How to use LCA in a company context – the case of a dairy cooperative

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ABSTRACT

The present paper uses the dairy cooperative Arla Foods as an example how life cycle assessment (LCA) can be used within a company. The total carbon footprint for Arla Foods, from cow to consumer, is estimated at almost 18 million tonnes CO_2e, where primary production represents about 80% of the emissions. Arla Foods has defined environmental goals for all stages of the life cycle. The goal for greenhouse gas (GHG) emissions is to reduce emissions with 30% per kg milk at farm level (between 1990 and 2020) and with 25% for processing, transports and packaging (between 2005 and 2020). Another goal is to help consumers to reduce their food waste with 50%. In order to follow up and reach the goals, different tools have been developed to support the environmental work. Some of the challenges faced during the process, especially at farm level, are also discussed.

Keywords: dairy, life cycle assessment, carbon footprint, greenhouse gas emissions, emission reduction

1. Introduction

During recent years there has been a change in the focus of the environmental work among companies. From being a matter of complying with environmental legislations at site level, many companies now also have strategies and targets to reduce the environmental impacts at other parts of the value chain. Life cycle assessment (LCA) is a useful tool to understand the magnitude of environmental impacts at different stages of the life cycle and how these can be reduced. Life cycle thinking is also important to be able to track net-improvements and to avoid (or minimize) shift-of-burden problems, where solutions to one problem becomes the cause of another. The present paper uses the dairy cooperative Arla Foods as an example how LCA can be used within a company context to reduce environmental impact and to become more sustainable. Arla Foods is one of the largest dairy companies owned by about 12000 farmers in seven different countries (Sweden, Denmark, UK, Germany, the Netherlands, Belgium and Luxemburg) and with a global milk intake of almost 13 million tonnes milk.

Arla Foods has worked with reducing the environmental impacts for several decades. Initially the focus was on issues within Arla Foods' own operation, e.g. waste water, emissions to air, noise and odor at site level, followed by reductions in energy and water use as well as logistic planning to reduce fuel consumption. Around year 2000, the focus expanded to include packaging and externally managed transports. In 2008, the concept *'Closer to Nature'* was launched by Arla Foods with environment and climate concerns as an essential element. One of the goals was to reduce greenhouse gas emissions with 25% within the areas processing, transport and packaging between 2005 and 2020. Some years later, in 2011, a new environmental strategy for 2020 was presented, in which Arla Foods promised to take responsibility for the full value chain – 'from cow to consumer'. It was stated that Arla Foods would promote sustainable dairy farming and that specific targets should be developed. At processing level it was decided that 50% of all energy use should be renewable and that there should be zero waste (i.e. all waste should be reused or recycled). Specific goals were defined also at the last stage of the value chain, at consumer level and for waste management, where food waste at consumer level should be halved and all packaging should be 100% recyclable. After a couple of years a dairy farming sustainability strategy was adopted focusing on the areas animals, climate, resources and nature. A climate target was defined at farm level, where greenhouse gas (GHG) emissions should be reduced with 30% per kg of milk between 1990 and 2020. Figure 1 illustrates how the environmental work at Arla Foods has evolved and how Arla Foods has developed specific environmental targets, starting with its own operations (processing, transport and packaging) to finally include the whole value chain. The cradle to gate carbon footprint (CF) for Arla Foods has been calculated previously, but no study of Arla Foods' total CF from cow to consumer has yet been conducted.

