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The environmental impact of the consumption of sweets, crisps and soft drinks

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Content

Summary

The Swedish Food Administration (Livsmedelsverket) commissioned SIK to conduct a Life Cycle Assessment (LCA) study of the product segment snacks and soft drinks in order to quantify its impact upon greenhouse-gas emissions, eutrophication and primary energy use. The products studied were crisps, sweets and soft drinks produced in Sweden and consumed in the Scandinavian capitals. The life-cycle phases included in the study are raw material and ingredient production; transportation of raw materials and ingredients; industrial processing (i.e. factory); and transportation to the central warehouse and to the local retailer.

The study was conducted in co-operation with the Swedish companies Svenska Lantchips, Leaf and Spendrups. Inventories were taken at their plants in order to generate specific data for processing. Where the data was incomplete or inadequate, assumptions have been made, as specified, for each system.

The project has been supported by the Swedish Board of Agriculture via its “A Food Strategy for Sweden” programme. The Nordic Council of Ministers provided funding via grants from the Nordic Working Group for Diet, Food and Toxicology (NKMT) and the Nordic Strategy for Sustainable Development.

Aggregated results from the current study in relation to greenhouse-gas emissions are presented in the chart below. The products’ greenhouse-gas emissions per kg of product are compared to other snacks and to some common staple foods that may have the same function as snacks and soft drinks.

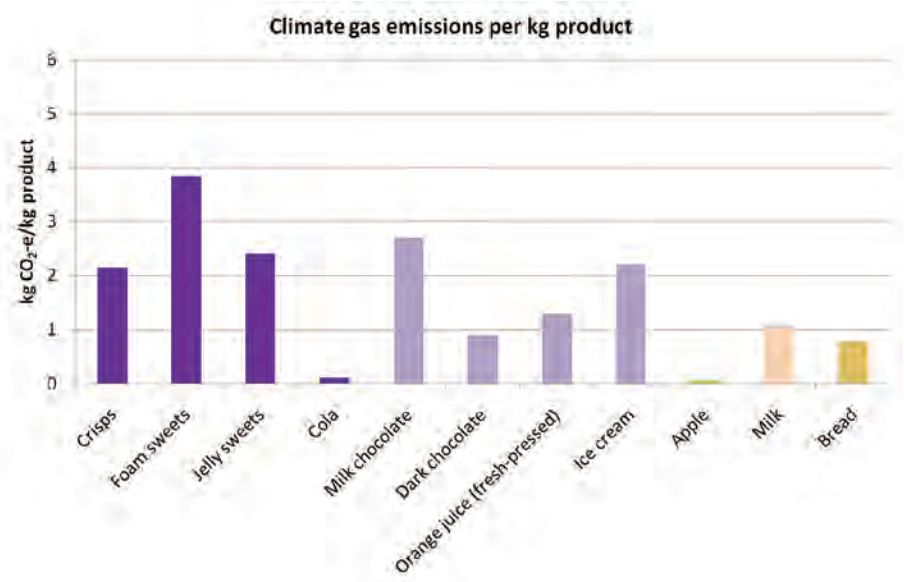

Illustration 1: Climate gas emissions for snacks and soft drinks at the factory gate. The snacks and soft drinks studied are shown in dark purple; light purple represents previous results for this type of food; and the other colours depict the results for basic foodstuffs. References: Chocolate, juice, ice cream and bread: SIK website (www.sik.se/matoklimat). Milk: SR 793 (SIK www.sik.se under Library/Reports – Environment). Apple: SR 630 (can be ordered in hard copy from the library at SIK).

Obviously, the products do not have the same nutritional content and are not eaten in the same quantities, so the comparisons do not indicate which foods are preferable from a climate point of view, but rather show the spread in the snacks and soft drinks product segment.

There have been few previous studies on the environmental impact of snacks and soft drinks – and no publicly available life-cycle analysis has been found in relation to sweets. The results of this analysis therefore represent new knowledge about the environmental impact of food.

Walkers Crisps, England, was the first company in the UK to put a climate label – a Carbon Footprint – on one of their products (http://www.walkerscarbonfootprint.co.uk/). The climate-gas emissions for the English crisps were 3.2 kg of CO_2 equivalents per kg of crisps. This is a slightly higher value than that of the crisps in this analysis (2.2 kg CO_2 equivalents/kg crisps). The difference reflects the variation that occurs between various systems. For example, the potatoes used in the two varieties may be grown in different areas, and the crisps might not be fried in the same oil.

Of all the products studied in this analysis, sweets have the greatest environmental impact per kg. Foam sweets make a higher contribution to greenhouse-gas emissions and eutrophication and use more energy than jelly sweets. The sweets' ingredients account for the greatest environmental impact of all the life-cycle steps in the analysis. Both products lose mass during production, mainly due to evaporation, and therefore the products' processing mixture has a volume that is larger than that of the finished product. Foam sweets have a lower product yield, which means that a relatively small quantity of finished product is responsible for the environmental impact of its raw materials and ingredients. Grains and sugar beets are the raw materials for many of the two products' ingredients (sugar, glucose syrup, ethanol and lactic acid), and the environmental impact of these ingredients stems from the raw material production. The contribution to eutrophication for both products is dominated by the impact from production of the ingredients (including raw materials).

Soft drinks have a relatively limited climate impact and eutrophication contribution as well as a lower energy use per kg than the other products studied. The environmental impact of the packaging is more significant, mainly due to the larger proportion of packaging material used per amount of product. For soft drinks sold in Sweden, the contribution of the packaging is lower because the bottles are returnable. For soft drinks sold in Norway, Denmark and Finland, the contribution is higher because they are assumed to be disposable. Coca-Cola in Britain has carried out Carbon Footprint analyses of their products. A 33 cl Coca-Cola in a glass bottle (disposable, including beverage) has a climate contribution of 360g of CO_2 equivalents (http://www.coca-cola.co.uk/environment/what-s-the-carbon-footprint-of-a-Coca-cola.html), which corresponds to this study's results for cola drinks in a disposable bottle. Only 6% of this contribution stems from the ingredients, the rest comes mainly from the container – but the production process also contributes.

Switching to renewable energy (from both electricity and other sources) at the factory stage would lower climate-gas emissions (this applies to all products studied).

