includes all activities at the dairy site, all packaging material and all transports; however, the agricultural stage is not included in the reduction goal.

Arla Foods has as basis for the CF calculation followed the guidance and principles set out in the "Greenhouse Gas Protocol Corporate Accounting and Reporting Standard" (GHG Protocol) (WRI & WBCSD 2004). The GHG Protocol is the most widely used international accounting tool for government and companies to assess their GHG emissions (The Greenhouse Gas Protocol Initiative 2009).

The GHG protocol requires emissions to be reported against three different "scopes", see Table 1.

Table 1: The different scopes defined in GHG protocol (WRI & WBCSD 2004).

Scope 1	Scope 2	Scope 3
Direct emissions from sources that are owned or controlled by the company (e.g. emissions from combustion of fuels in boilers, furnaces and turbines).	Indirect emissions associated with generation of purchased electricity consumed by the company.	All other indirect emissions as a consequence of the activities of the company that occur from sources neither owned nor controlled by the company (e.g. outsourced distribution).

The activities for Arla Foods associated with each scope are:

Scope 1: All emissions from combustion of fuels within the operation, including transports with Arla Foods' own fleet, and GHG emissions attributable to chemical/physical processes,

Scope 2: Purchased electricity and district heating, and

Scope 3: Raw material, including provision of fuels, and emissions from waste handling from waste arising at Arla Foods' facilities.

More than 90% of GHG emissions are related to Scope 3, while Scope 1 and Scope 2 gives similar emissions (i.e. Scope 1 stands for 4%, Scope 2 stands for between 2-3% and Scope 3 stands for 94%). Analysing the different activities, i.e. agriculture (covered under Scope 3), operation (mainly covered under Scopes 1 and 2), packaging (covered under Scope 3) and transport (covered under Scopes 1 and 3), show that the largest contribution to GWP occurs at the primary production, i.e. agriculture (86-87%), followed by operation (7-8%), packaging (3%) and transport (2%), as shown in Figure 4. It is obvious that the largest contribution to Arla Foods' CF comes from outside/off the company, why this part initially is most difficult to include in the reduction goal for the company.

However, as the company draws heavily on external resources and can do this differently dependent on policy, and likewise the products produced may inherently code for more or less environmental impact before final consumption. Thus, it is important to also put emphasis on understanding the activities before the dairy, i.e. the milk production at the farm.

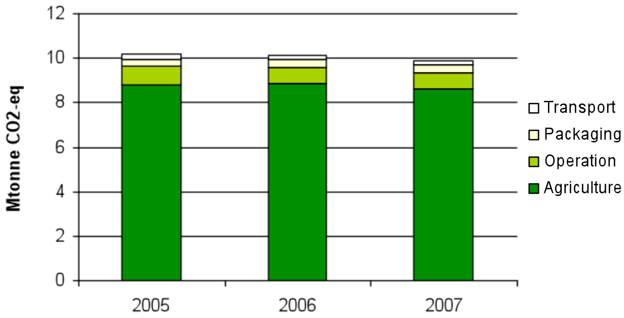

Figure 4: Total CF for the dairy company Arla Foods.

The total CF (including primary production) for Arla Foods was 10.2 Mtonne CO2-eq in 2005 compared with 9.9 Mtonne in 2007. Considering only the activities included in Arla Foods' reduction goal (i.e. excluding agriculture), this correspond to a decrease of 8.6% or 0.12 Mtonne CO2-eq. The total reduction by 2020 should be on 0.35 Mtonne CO2-eq.

A lot of effort has already been made at Arla Foods to reduce their CF, for example, reducing waste at production, more efficient use of energy, closing of less efficient production sites and moving production to more efficient sites, minimising packaging and training chuffers in "eco-driving". However, there are additional improvements where Arla Foods' can reduce their CF. While the primary production stage dominates the CF of dairy products, it is important to reduce losses of the raw material (i.e. the milk). Hence, every kg of milk saved will reduce the CF with around one kg CO2-eq (assuming the CF of milk to be one kg). Also, the further down in the production chain losses occur, the larger the impact, since this will affect all upstream processes where less milk/dairy products need to be produced, processed, transported and stored. This can be done by, for example, more efficient processing. In Berlin & Sonesson (2008) it was concluded that only by optimising sequencing, as much as 29%, or possibly up to half, of the waste from cultured dairy products could be eliminated. Also, it is estimated that product losses, at other stages or for other product groups, can be reduced by 15% by lowering milk waste at the dairy, 12% for yoghurt processing (pasteurisation, fermentation, packaging), 2.5% for cheese-making process and 50% for unsold milk and yoghurt products at retail (Berlin *et al* 2008). Also at consumer stage there are potential for reduction in product loss. In a study analysing the food waste in UK (Ventour 2008), it is stated that 3.4% of all dairy products purchased are avoidable waste (based on the weight; which on cost basis equal 9.8%). However, the study does not include milk and other dairy products disposed via the sink, hence this figure is heavily underestimated. A rough estimate on the GHG emissions related to the avoidable waste of dairy products in UK based on Ventour (2008) is 0.46 Mtonne CO2-eq[2], i.e. in absolute numbers, the improvement potential at the consumer stage is in the same magnitude as Arla Foods' reduction goal. This shows there are great potential for Arla Foods to e.g. improve packaging to reduce 'leftovers', develop products that are more durable etc.