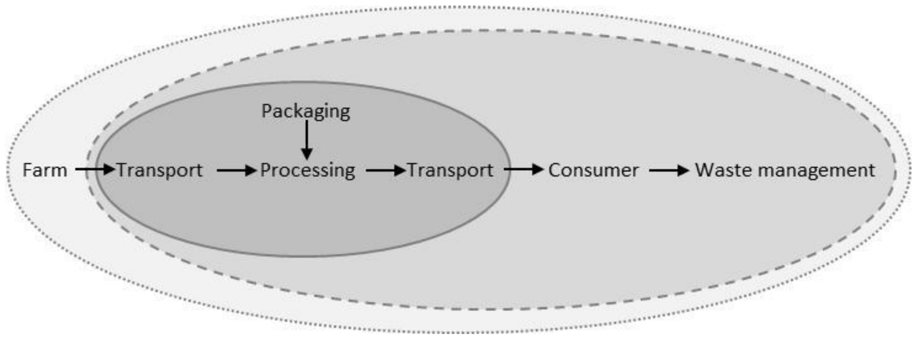

Figure 1. Illustration of how Arla Foods has worked with defining environmental targets within different areas over time, starting with processing, transport and packaging (solid line), then including also consumer and waste management (stippled line) and finally also including farm level (dotted line).

Arla Foods has also established goals on other parameters besides contribution to global warming (such as animal welfare, water and energy). However, the present paper focuses primarily on GHG emissions since this is the area which has gained most attention and where several methodological challenges have been identified.

The overall purpose of the present paper is to show how LCA can be used within a company context in order to reduce environmental impacts. More specifically the total CF for Arla Foods, from cow to consumer, is estimated, as well as the CF for some specific dairy products. In addition some of the main challenges and difficulties faced during the process are discussed. Finally some aspects of Arla Foods future work on sustainability are addressed.

2. Methods

LCA has been the methodological approach for the whole environmental work of Arla Foods, both when setting targets based on the strategies and when defining actions to fulfill the targets as well as following up on targets. The applied methodology related to the different stages of the life cycle is described in the following.

2.1. Farm level

Pre-farm gate emissions constitute the largest share of the environmental burdens in the value chain of dairy products. Raw milk production typically constitutes 80-90% of the CF of milk at the point of distribution to retail (Gerber et al., 2010). It is therefore pivotal to include farm level when promoting a more sustainable dairy production. One critical aspect for the CF result of milk at farm level is which LCA methodology is used: attributional LCA (ALCA) or consequential LCA (CLCA) (Thomassen et al., 2008). The two methodologies obviously answers different questions, where ALCA has a 'what is' focus while CLCA has a 'what if' focus. Some standards leave room for interpretation and leave it up to the practitioner to define the 'rules' for ALCA and CLCA (e.g. ISO 14040 and ISO 14044 (ISO 2006a,b)). Other standards/guidelines give clear guidelines when ALCA and CLCA should be used and how e.g. co-product handling should be conducted in the different cases (e.g. ILCD by the European Commission, Joint Research Institute and Institute for Environment and Sustainability (2010)). There are also some standards/guidelines that specifically recommend a certain LCA method (e.g. PAS2050 (BSI, 2011)). As farm level results in the largest share of GHG emissions of milk, Arla Foods decided to develop a tool that could handle several LCA methodologies in order to answer different questions to assure that reductions are achieved no matter what methodology is used. It resulted in a tool that has a 'switch' that makes it possible to generate results according to CLCA, ALCA (using only economic allocation), PAS2050 (Carbon Trust, 2010) and IDF (IDF, 2010) respectively, using the same input data (Dalgaard et al., 2014).

However, it is not feasible to report and communicate results from four different methodologies. Arla Foods has therefore decided to follow the methodology from the International Dairy Federation (IDF, 2010), developed by the global dairy industry, to report and deliver on the goal of reducing GHG emission. Since there is no agreed method on how to deal with emissions from land use change (LUC) Arla Foods do not include LUC emissions as default.

In the calculations of the total CF of Arla Foods in the present paper, the average CF of milk at the farm gate is estimated to be one kg CO_2e per kg milk, as no more detailed and uniformly calculated CF data are available in all countries where Arla Foods has production. This estimate is based on reviewing literature (Flysjö et al., 2011a; Hagemann et al., 2011; Kristensen et al., 2011; Williams et al., 2006) and comparing with the CF for milk in Sweden and Denmark in 1990 and 2005, and in Germany and UK in 1990 (Figure 3) (Dalgaard and Schmidt, 2012; De Rosa et al., 2013; Schmidt and Dalgaard, 2012), and is considered realistic and even somewhat conservative. As described above, emissions associated with LUC is not shown in the results in the present paper, however, the tool developed for calculating the CF of milk at farm level has a 'switch' to include missions from LUC using different methods. The different features of the CF tool are further addressed in the discussion.