In 2007, Swedes consumed 1.6 kg of crisps, 15.2 kg of chocolate and confectionery, and 87.7 litres of soda per person (SJV, 2009a). The contribution to climate-gas emission of this consumption would be approximately 450,000 tonnes of CO_2 equivalents (calculated on the basis of the population in 2007, which was 9,182,927 according to Swedish statistics by SCB 2008). This illustration is based on the climate-contribution results for the products in this report (at the factory gate, excluding packaging), and the assumption that 50% of the chocolate and confectionery consumption is chocolate (half dark, half light) and 50% is sweets (half jelly, half foam). In a report to the Board of Agriculture (SJV, 2009b), SIK estimated that greenhouse-gas emissions from total food consumption in Sweden amount to approx. 17.3 million tonnes of CO_2 equivalents (based on primary production only). Consumption of snacks and soft drinks accounts for approximately 2.6% of these emissions. The corresponding figures for meat, dairy products and eggs are approx. 35%, 20% and 1% respectively (figures from SR 794 (www.sik.se under Library/Reports – Environment)).

1 Background

Food production is currently estimated to account for around 25% of Sweden's total impact on the climate, around 75% of eutrophication and around 20% of primary energy use. These figures include all ingredients and resources used throughout the food-production life cycle. These findings have led to increased interest in and demand for greater knowledge of the environmental impact of various food products from producers, public bodies and researchers. In recent years, there has also been increased interest in the impact of food products on the climate.

Research is currently being conducted to improve knowledge of the environmental impact of food production. This research could form the basis for measures to reduce the environmental impact of food production and consumption. One segment in which environmental studies have been lacking is the segment often referred to as "snack food", i.e. sweets, crisps and soft drinks. In Sweden, the consumption of sweets, crisps and soft drinks has increased by around 50% since 1990 (Swedish Board of Agriculture, 2008). Since 2000, snack food has had a significant and stable share of total food consumption. For example, in 2005, the Swedes drank just as much skimmed and semi-skilled milk as soft drinks and cider (approx. 85 litres per person p.a.). It is therefore of interest to compare the environmental impact of this product group with other food groups.

The Swedish Food Administration, with funding from the Nordic Council of Ministers and the Swedish Board of Agriculture (via its "A Food Strategy for Sweden" programme (LISS)), has therefore commissioned SIK (the Swedish Institute for Food and Biotechnology) to quantify greenhouse-gas emissions, eutrophication and energy use for selected products in the category "snacks and soft drinks".

For the last 15 years, SIK has studied the environmental and climate-change impact of food using Life Cycle Assessment (LCA) analyses. It has built up a unique skill set and database in this area, which has been put to good use in this project.

2 The environmental impact of food in general

Primary production, i.e. the agricultural production of raw materials, generally accounts for the majority of a product's environmental impact over its whole life cycle. Subsequent stages in the production chain, e.g. transport, processing and packaging, are generally less significant (with certain exceptions).

The food sector is estimated to account for approx. 25% of total greenhouse-gas emissions from private consumption (Swedish Environmental Protection Agency, 2008). For agricultural products as a whole, 80% of this impact stems from primary production. For meat and dairy products, the proportion is even higher (90–95%), and for vegetable products it is lower. The major part of this contribution stems from emissions of methane gas (CH_4) from livestock (ruminants), from emissions of nitrous oxide (N_2O) and carbon dioxide (CO_2) in mineral fertiliser production, and from nitrogen application to fields. Leakage of nitrous oxide and ammonia from manure stores also contributes to the climate-change impact, while emissions from diesel used on farms make a minor contribution.

Life-cycle phases after primary production generally make a smaller contribution. During the transport phase, consumption of fossil fuels results in emissions of carbon dioxide. Leakage of the synthetic refrigerants used in vehicles and warehouses can result in extremely high greenhouse-gas emissions, as many of the so-called soft freons (HCFCs, which replaced the ozone-depleting hard freons, CFCs) have a heavy climate impact. Electricity also has an impact on the climate if it is generated from fossil fuels, e.g. from a coal-fired power station.

Animal products generally have a higher climate impact than vegetable products – often approx. 2–30 kg more CO_2 equivalents per kilo of product. The exceptions to this are milk and certain dairy products, which have a carbon footprint of around 1–2 kg of CO_2 equivalents per kilo of product. Examples of animal products that affect the climate by approx. 2–3 kg of CO_2 equivalents per kilo of product are chicken and pelagic fish (fish that live in open waters, e.g. herring, and which can be fished with equipment that does not come into contact with the seabed). Among vegetable products, rice is in a class of its own – it has very high greenhouse-gas emissions due to the methane generated by rice fields. Vegetables cultivated in greenhouses heated by fossil fuels also have a heavy climate impact. Fruit, root crops and vegetables cultivated in the open air have the lowest impact. For these products, transport, packaging and processing are normally more significant in the life cycle.

Primary production often accounts for up to 95% of food production's total contribution to eutrophication, due to excessive emissions of nutrient nitrogen and phosphorous. The main cause of these emissions is the use of fertilisers in agriculture and the consequent leakage of nutrients.

Energy is used during every phase of the food product's life cycle. The most energy-intensive stages are the production of raw materials and ingredients, which involves a large amount of mineral fertilisers, as well as diesel use on the farm, and energy use in processing, packaging production and, in certain cases, transport. Energy use has an indirect effect on climate impact through greenhouse-gas emissions, the extent of which depends on the type of energy used – i.e. fossil fuels produce more emissions than renewable sources.

Primary production systems (i.e. how various types of agriculture, fish farming and fisheries are conducted) vary greatly, both within and between countries. This means that the results of a given life-cycle analysis cannot be regarded as comprehensive and applicable to all products within the relevant product group. Life-cycle analysis of a food product provides information on environmental impact at various phases of the life cycle, and can therefore form a basis for the development and implementation of improvements at various points in the chain.

3 Aim and scope

This project was commissioned by the Swedish Food Administration and funded by the Nordic Council of Ministers and the Swedish Board of Agriculture through its “A Food Strategy for Sweden” (LISS) programme.

3.1 Aim

The aim of the study is to use life-cycle analyses to quantify the environmental impact in the form of greenhouse-gas emissions, eutrophication and energy consumption during the life cycle of four products in the snack food category: crisps, soft drinks and two types of sweets (jelly and foam). The findings provide insights into the points of the production chain that have the greatest environmental impact. The results can form a basis on which to develop proposals for improvements and, on the basis of these, to introduce practical measures that generate the greatest possible reduction in environmental impact. The results principally apply to Swedish production because the inventory of industries was carried out in Sweden, but they are also considered applicable to the production of Scandinavian crisps, sweets and soft drinks because these countries use broadly similar industrial techniques. In the LCA calculations, NORDEL has been used for electricity production, which means that the results for this branch of industry can serve as an approximation of Scandinavian production. With regard to packaging, waste processing has been calculated on the basis of country-specific recycling statistics – four different outcomes are presented for each product, in order to adjust the result as closely as possible to the circumstances in the country in which the product is likely to be consumed. The results can therefore be used to estimate production in the other Scandinavian countries.