Besides waste minimisation several other possibilities for reduction in CF are possible. These include use of alternative types of fuels (e.g. bio based fuels instead of fossil fuels) and to purchase electricity from renewable sources. Moreover, more efficient logistics can be implemented, both regarding storage and transportation. Even though a big effort has been taken within the packaging area, there are still possibilities for improvements why different solutions continuously are analysed. Finally, investing in new and more efficient technologies can, for example, reduce both energy use and product losses. However, several of these issues need further investigation.

3. Carbon Labelling

There are different ways to obtain a carbon label on a product. Below is given a brief description on some of the initiatives. Basically there are two approaches, either 1) to calculate the CF for the product (i.e. for the whole lifecycle of a product) or 2) to identify criteria to be fulfilled at each production stage (i.e. primary production, processing, packaging, transportation etc). Obviously, there are pros and cons in both approaches why several initiatives have been taken to investigate alternative options. As mentioned previously, PAS 2050 (2008), is one of the initiatives that are intended to help organisations to calculate their CF, thus it also can be the basis for communication to consumers, i.e. labelling. Likewise, the International Standard Organisation (ISO) is working on how GHG emissions specifically, can be calculated, developing a standard around CF for products (ISO 14067)

[2] own calculations, CO2-eq for different products is taken from Berlin 2002, Berlin *et al* 2006, Lagerberg Fogelberg 2008, SIK 2008

regarding both quantification and communication (ISO 2009). One of the first CF labels, The Carbon Reduction Label, was developed by the Carbon Trust. This takes into account all GHG emissions during the whole lifecycle of a product and also includes a reduction goal, which commit the company to reduce the GHG emissions associated with the product (Carbon Trust 2009). All of the above mentioned CF methods are examples based on approach 1). This allows comparison of products and hereby makes it possible to make decision between product groups (e.g. comparing meat products with vegetable options).

There are also other initiatives, which are based on approach 2). This include the Swedish initiative on climate labelling for food, initiated by KRAV, the Swedish organisation for organic labelling, and The Swedish Seal of Quality (Svenskt Sigill), a quality label for assured food. In this initiative general standards are developed to regulate different activities in the food production chain (i.e. primary production, processing, packaging and transportation). Consequently, there will be specific standards for different products/product groups, even though for some activities (e.g. transports) the standard will be the same for all product categories. Thus, the purpose with the label is not to guide the consumer to choose between different product groups, but to help them choose within product groups (Klimatmärkning för mat 2009).

While the above are some of the labelling initiatives, or bases for labelling possibilities, there are several opportunities for a company to reduce their GHG emissions and to communicate their strategies to consumers or other stakeholders. The challenges and opportunities with carbon labelling, with focus on dairy products, are discussed more in detail below.

3.1. Challenges in carbon labelling

As mentioned above, many carbon labelling initiatives focus on "one number" (approach 1) explained above), i.e. the total CF of a product. Obtaining a numerical value includes many uncertainties (see Challenges with CF), and would represent a significant burden to companies in terms of assessment and documentation. Besides it could be argued that a numerical value on a product can be difficult to understand for the consumers (Upham 2008). Moreover, it might also appear confusing to begin to relate to an additional label. One option could be to include the carbon label in already existing labels, to avoid more labels on products.

Obviously, there is a challenge of how to label a product in an informative way for the consumer, which provide enough information without providing too much information that only will confuse. If there should be a separate label for GWP, one option could be a "traffic light" system, or a scale from "good" to "bad" indicating the performance of the product. However, it might be difficult for the consumer to choose between products if it is an absolute scale, showing that carrots, with relatively low CF, is "good" and pork, which has a higher CF, is "bad" (or at least worse). For the consumer the choice will probably not stand between carrots or pork, but rather choosing within product groups (i.e. vegetables, meats etc). An alternative would then be to have a scale for each product group (i.e. a relative scale), but then there need to be a definition of different product groups, and preferably also how the different product groups relates to each other (i.e. make the consumer aware of the impact from meat compared to a vegetable option). It is also important to communicate to the consumer that a product can have a high CF, though it is showing "good" on a scale.

Additionally, focusing on GWP only means that all other environmental impact categories (e.g. eutrophication, acidification, toxicity etc) are not included; hence there could be trade-offs between different impact categories, which might be important to consider. Furthermore, there could also be tradeoffs between GWP and other non-environmental aspect of sustainability.