2.2. Processing, transport and packaging

Arla Foods is collecting data on a yearly basis for all energy use for and waste from processing, transports (own operations as well as externally managed) and packaging. The data is used to follow up on reduction goals and is used in the present study to calculate the total CF of Arla Foods. Dairy products such as cheese, butter, milk powder and whey are also purchased together with 'other' raw materials and ingredients such as jam, sugar, salt and vegetable oil. To estimate the CF for purchased dairy products the method presented in Flysjö *et al.* (2014) is used, and data for other raw materials and ingredients are obtained from Davis et al (2011), Ecoinvent (2010), Schmidt (2007) and SIK (2009).

In the present study, the CF for some general dairy products is presented; whole milk (3% fat), yoghurt (3% fat), butter blend (with 60% fat of which 63% butter fat and 37% vegetable oil) and yellow cheese (17% fat). The packaging for the different products are one liter paper carton with plastic cap for milk and yoghurt, 250 gram tub for butter blend and plastic foil for cheese (packaging size of 800 gram). One of the most critical decisions for the CF of dairy products is co-product handling. To calculate the CF for the products mentioned above the method in Flysjö et al. (2014) is used, where allocation of raw milk is done based on the value of the different milk solids (fat, protein and lactose) in the final products.

2.3. Consumer level

To analyze the CF of the whole value chain of Arla Foods, the consumer stage also needs to be accounted for. In the present paper data for GHG emissions from retail, home transport and storage in refrigerator at consumer have been added to the total emissions of Arla Foods. Data for the latter part of the life cycle is taken from Flysjö (2011) and Flysjö (2012). Another aspect that can impact the CF value is food waste, especially at consumer level. This is also analyzed and estimated numbers on food waste at consumer used in the present study are 4% for milk, 10% for yoghurt, 3% for cheese (Berlin et al., 2008) and 5% for butter blend (Flysjö, 2011).

3. Results

The total CF – from cow to consumer – of Arla Foods in 2013 is estimated to almost18 million tonnes CO_2e (Figure 2). Milk and raw materials stand for the largest share of the CF (about 80%), while processing, transport and packaging stand for about the same amount of emissions as consumer stage. Emissions associated with raw milk production represent the largest share (almost 90%) of the first bar in Figure 2, whereas purchased dairy products stand for about 10% and other raw materials and ingredients stand for less than 2%. The largest share of direct emissions at consumer stage is from home transport (about 70%). Food waste is not shown in Figure 2 as these emissions are related to up-stream activities. Overall, however, food waste is likely to represent the largest environmental impact at the consumer stage.

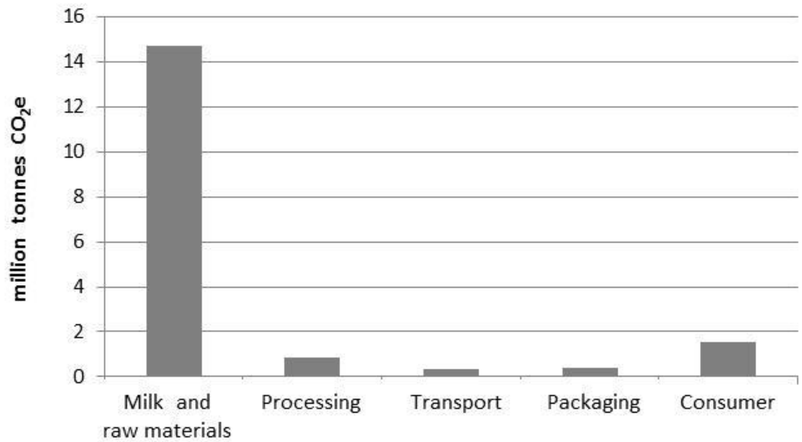

Figure 2. Total CF of Arla Foods production, from cow to consumer.