3.2 Analysis methodology

The Life Cycle Assessment (LCA) method has been used to calculate the total environmental impact of each product. The life cycle is defined by setting system limits, i.e. each system has a beginning (e.g. agricultural input) and an end (e.g. management of product or packaging waste). This establishes a functional unit that serves as the base calculation to which emissions are related, and reflects the product’s functions. Further definitions are made of assumptions and limits and of how allocations are made between the main product and its by-products. The methodology is clearly described below in this report. The LCA method used is descriptive LCA, which identifies the environmental effects ascribed to a given product. Life Cycle Assessment is a standardised methodology complying with ISO 14040–14044.

3.3 Functional units

In a Life Cycle Assessment, a base unit is chosen, to which the results of the environmental calculations are related. This is known as the functional unit. The functional unit reflects the function of the product in question, so packaging, a portion or a kilogramme of the product being studied is often chosen. The functional units for products in this study are as follows:

- The functional unit for crisps is 200 g of crisps in consumer packaging, transported to a local retailer.
- The functional unit for foam sweets is 125 g of foam sweets in consumer packaging, transported to a local retailer.
- The functional unit for jelly sweets is 2 kg of jelly sweets, packed in containers for loose sale and transported to a local retailer.
- The functional unit for soft drinks is a 33 cl bottle of cola, transported to a local retailer.

3.4 Scope of the study

The life cycles of the four products in question begin with the primary production of raw materials, while the final phase is delivery of the products to four selected retailers in Stockholm, Oslo, Copenhagen and Helsinki. The various cases are theoretical (for example, Spendrups cola and Svenska Lantchips crisps are not exported in reality). The Swedish production processes are considered to be representative of Scandinavian production of crisps, sweets and soft drinks, as the Scandinavian countries are at a similar level of technical development. Since NORDEL was used for the energy calculations, the manufacturing plants in the study could just as easily have been located in another Scandinavian country, so the results for these products are considered to be representative of Scandinavian production as a whole. Both foam and jelly sweets are exported to the Scandinavian markets (there are offices not only in Sweden, but in Norway and Denmark). Waste disposal of packaging materials specific to the country in question is included in the study. The quality of the data that underpins the results is crucial, and below follows a summary of the various sub-sections of the study and a short account of the data used.

The process stages (Illustration 1):

- Primary production (cultivation) of raw materials (start of life cycle)
- Transport of raw materials to plant for processing

- Industrial processing of raw materials (e.g. various stages of sugar refinement)
- Manufacture of product packaging
- Transport to product-manufacturing plant
- Production processes for the various products, plus packaging
- Transport to central warehouse
- Central warehouse
- Transport to retailer

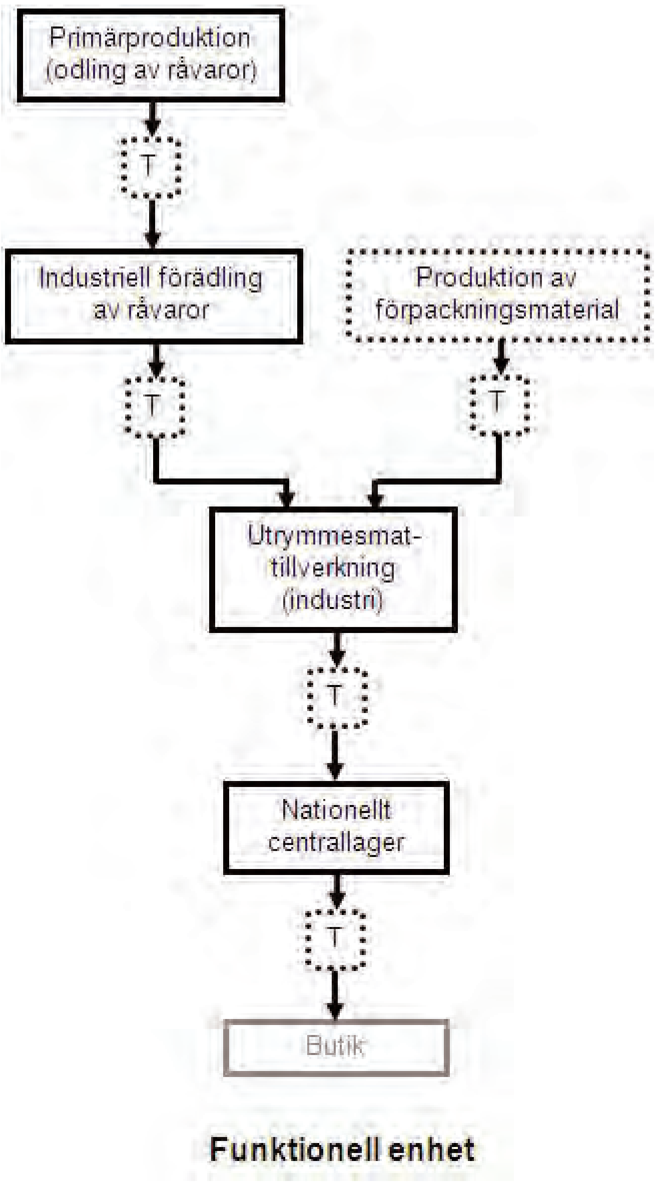

Illustration 1: Schematic illustration of systems studied for sweets, crisps and soft drinks. T stands for transport. Boxes with black edges have been inventoried for quantity/distance, but production and transport data have not been specifically inventoried, except for the production of snack food and drink, which have been specifically inventoried. Boxes with grey edges are not included. Boxes with dotted edges have been inventoried in relation to distance and quantity, but database values have been used for fuel production and combustion processes.

Data has been collated in order to calculate the potential climate-change impact, eutrophication contribution and energy use of the production of crisps, sweets and soft drinks in Sweden. SIK sourced the data by contacting Swedish manufacturers in the snack food sector, who supplied data for manufacturing plants, raw materials, packaging and transports. SIK staff have also been on inventory visits to manufacturing plants in order to better understand production processes. As far as possible, specific production data has been used as the basis for the calculations, but where this was not possible, research literature has been used and assumptions made to exclude as little as possible from the study. The data used as the basis for the calculations is specified in the section “Data sources and data quality”.