Another aspect, which is difficult to handle in a satisfactory way within carbon labelling of products is the function of the product (e.g. nutritional value). Some products have unique qualities and it is therefore difficult to compare them with other products. However, in some cases comparison is possible, e.g. meat compared with some vegetable option, but most likely not by comparing one kg with another, but rather on for example a protein bases (even though that might not fulfil the identically function either). Hence, it is important to not only to focus on GWP per product, but also to include the "function" of the product.

The focus in this paper is milk and dairy products, which in many aspects are unique products. Milk contains 18 of the 22 essential vitamins and minerals needed daily (Swedish Dairy Association 2009). It is therefore not possible to see milk solely as a drink and compare it with e.g. juice, but rather to find a composition of products, which corresponds to the nutritional value of milk. Obviously, this is challenge to communicate within carbon labelling.

3.2. Opportunities in carbon labelling

Many consumers are showing interest in learning more about products' contribution to global warming and want to be able to make choices favouring products with lower CF (Thomas & Preece 2008). Industries are also likely to comply with these requirements in various ways. To get consumers engaged in those issues and increase awareness and knowledge is desirable. However, as illustrated above, there are many challenges before carbon labelling will be an established method in the communication with the consumers. Initially, carbon labelling can be used between industries to put demands on suppliers. Using CF analysis and carbon labelling as a competition tool will help improving the overall performance of industries, and thus fulfil the overall goal.

Besides the more “conventional” way of putting a label on a product, there are several other opportunities how to use carbon labelling. Upon broadening of the concept, several ideas of communicate the CF work of an industry, or inform consumers how they can help reducing GHG emissions, are summarised/described in the following section.

A well-documented work around CF with an intension to reduce the overall GHG emissions of a company is a profound way to be profiled as a “low carbon company”. Purchasing products from that company would then assure consumers that they support a business that reduces GHG emissions. This would in many ways be an easy approach, however, this does not allow for comparison between products, nor businesses. Developing packaging easy to empty and put information about the importance of waste minimisation on the package is another way of informing consumers how they can help to reduce environmental impact. An obvious choice for the dairy industry could be to focus on e.g. yoghurt packages. These are possible to design in many ways that improve emptying that could be combined with information regarding consumer awareness on the importance with emptying the package as much as possible. This approach could help reduce the waste at the consumer stage. Moreover, several other opportunities are evident, which can be just to add additional information on packaging regarding waste treatment, e.g. information about how much CO2-eq is saved by the right waste treatment through recycling rather than disposal. Milk packages are, for example, since many years used for various types of information and could be used for “knowledge spreading” and communicating with consumers about e.g. environmental aspects and how to help reducing GHG emissions.

4. Discussion and conclusion

The largest uncertainties in estimates of the CF for a dairy product are related to the milk production on the farm (i.e. primary production) and how the environmental impact is distributed between different dairy products at the dairy. As shown here, handling of co-products is crucial; various types of allocation and system expansion can give significantly different results. In general, system expansion as method to handle the co-products meat and calves from dairy farms results in lower GHG emissions per kg milk, than when allocation is used. With regard to the dairy site, no literature has been found where system expansion has been used for all dairy products and by-products. However, the type of allocation method (i.e. economic, protein, fat, mass etc) applied is critical for the outcome of the result (Feitz *et al* 2007).

The EFs used for calculating biogenic GHGs, e.g. nitrous oxide from nitrogen fertiliser application, is also known to have significant impact on the final result. Considering the uncertainties of emissions from biological systems (soil, animals, manure), it is important to use data obtained with the same/similar calculation method, to minimise the uncertainties when comparing different systems. For estimating GHG emissions from milk production, the emissions from biological processes (methane and nitrous oxide emissions) are probably the data sources with the highest uncertainty. Consequently, there will always be an uncertainty in the results even when high quality data are used, considering the “inherent uncertainty” of these emissions. It is therefore important to analyse the uncertainties for these data and to include uncertainty assessment to a higher degree. This will give a better understanding for the systems and how the uncertainties/variations affect the final results.

Finally, it is important for stakeholders to get an understanding of the complexity of the systems and not to stress decisions or take decisions on wrong information/bases. Hence, it is important to continue to assess the contribution to global warming from products and to increase the knowledge about assessment methods, systems and uncertainties related to results. Especially if the results will be used for communication with consumers (i.e. carbon labelling), since this will impact both the credibility of the company as well as of carbon footprint and labelling as a method. As mentioned, many challenges remain regarding carbon labelling. While consumers are showing interest in learning more about products’ contribution to global warming and want to be able to make choices favouring products with lower CF, it might be difficult to introduce a label specifically for CF. There are uncertainties with CF assessments, as discussed, which increases the challenges how to communicate results to consumers. However, there are several opportunities to inform consumers, and also other stakeholders, about the company’s CF work and what can be done to reduce GHG emissions further.

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