The CF per kg of fat and protein corrected milk (FPCM) at farm gate was about 1.25-1.3 kg CO2e in Sweden, Denmark, Germany and UK in 1990 (using the IDF methodology and excluding emissions from LUC) (Dalgaard and Schmidt, 2012; De Rosa et al., 2013; Schmidt and Dalgaard, 2012). In 2005 the CF per kg FPCM was reduced by 15% and 22% for Sweden and Denmark, respectively. No CF results have been estimated for Germany and UK for 2005. The stippled line in Figure 3 shows the reduction goal of -30% emissions per kg milk in 2020, compared to 1990.

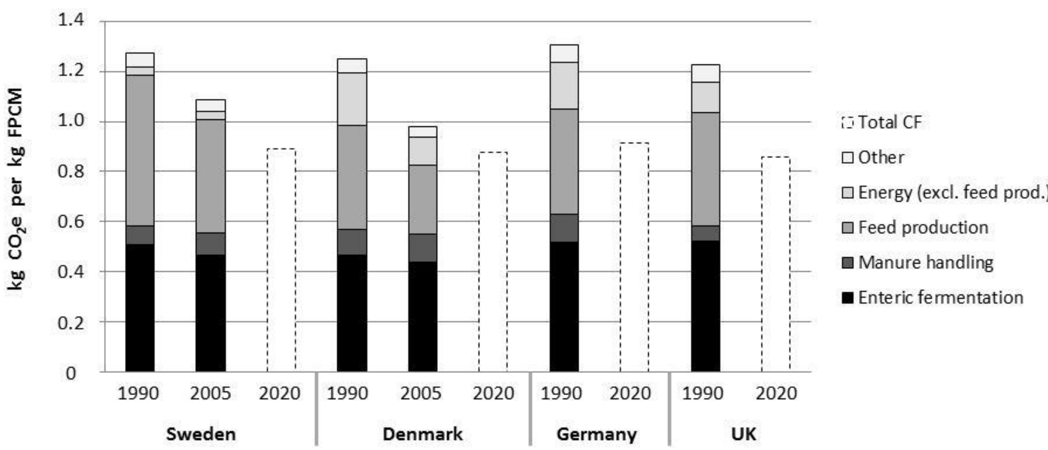

Figure 3. The carbon footprint of fat and protein corrected milk (FPCM) at farm gate in Sweden, Denmark, Germany and UK in 1990 and 2005 (latter only for Sweden and Denmark). Stippled line shows 30% lower CF compared to 1990, which is Arla Foods target at farm level.

Figure 4 shows the total reductions for Arla Foods in GHG emissions for processing, transport and packaging from 2005 to 2013. Most reductions have been achieved for processing and packaging (about -15%, respectively), while transport is about same in 2013 as in 2005. There are uncertainties in the numbers, as Arla Foods has been through a number of mergers and acquisitions since 2005 and reporting might not be the same in other companies.

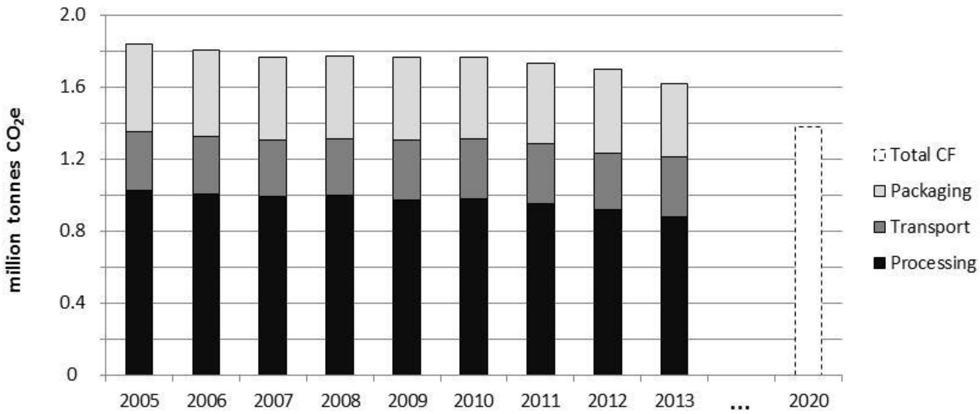

Figure 4. Arla Foods' total reduction in greenhouse gas emissions from processing, transport and packaging from 2005 to 2013. The stippled line shows the goal of -25% emissions in 2020.