3.5 Environmental impact categories and assessment methods

The following three environmental impact categories are included in the analysis:

- Climate-change impact – GWP (Global Warming Potential/Greenhouse-Gas Emissions), expressed as kg CO_2 equivalents/kg product
- Eutrophication – EP (Eutrophication Potential),
- expressed as kg PO_4 equivalents/kg product
- Use of primary energy – PE (Primary Energy),
- expressed as MJ equivalents/kg product.

3.5.1 Climate-change impact

Climate-change impact is calculated on the basis of emissions of greenhouse gases into the atmosphere. Emissions resulting from anthropogenic activity reinforce the natural greenhouse effect, and therefore raise the median temperature of the lower atmosphere. These greenhouse gases are classified according to IPCC (2007), which also quantified their respective potencies, from a climate-change perspective, compared to carbon dioxide. A kilogramme of a particular gas contributes a certain number of carbon dioxide equivalents (CO_2-e), each representing the climate-change effect of a kilogramme of carbon dioxide. This unit is used in order to calculate the combined climate-change impact of the system studied. In Sweden, the climate-change impact of private consumption has been calculated as follows: eating 25%; housing 30%; travel 30%; and shopping 15% (Swedish Environmental Protection Agency, 2008).

3.5.2 Eutrophication

The largest contributor to eutrophication is livestock farming, which leads to nitrogen leakage from fields and ammonia emissions from manure. Nitrogen leakage results from the use of both fertilisers and manure, and it also occurs in soil management – where early autumn ploughing in particular leads to greater run-off (Federation of Swedish Farmers, 2002). Eutrophying emissions in vegetable production consist mainly of nitrogen leakage from fields, caused by both fertiliser use and mechanical preparation of the soil. Phosphorous leakage also has an impact, but nitrogen is the main problem. Emissions of nitrous oxides from the use of diesel fuel in tractors have a smaller effect, but rather greater than for animal products, where ammonia emissions overshadow the eutrophication impact of nitrous oxides.

Nitrogen and phosphorous are lost from fields and conveyed both by groundwater and by run-off water into waterways and then onward to lakes and the sea. When nutrients accumulate in these waters, they provide nourishment to the primary producers in the water, the algae. Major algal bloom can occur, after which the algae die and sink to the seabed, causing oxygen depletion on the seabed when the organic material decomposes. Oxygen depletion has a negative impact on other organisms – it can, for example, affect fish stocks. A regular influx of nutrients alters the ecosystems of lakes and seas, and can cause them to become wetlands instead.

Eutrophication is not only caused by nutrient releases from crops – other sources are forestry, paper production, municipal waste water-treatment plants and individual drains. Eutrophying emissions also stem from nitrous oxides released by vehicles and heating systems (i.e. those powered by the combustion of fossil fuels), which are returned to lakes and seas in the rainwater.

3.5.3 Primary energy

Primary energy is the energy used in the various activities in the life cycle, and is directly extracted from natural sources, e.g. oil, uranium and coal. It takes approx. 3 megajoules (MJ) of primary energy to produce 1 MJ of electricity, which is a secondary energy form.

The characterisation method used for GWP and EP is CML2001 (Guinee et al. 2002), based on updated data from 2007. The method has been changed to take account of the latest characterisation factors from IPCC (2007) for methane (25g CO_2-e./g CH_4) and nitrous oxide (298g CO_2-e./g N_2O). In relation to eutrophication, all eutrophying emissions, both phosphorous and nitrogen, have been converted to phosphate equivalents. For primary energy (PE) the combined energy requirements have been calculated according to the CED (Cumulative Energy Demand) method published by Ecoinvent (Frischknecht et al., 2003). Energy from the following categories has been included: fossil fuels, nuclear power, biomass, wind power, solar energy, geothermal energy and hydro-electricity. Both methods are available in the software used for the analyses, SimaPro (PRE, 2007).

3.6 Allocation

Allocation is a method for dividing the environmental impact between different products and by-products in the same food production chain or production stage (e.g. a cow provides both beef and milk). The ISO standard requires that a system expansion should, if possible, be carried out in the first instance, i.e. the production of a by-product of equal value should be inventoried and its environmental impact subtracted from the process stage, so that the residual environmental impact is ascribed to the main product. This is often difficult, both because it makes demands on resources and because it is not always easy to identify an equivalent product to the by-product. The alternative is to distribute the environmental impact, i.e. make an *allocation*. This can be done on the basis of various interrelationships, which may be physical or financial in nature.

The allocations in this study are generally based on the financial value of the various products. In some cases, the allocation has been based on the mass or volume of the manufactured products. Allocation choices are described for the relevant products.

3.7 Data sources and data quality

This project has used available life-cycle analysis data for most of the raw materials used. Actual figures for energy consumption, packaging materials and transport distances (known as foreground data), as well as information on industrial processing and some raw material (ingredient) use, were specifically collected from the manufacturers.

Primary data is that which has been specifically inventoried for the purpose of the analysis, while secondary data is that which has been acquired from databases, literature or previous studies. Secondary data is often used for the background system.

Primary data for the four snack-food sector products was sourced from the processing companies taking part. For crisps, the processing of potatoes was inventoried (inventory data is presented in the chapter on crisps), while for sweets, an inventory was made of the yield for the process of producing lactic acid (sugar to lactic acid), with the data supplied by the Purac company. Data for the remaining ingredients was taken from the SIK foodstuffs database and from EcoInvent (including the salt on crisps). Secondary data, such as the environmental impact of electricity production, fuel combustion, plastic production and transport emissions, have not been specifically inventoried but acquired from life-cycle assessment databases (EcoInvent, 2007). As far as secondary data is concerned, SIK selected the data that was considered the most relevant in terms of age and quality. The best available data has been used, i.e. the most up-to-date available data based on the most comprehensive data it has been possible to derive from life-cycle assessment methodology.

For electricity consumption at the processing plants, the NORDEL energy mix (based on Ecoinvent, 2007) was used. If a particular form of electricity was used at a plant, i.e. electricity produced from a renewable source, data for this has been used instead. For several of the ingredients, mainly Swedish-produced electricity was used, which means that NORDEL sources were not used throughout the process. For fossil fuels, emissions over the entire life cycle are included. Data on emissions from the production and use of energy were acquired from the Ecoinvent (2007) database.