Figure 5 shows the relative distribution of GHG emissions between the different life cycle stages for milk, yoghurt, low fat butter blend and yellow cheese, both including and excluding waste at consumer level. The estimated CF for each product including waste at consumer is 1.4 kg CO_2e per kg milk, 1.6 kg CO_2e per kg yoghurt, 7.1 kg CO_2e per kg butter blend and 8.8 kg CO_2e per kg cheese. Retail and consumer level emissions constitute a relatively larger share of the CF for milk and yoghurt, as these products has a lower CF per kg product compared to butter blend and cheese.

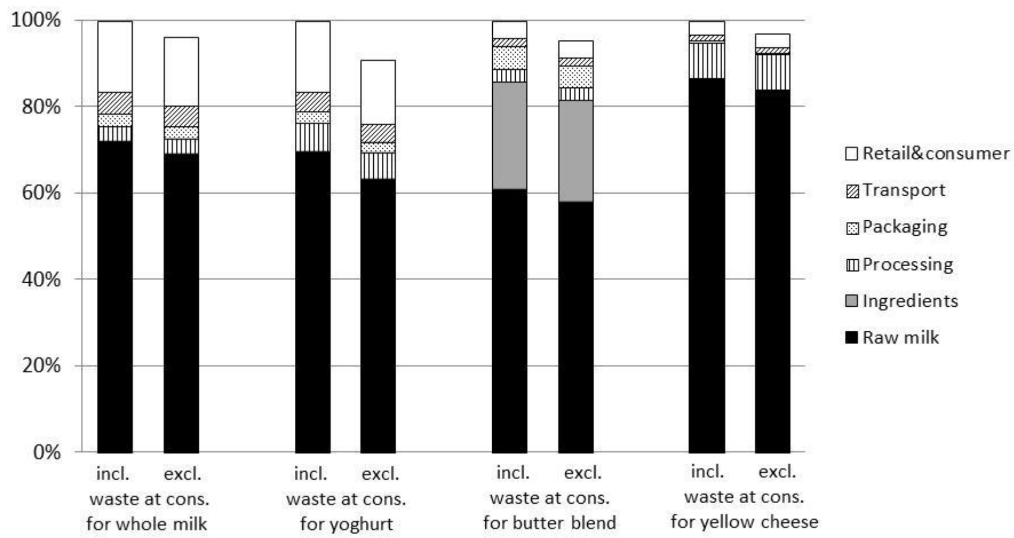

Figure 5. Relative distribution of the carbon footprint between life cycle stages for the different dairy products; milk, yoghurt, butter blend, and yellow cheese, including and excluding waste at consumer level. Ingredients in butter blend is vegetable oil.

4. Discussion

Having a life cycle perspective is important to achieve efficient environmental improvements and to ensure net benefits throughout the value chain. Initially, focus was put on Arla Foods' own operations, but today the whole value chain is included. Figure 6 shows the relative environmental impact of the different life cycle stages and illustrates the possibility Arla Foods has to influence the different life cycle stages. Farm level is obviously the life cycle stage which stands for the largest share of emissions for dairy products, followed by the consumer stage (Figure 2). Thus, from a life cycle perspective, farm level and consumer level would be the two life cycle stages to focus to reduce emissions most efficiently. However, these two life cycle stages are also the ones most challenging to influence. Some of the challenges related to the LCA methodology and data gathering are discussed below. One of the critical aspects is to find a model that captures enough detail and relevant aspects of GHG emissions at farm level to ensure that the goals are reached, i.e. that actual reductions are achieved.

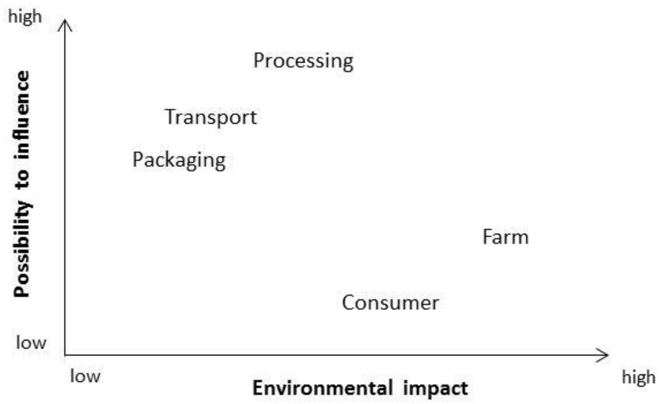

Figure 6. Illustration of which life cycle stages have the largest emissions and where Arla Foods has the largest influence.

4.1. Farm level

One of the main differences between primary production and the rest of the value chain is that methane (CH_4) and nitrous oxide (N_2O) constitute the largest part (70-80%) of the GHG emissions, while for processing, transport, packaging and consumer level it is carbon dioxide (CO_2) from combustion of fossil fuel that is the main contributor to the CF. There is a relatively large certainty in the CO_2 emissions from combustion of fossil fuel and a reduction in these emissions is thereby relatively certain. When it comes to emissions of CH_4 and N_2O on the other hand, there is a larger inherent uncertainty in these emissions (Flysjö et al., 2011b). The main share of the CH_4 is from enteric fermentation when the cow is digesting the feed and is a naturally process for ruminants in order to make use of grass and other feed sources inedible for humans. The largest share of N_2O emissions is from nitrogen turnover (from synthetic fertilizers, manure/excreta and crop residues) in agricultural soils used for feed production and is also a natural and inherent variable process. Hence, there will always be CH_4 and N_2O emissions from milk production due to the characteristic of milk and agricultural production. Also, the CF of milk at farm level is related with a relatively large uncertainty, which obviously makes it more difficult to estimate total emissions and to follow up on reduction measures. In some cases reduction measures can be known (e.g. drainage of soils), but not captured in the models/calculations and thereby not part of the reported emission reductions as it is not possible to quantify them. Another challenge is the representativeness. Arla Foods has over 12000 dairy farms in seven different countries delivering milk, and it is not realistic to collect data from all these farms. The ease at which a CF for an individual farm can be calculated is very much related to data availability and differs between countries. In Denmark farmers report more data to statistics compared to e.g. Sweden and Germany. Hence, in Denmark it would be easier to calculate the CF for a larger number of farms compared to the other two countries. However, Arla Foods want to have a similar approach in all countries and plan to calculate the CF for about 200 farms yearly in Sweden, Denmark, UK and Germany, respectively (Germany also include the farmers in the Netherlands, Belgium and Luxembourg). The number of CF assessments at farms is assumed to be more than enough to be representative according to the Carbon Trust (2010). Today about 1500 CF assessments have taken place together with almost 300 farm workshops that Arla Foods has arranged with focus on sustainable dairy farming in Sweden, Denmark and UK. However, it needs to be evaluated whether it is possible to use these ‘bottom-up’ CF numbers to follow up on the overall reduction goal, where the baseline for 1990 was calculated ‘top-down’ using national statistics. It is important to keep in mind that CF numbers should not be compared unless they are estimated in a comparable way (Henriksson, 2014). At the moment different support is also provided from authorities in the different countries regarding calculating CF at farm level and extension services coupled to these calculations. It is important to make use of national initiatives, but risks introducing differences in methodology. The feature with the Arla tool was to use the same tool, but with country specific background data, to calculate the CF for milk for different countries. However, due to data availability and data transfer this is not up and running for the moment. Another feature with the Arla tool was to be able to use the same input data and generate results according to different LCA methodologies. Being able to present CF results using different methodologies can be useful in some situations. While the IDF methodology is chosen for reporting and in communication with farms, the CLCA approach can be useful on a policy level and to understand e.g. the link between milk and meat production and what effect milk production has on other systems. Having the different methodologies in the tool can also be used to assure that improvements are taking place. This was shown when calculating the CF for milk in Sweden and Denmark in 1990 and 2005, where there had been a reduction in emissions between the years no matter which LCA methodology was used (results not shown).