With regard to the waste management of packaging materials, various scenarios were employed, based on the norms for waste management in the consuming countries (Sweden, Denmark, Finland and Norway). Waste management data for 2008 in respect of the EU member states (Sweden, Denmark and Finland) was acquired from Eurostat (Cewep, 2010). Corresponding 2008 data for Norway was acquired from Statistics Norway (SSB Norge, 2009). The waste-management alternatives accounted for in the EU statistics are recycling, incineration and landfill. The Norwegian statistics also covered other forms of waste management. The overall figures have therefore been simplified as follows: recycling 40%, incineration 35% and landfill 25%. The underlying electricity-production savings in waste-management processes are based on Swedish electricity data from Ecoinvent. Had country-specific electricity data been used instead, the results would have been more specific. Tests were done to determine the extent to which a change in electricity supplier would affect the results – it was found that the total result was reduced by <1% if Swedish electricity was replaced by Danish electricity in the recycling scenario for plastic containers for jelly sweets in Denmark.

Secondary data for glass materials for soft drinks bottles was acquired from Ecoinvent. This data takes account of the contribution made by the production of bottles and the fact that 58% of the raw materials stem from recycling. These figures correspond to the proportion of recycled glass found in Swedish white packaging glass (circa 60%).

The transport data included in the analysis covers transport during the ingredient and raw materials stage; the transport of raw materials and ingredients to the factory (insofar as we have data for this, it is specifically presented for each product); and the transport of finished products from factory to central warehouse in Malmö and onward to retailers in the Scandinavian capitals (Stockholm, Copenhagen, Helsinki and Oslo). Transport data is sourced from the Network for Transport and the Environment (NTM), 2007, with diesel-production data from Ecoinvent. Some transport data is also based on Ecoinvent processes (Ecoinvent, 2007).

Emissions due to land-use changes (in the cultivation of oil palm) are included in the analysis for palm oil. This includes carbon losses resulting from deforestation (cutting down forests results in a large net rise in atmospheric CO_2 due to reduced carbon-capture ability) and from CO_2 leakage from crop fields. This data was acquired from Ecoinvent (Ecoinvent, 2006).

3.8 Assumptions and limitations

This project covers the categories climate-change impact, eutrophication and energy use, and as such it does not present a complete picture of a product's total environmental impact. Toxicity, as related to the environmental objective of a "non-toxic environment", is not included within the framework for the study, since insufficient information on the relevant raw materials is available.

The study includes transportation of products from the factory to central warehouses and onward to retailers, but energy consumption in the warehouses has not been included, as this would normally make only a marginal contribution to the environmental impact within the life cycle of a food product. Similarly, energy consumption at retailers has not been included, since the functional unit for the snack food products ends with delivery to the retailer.

Environmental data is unavailable for certain ingredients, and these are therefore not included in the environmental assessment. Items included or excluded from the systems studied are specified in each product's inventory.

4 Products studied and the inventory process

4.1 Crisps

4.1.1 Choice of study object

In the this category, a specific packet of crisps – "lightly salted", 200g, including contents, manufactured by Svenska Lantchips on a continuous production line – has been selected because it is one of the biggest products (30% of production by volume) made in Sweden by Svenska Lantchips. Crisps from the continuous production line are not sold under the Svenska Lantchips brand, but rather as "private label" products, e.g. as supermarket "own brands".

Illustration 2: Crisps

The potato used is the Saturna variety, the high starch content of which makes it suitable for crisp production. It also differs from other potatoes in terms of storage, as it can be stored at higher temperatures (around 8°C). As well as crisps, the Saturna is also used to make French fries.

4.1.2 Production

The potatoes arrive, washed, at the Svenska Lantchips plant in Södertälje. Potatoes that do not meet the quality standard are removed and used for summertime pig feed. The potato is peeled using sandpaper, then sliced and lightly washed to remove starch. The water used is unheated and recirculated to minimise energy and water consumption. The slices of potato are fried in palm oil and then salted. The crisps are then ready for packaging in 200g packets. These are then packed in 20-packet cartons and placed on pallets. Each pallet bears 650 packets of 200g (130 kg).

4.1.3 Raw materials

The factory uses around 6,000 tonnes of potatoes per year, and produces around 2,000 tonnes of crisps, i.e. it takes 3 kg of potatoes to make one kilogramme of crisps. The reason for this rather low yield is that water accounts for much of the potato's weight, and this is removed during processing. Every tonne of crisps uses 275 kg of palm oil. The finished product is approx. 24–27% palm oil, 1% salt, and 72–75% potato.

Svenska Lantchips' potato buyer in Denmark supplied production data, including details of the recommended fertilisation levels/ha for the Saturna potato: 160 kg N, 25 kg P, 150 kg K (+15 kg Mg). The buyer also provided average harvest yields: 46,600 kg/hectare gross, 37,700 kg of sellable potatoes net (soil residue and losses during storage have been deducted to arrive at the net weight). SIK agronomist Christel Cederberg (personal communication, 2010) examined this data and confirmed that the levels were appropriate. These fertiliser recommendations and harvest yields have therefore been used as a basis on which to calculate the environmental impact of potato cultivation. from Christel

4.1.4 Packaging

The crisps are packaged in plastic packets consisting of two components: oriented polypropylene (OPP) and metallised oriented polypropylene (metallised OPP). The two layers are glued together with 2 grammes of adhesive per m^2 of plastic. The outer layer is OPP, 30 µm thick, with a density of 0.91tonne/m^3. The inner layer, metallised OPP, is a "fluffier" material, 28 µm thick, with a density of 0.63 tonne /m^3. Since the packet consists of more than one component, recycling is not possible. Waste management therefore consists of incineration, the impact of which has been included in the final life-cycle phase. In order to calculate the amount of aluminium used in a packet, the thickness of 0.7 µm was multiplied by the area of a 200g crisp packet (0.13 m^2). Using database values (Ecoinvent, 2007) for aluminium production, it was calculated that the aluminium in a single packet corresponds to emissions of 2.9 grammes of CO_2 equivalents. Aluminium production has therefore been taken into account in crisp-packet production. However, energy consumption for the process by which the aluminium is fixed to the OPP (which takes place at a temperature of around 1,500 ºC) has not been included, because data for this process is not available.

4.1.4 Inventory of crisp production

Recipe

Ingredient use and processing data for the factory are based on inventories conducted on site by SIK staff in collaboration with quality-control staff at Svenska Lantchips. Information has also been collected by telephone and e-mail with the staff of Svenska Lantchips, who have been very helpful.

Wastage

No specific wastage data has been obtained for the processing stage, as it is included automatically. For example, wastage in the form of potato peel, etc. is accounted for in the inventory process for the total annual production of crisps in 2009 (which included the quantity of potatoes purchased as well as the volume of crisps sold). Crisps discarded due to poor quality etc., are incinerated to heat the factory. Insofar as this reduces the need for electricity consumption, etc., this particular wastage is registered as a minus item in terms of environmental impact. Potatoes that are too small to be used are discarded and given away to pig farmers.