4.2. Processing, transport and packaging

For the next part of the value chain, on the other hand, it is much easier to ensure that reductions are achieved, since a reduction in e.g. fuel oil results in lowered emissions. On-site energy use is also within the direct control of Arla Foods and it is thereby easier to implement actions to ensure reductions. The same also goes for own operation transports. In many cases, however, infrastructure can be limiting and it can thereby be difficult to e.g. increase the use of renewable energy sources. For the externally managed transport it is important to work with suppliers and request transports with lower emissions. When it comes to packaging there are several aspects to consider. Different materials have different environmental impact, so the choice of the material is obviously important. The packaging should preferably also be possible to recycle, why also the end-of-life needs to be considered. Again, a limiting factor can be infrastructure, such as waste management systems in the country where the products are sold, since not all countries have a recycling system for waste. To put focus on the environmental impact of packaging, Arla Foods has developed a tool to analyze the CF of different packaging solutions (materials, end-of-life solutions etc). This allows incorporating environmental thinking already in the design of the packaging. The function of the packaging is another aspect that needs to be considered. The trend today is that there are more single households, more advanced packaging (e.g. milk cartons with plastic cap, sliced cheese in plastic pack) and more ‘on the go’ meals (one portions with plastic spoon etc). All this results in more packaging per kg of product, but at the same time such packaging can contribute to less food waste. So in total there might be a net benefit considering the whole life cycle of the packaging (including the product).

Arla Foods are reporting its total GHG emissions according to the greenhouse gas protocol (World Business Council and World Resource Institute for Sustainable Development) and the goal on reducing the GHG emissions is established according to that. The 25% reduction is in absolute numbers, i.e. not per kg of product. However, if the company is expanding through mergers or acquisitions the baseline needs to be recalculated, but any organic growth is not accounted for. Since the reduction goal does not account for the amount of products produced, it would also be desirable to calculate the CF per product or product group, to also capture the efficiency of production. Today Arla Foods has developed a method to calculate the CF of dairy products (Flysjö et al., 2014) and has assessed the CF for a number of dairy products (Flysjö, 2012). The next step is to implement the model on site level to follow improvements on product level. This would for example account for reductions in product losses which currently are not reflected in the reporting according to the GHG protocol.

4.3. Consumer level

Home transport showed to be the activity leading to the main share of direct emissions at consumer stage (Figure 2). This estimate is obviously related with rather high uncertainty, and little information is found on consumer travels associated with food purchasing. Sonesson et al. (2005) suggests 28-63 km per week and household to be a reasonable assumption for food purchases in Sweden. The present study uses the lower value when estimating Arla Foods total CF.

Another aspect, probably even more important to focus on at consumer level, is food waste. Even though the emissions associated with food waste occurs up-stream of the value chain (e.g. at farm level, processing, transport), the consumer has the possibility to reduce the amount of food waste and therewith reduce the amount of food that is produced for no reason. A study initiated by the Food and Agricultural Organization of the United Nation (FAO) estimated that 7% of dairy products are wasted at consumer level in Europe and in US the number is about twice as high (Gustavsson et al., 2011). Sonesson et al. (2005) found even larger waste numbers for dairy. Assuming the food waste of dairy products to be 7% it would equal a CF on 1.3 million tonnes CO_2e, and if the waste would be 15% it would be about 2.7 million tonnes CO_2e, for Arla Foods total production.

Arla Foods has a goal on reducing food waste at consumer with 50% by 2020 and are analyzing ways to help and inspire consumer to avoid wastage of food. Among other things an ‘empty your fridge’ app for smart phones is developed (for the Danish market), with recipes to help consumers make use of left overs. Packaging design is another way to reduce food waste and is one aspect Arla Foods is working with. A study analyzing the CF of butter showed that 37% of the butter in mini-tubs was wasted (Flysjö 2011). Arla Foods has now redesigned the packaging which now consists of 8 gram butter instead of 10 gram. There has not yet been any study to follow up the results, but less butter in mini tubs are likely to be wasted.