Assumptions and cut-offs

The data for potato cultivation is based on recommendations from a Danish potato buyer. Most of the potatoes used by Svenska Lantchips are sourced from Denmark via this buyer, who provided details of recommended fertiliser levels, etc.

The small potatoes that are discarded are given away to pig farmers. These potatoes presumably replace some other feed that the pigs would otherwise receive. In such cases, it is the norm to expand the scope of the analysis in order to deduct the environmental impact of alternative pig feed from the results for crisps. However, this has not been done here, as the production of pig feed is not normally a separate system, but consists of by-products from the production of food for human consumption.

Potato peelings from processing are sent for biogas recovery at a waste-water treatment plant. The biogas produced is assumed to replace other biogas production, which means that this process is treated as an “environmental improvement” activity. Carlsson & Uldal (2009) supplied data for the biogas yield from potatoes. According to the ÅF Group consultancy (2009), the energy content of biogas has been assumed to be equal to the energy content of natural gas, and the energy that can be extracted from potato peelings is treated as a minus post for energy consumption in crisp production. A minus item for this process (“Natural gas, at plant RER/S”) from Ecoinvent (2007) has been used to approximate the biogas, as no pure biogas is present in the calculation programme’s databases. The soil-improving sludge produced as a by-product of this process has been ignored, as no yield data is available. Energy use for extracting biogas from potato peel has not been included, as it is assumed that these two processes (a minus item for soil-improving sludge and a plus item for energy consumption) cancel each other out.

Chemicals used in the production process, e.g. to prevent foaming, have been included in the form of COD and BOD, and are included in the environmental impact calculations. Lye and acid production have been included in the calculations, but their transport to the factory has been excluded.

Transport

The transport of packaging to the Svenska Lantchips factory has not been included in the calculations. The results include transport of ingredients to the factory. The contribution of transport of the palm oil by ship from Malaysia is taken into account, but included in the contribution for palm oil. The specific transport contribution is discussed in the explanatory text for the results. For potatoes, transport by lorry from farms in Denmark to the factory in Södertälje is included. Salt is bought in from Halmstad and transported to the factory by lorry. After production, the crisps are transported to a warehouse in Malmö.

4.2 Sweets

4.2.1 Choice of study object

Two products manufactured by Leaf in Gävle have been chosen for this study: *Ahlgrens bilar* (Ahlgren's Cars), in 125g packets, and Stora zoo (Stora Zoo sweets), in 2 kg plastic packages, for sale as loose confectionery. The products were chosen as representative types: the former are foam sweets, while the latter represent a typical jelly sweet. Ahlgren's car sweets comprise a major part of production (around 30%) at the Leaf plant, which also informed the choice of this product for study.

Illustration 3: Foam sweets and jelly sweets.

4.2.2 Production

The car and Zoo sweets are produced in a similar fashion. Dry ingredients are mixed, flavourings and colourings are added, and then liquid ingredients are mixed in so that the batch can be boiled down to a manageable consistency. Foam products (e.g. Ahlgren's Cars) are whisked in order to get enough air into the mixture to obtain the desired fluffy consistency. The boiled liquid mass reaches a temperature of 60–80ºC before being piped into cornflour moulds with shapes punched by a metal stamping machine. Both products are heated and dried in the moulds, which fixes their shape. The cars are dried first for 180 minutes and then for a further 300 minutes, while the Zoo sweets are dried for 48 hours. This process uses heating oil as an energy source. No specific data is available on energy consumption during the drying process, so energy consumption for the whole plant has been divided by the total production at Leaf in Gävle to arrive at a value for energy consumption per kilogramme of product – in other words, energy use has been mass-allocated. However, Leaf also manufactures products that use a different drying process, which means that the specific energy consumption per kilogramme of car sweets and Zoo sweets may differ somewhat from the illustrations used in the study.

After drying, the products are tipped out of the cornflour mould (which is reused) and pass into a rotating drum for oil (vegetable carnauba wax) treatment, which gives the sweets their shiny surface. After this stage, the products still have a soft consistency, and further drying (this time without heating) is required before sale. The products are packed before this process begins, i.e. they are dried in their consumer packaging. This drying process takes place at the Leaf production plant. The products are then despatched to the central warehouse in Malmö.

4.2.3 Raw materials

The following text presents the consumption of raw material ingredients in the production of these two types of sweets, ranked in declining order according to their respective volumes.

Ahlgren's Cars

The three main ingredients in Ahlgren's car sweets are as follows: lactic acid (extracted from various types of sugar) and pure alcohol (ethanol), which is used to dissolve menthol crystals in the mixture. This ethanol evaporates during the process (when the mixture is boiled), and so is not an ingredient of the finished product. In third place are the essences, which consist of approx. 60% ethanol, and the flavourings dissolved in them. These give the car sweets their characteristic taste. Colourings are used to give the car sweets their pink and green colouring.

Stora Zoo

Lactic acid is also the dominant ingredient in Zoo sweets, followed in second and third place by roughly equal parts sugar and starch syrup.

4.2.4 Packaging

Packaging for both Ahlgren's car sweets and Stora Zoo sweets consists of PP (polypropylene) plastic.

4.2.5 Production inventory

Leaf provided the recipes for Ahlgren's car sweets and Stora Zoo sweets. These recipes form the basis of the calculations. Most of the data for the various ingredients has been taken from SIK's internal food database.

Wastage

Products classified as "seconds" in the production process are melted down and reused. Certain other wastage, classified as "rejection", goes to composting. The rejection rate for car sweets was 0.37% in 2009. No rejection figures for Stora Zoo are available, so a wastage rate of 0.37% has also been assumed for this product.

Assumptions and cut-offs

A cut-off has been made for ingredients comprising less than 1% of the volume of a batch. Essences account for a quite significant part of the recipe and have therefore been included, even though reliable data for them is not available. Essences consist of 60% ethanol, and this part of the essence has been included in the calculations – but it should be noted that the environmental impact of the remaining 40% of the content is not included. With regard to transport, data has been collated for the most important ingredients, while ingredients accounting for 5% or less of a batch have been excluded. Since transport normally makes a smaller contribution to total life cycle emissions (except for airfreight, which is not relevant here), this has been judged to be a reasonable cut-off. Two exceptions have been made to the 5% rule: transport for two colourings and flavourings have been excluded because no data was available for these ingredients.

4.3 Soft drinks

4.3.1 Choice of study object

Nygårda cola, sold in a 33 cl returnable glass bottle, was chosen for the study of soft drinks, as Spendrups co-operated with the project. For cola-type soft drinks, the 33 cl returnable is the most common bottle, so this volume and packaging was chosen as the functional unit for the study. Spendrups has several production plants in Sweden. Grängesberg in Dalarna is the largest, but cola drinks are produced mainly in Vårby, outside Stockholm, so data from that plant has been used in the inventory of climate-change impact, eutrophication and energy use. This cola drink is a good representative of products in the soft drinks segment. The difference between various kinds of soft drink consists mainly of flavourings and colourings, both of which account only for a small part of the ingredients and a marginal proportion of the drinks' environmental impact. The environmental impact of various packaging types (glass bottle, PET plastic bottle or aluminium can) is dealt with in the discussion section.

Illustration 4: Soft drink with cola flavouring

4.3.2 Production

The soft drink base is a mixture of syrup, made from sugar syrup, starch syrup and flavouring concentrate, plus a small amount of added water to maintain the desired liquid consistency. This mixture is then diluted with water before being carbonated. The drink is then bottled in 33 cl glass returnables. The energy types used at the plant are electricity (58% renewable, mainly hydropower) and oil (Ultra LS fuel oil 3a). In terms of energy consumption, the most demanding process is not soft drink production but beer production, which consumes a larger proportion of the oil. About half of the oil is used for beer production while the remainder is used for soft drinks, cider and carbonated water production, as well as for heating the premises. This rest of the oil is split between soft drinks, cider and carbonated water production based on their respective volumes – this is known as a mass allocation.

4.3.3 Raw materials

The three main ingredients in Nygårda cola are water, sugar and starch syrup. Sugar from Swedish sugar beets is used in the soda and wheat is the base for the starch syrup used. Flavourings and colourings are used in small quantities.

4.3.4 Packaging

The bulk of cola (97%) produced by Spendrups is sold in 33 cl glass bottles, which are packed in 20-bottle returnable crates. This means that new glass is not required for every newly manufactured cola bottle. The return systems in the Scandinavian countries vary. In Sweden, the whole bottle is returned, washed and reused. In Finland, bottles are collected but crushed for the manufacture of new bottles and other glass products. A cola bottle in Sweden is used an average of 33 times before it is removed from the system. The Swedish calculation therefore assumes that the glass per bottle of soft drink is 1/33 of the weight of a glass bottle. For the other countries it has been assumed that new bottles have to be produced every time (i.e. there is no return system), so 305g of glass is needed per 33 cl of cola.

4.3.5 Inventory of soft drinks production

Recipe

Ingredients consumption and processing data have been acquired during the inventory process at the soft drinks production plant. The inventory was conducted on site by SIK staff along with the company's own environmental officers. Production data was inventoried both on site and via e-mail before and after the visit.

Wastage

Wastage during the production process is approx. 7%, while wastage of finished (bottled) product is 0.4%. These rates have been included in the calculations.

Assumptions and cut-offs

Flavouring concentrates have not been included in the analysis, since the exact composition of these concentrates is unknown. They account for less than 5% of content. To compensate, the remaining ingredients have been adjusted upwards so that the amount of ingredients in the calculations corresponds to 100% of the ingredients in the recipe. As far as transport of ingredients is concerned, transport data was acquired for all ingredients except concentrates, which were excluded from the calculations. The bottled products are transported to retailers via a depot/terminal. For Spendrups, the median distance for this journey is 410 km, a distance which has been used in the calculations. The depot has been assumed to be in Malmö (even though Spendrups' largest depot is actually in the Stockholm area), and so the transport from depot to retailer is the same distance as for crisps and sweets. The four terminals are retailers in Stockholm, Oslo, Copenhagen and Helsinki (as per crisps and sweets). No data for waste management of glass is available in the Ecoinvent database, so waste management of glass bottles has been excluded.

5. Results

Below are the results for the four products studied. For each product, an account is given firstly for the life cycle from cultivation of raw materials to factory gate, i.e. until the finished product leaves the factory. This result is divided up in such a way that contributions from ingredients, the production process, transport and packaging are accounted for separately in an illustration. In the case of snack foods, the transport of finished products from the factory gate generally has little impact compared to earlier life-cycle phases, so the pattern of environmental impact in the various impact categories studied will be similar for the product and even between products. The same text therefore reappears in the tables for the total results for each product.

5.1 Crisps

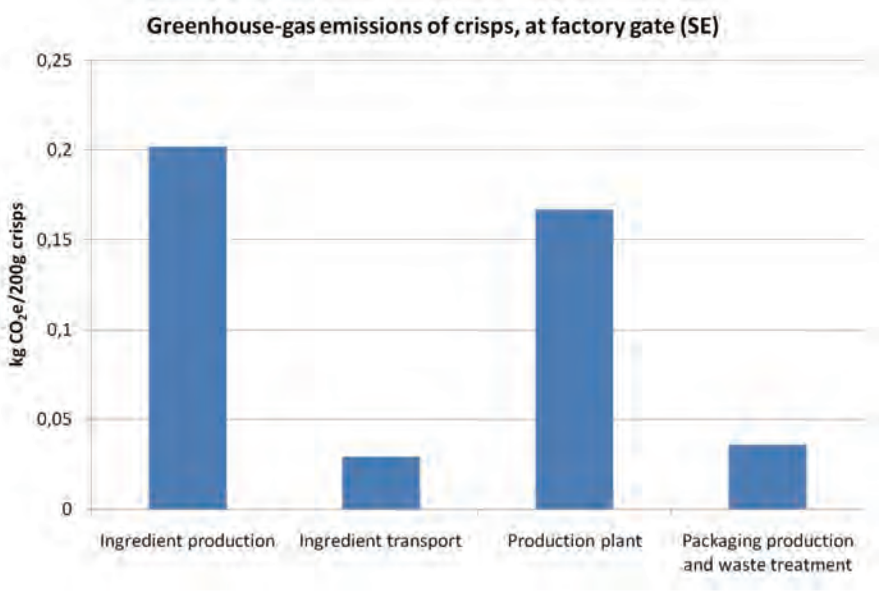

Illustration 5: Greenhouse-gas emissions in the life cycle of crisps, expressed as kg of CO_2 equivalent per 200g packet of crisps at the factory gate.