4.4. From minimizing negative impact to maximizing positive impact

During the last decades, the environmental work of Arla Foods has shifted from focusing on single impacts (e.g. emissions and resources) at only part of the value chain where Arla Foods has direct influence (e.g. processing), to include several impact categories to better capture the whole concept of sustainability (e.g. GHG emissions, resources, animal welfare, biodiversity) for the entire value chain from cow to consumer (Figure 7). Hence, the scope has broadened both regarding focus areas/impact categories as well as stakeholders/value chain.

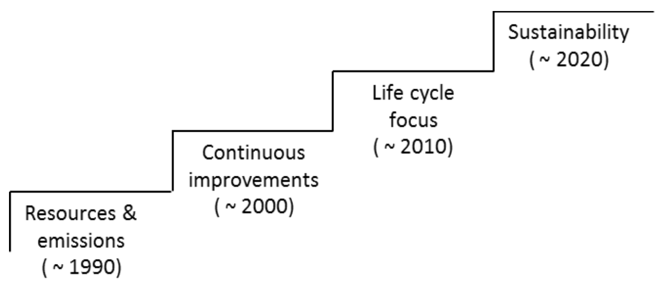

Figure 7. The development of focus areas for Arla Foods’ environmental work (inspired by Nielsen and Remmen, 2005).

One recent example is that in order to further improve the sustainability of the production, Arla Foods has decided to purchase RTRS certified soy (for all soy fed to the dairy cows delivering milk to Arla), certified palm oil (used in dairy products) and certified cacao (used in dairy products). There is also some other ‘sustainability’ projects on e.g. tree planting in Mozambique and Uganda.

As a cooperative, Arla Foods has a close dialogue with the dairy farms. This creates a unique possibility to work together to improve and reduce GHG emissions at farm level and promote a more sustainable dairy production. At the same time, however, it can be challenging as the farmers are the owners of Arla Foods and it is therefore not possible to simply define targets and put demands at farm level without their accept. In order to influence farmers a combination of awareness raising and motivation has to be adopted. Similarly, in order to achieve the goals related to consumer food waste, focus needs to be on motivating consumers to make more sustainable choices in addition to offering them e.g. packaging sizes that will enable them to avoid throwing valuable food away. Arla Foods has a long tradition of communicating closely with the consumers, through recipes, home pages, social media and apps for smart phones. The “empty the fridge” app for smart phones, mentioned earlier, is one concrete example on this. Other activities are advices on how to store food, recommendations on portion sizes and advices for “food planning”.

The focus of Arla Foods so far is mainly on minimizing the negative environmental impact – the footprint. However, it is also important to focus on maximizing the positive impact – the handprint. Handprints can be generated by reducing the footprint, helping someone else reducing their footprint or taking other generative action (e.g. tree planting) (G Norris, Harvard School of Public Health, Boston, Massachusetts, USA, personal communication). By broadened the scope to include e.g. consumer stage, Arla Foods is trying to inspire others to reduce their footprint. Actively engaging with consumers and other stakeholders, and creating a dialog on sustainability, is more about generating a positive impact and creating a handprint than just reducing the footprint.

Thus, shifting from only focusing on minimizing the environmental impact to maximizing the positive impact is important for a sustainable development.

5. Conclusion

During the last decades, the environmental work of Arla Foods has grown in scope and includes now the full value chain. The broadened scope has also resulted in more challenges. LCA is a valuable tool to report and focus the environmental work. The total CF of Arla Foods from cow to consumer is estimated at almost 18 million tonnes CO_2e. About 80% of the emissions occur at primary production while consumer stage represents about 10% of the CF. Environmental goals are defined for all stages of the life cycle, including consumer level. Between 1990 and 2005 GHG emissions at farm level have been reduced with about 15-20% in Sweden and Denmark. The average reduction in GHG emissions for processing, transport and packaging is 12% between 2005 and 2013. One of the goals at Arla Foods is to help consumers to reduce food waste with 50%. If this goal is achieved it would save about 0.6 million tonnes CO_2e of Arla Foods CF (assuming that 7% of all dairy products are wasted, as estimated for Europe).

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