The climate-change contribution for a 200g packet of crisps at the factory gate is 0.43 kg of CO_2 equivalent. Most of the greenhouse-gas emissions in the production process stem from ingredient production, primarily farming, closely followed by the factory (see Illustration 5). Of the ingredients, palm oil contributes the most, even though proportionally it is not the largest ingredient. Palm oil accounts for 70% of the ingredients' climate-change contribution, while potatoes account for 30%. The contribution for palm oil also includes transport by sea from Malaysia to Sweden. Although this is a long journey, shipping comprises only 4% of the climate-change contribution. The factory process for crisps contributes a larger proportion than is usual for food products. This is because the main raw material is potatoes, an agricultural product that provides high yields per hectare and therefore requires relatively few resources, whereas the production process is relatively high in terms of energy consumption, which raises the profile of the factory in the analysis. Some of the energy used in the factory comes from LPG (liquefied petroleum gas), which also contributes to the manufacturing process's significant role in the life cycle of the crisps in terms of climate-change impact.

The total result for a 200g packet of crisps delivered to the retailer is shown in Table 1.

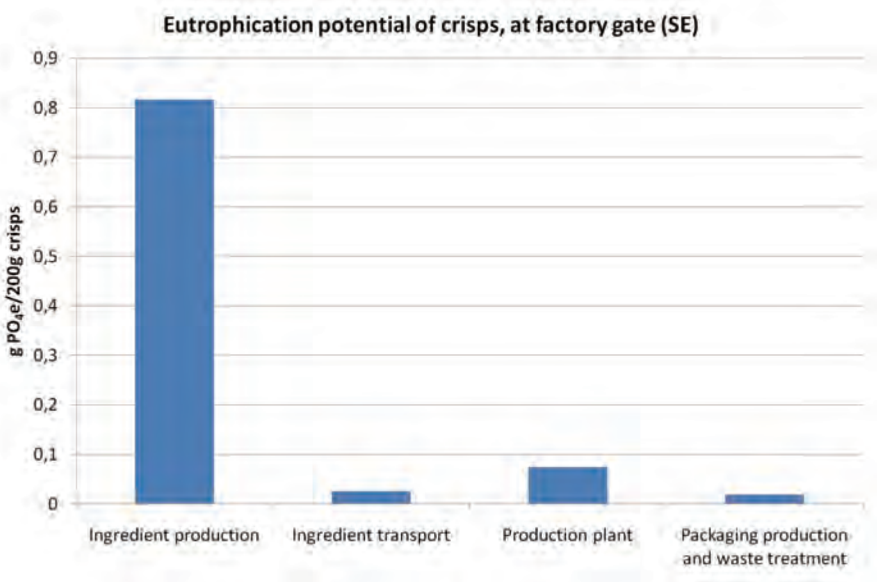

Illustration 6: Eutrophication potential in the life cycle of crisps, expressed as g PO_4 equivalent per 200g packet of crisps at the factory gate.

The eutrophication contribution of a packet of crisps (200g) at the factory gate is 0.93g of PO_4 equivalent. Ingredient production dominates the eutrophication contribution throughout the product's life cycle (see Illustration 6). This is because emissions of eutrophying substances consist mainly of agricultural fertiliser residues (various nitrogen and phosphorus compounds). The eutrophication contribution from factory activities is relatively small and stems mostly from the use of LPG.

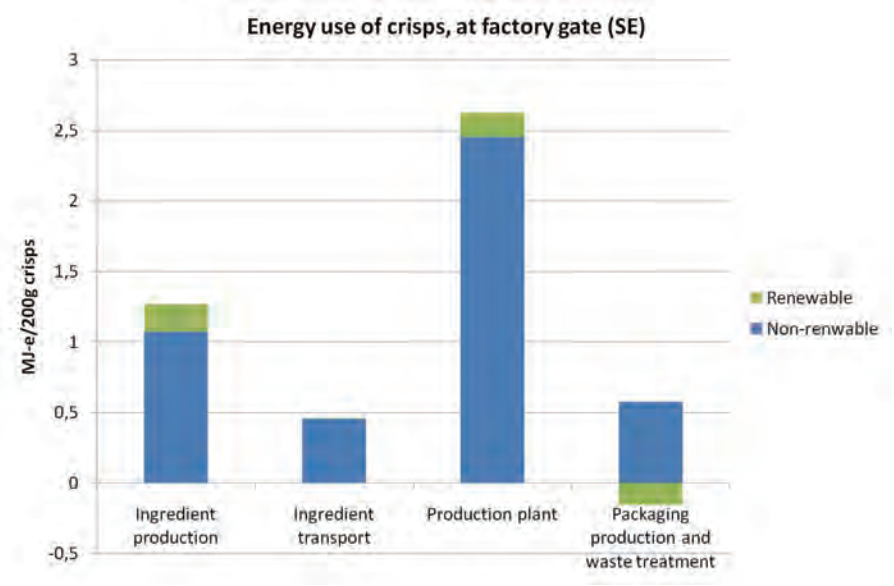

Illustration 7: Primary energy use (PE) in the life cycle of crisps, expressed as MJ equivalent per 200g packet of crisps at the factory gate.

Energy use for a 200g packet of crisps at the factory gate is 4.9 MJ equivalents. Energy use in the life-cycle phases studied is highest in the factory (see Illustration 7). The main source of energy is LPG, with electricity also used to a lesser degree. The potato peelings left over by the process are, as mentioned earlier, used in biogas production, which should result in some other biogas production being unnecessary (what is known as “avoided production”). This gives rise to a minus item in the category “Packaging production & waste management”, as the energy recovered from the biogas is deducted from the system studied. Recycling results in reduced demand for packaging materials, which is also registered as a minus item.

5.1.1 Total results: Crisps

The results are shown per functional unit (FU). The functional unit for crisps is a 200g packet. Deviations in the results for crisps at the factory gate are due to the use of country-specific statistics for waste management of packaging materials. Where the total sum does not appear to correspond to the various stages (factory gate, transport to warehouse, transport to retailer), this is due to the rounding of the numbers. The total sum does in fact completely correspond with the calculations.

Table 1: Total results for greenhouse-gas emissions of crisps ($kg CO_2$-e/FU), FU = 200g of crisps in packet.

Final destination	At factory gate ($kg CO_2$-e/FE)	Transport to central warehouse, Malmö ($kg CO_2$-e/FE)	Transport to retailers in Scandinavian capital ($kg CO_2$-e/FE)	Total result at retailer ($kg CO_2$-e/FE)
Stockholm	0.43	0.005	0.006	0.44
Oslo	0.43	0.005	0.005	0.44
Copenhagen	0.43	0.005	0.0004	0.44
Helsinki	0.43	0.005	0.009	0.45

According to Table 1, the majority of the climate-change impact occurs in the phase up to and including factory processing. Transport from factory to central warehouse in Malmö is the same, irrespective of final destination, and therefore contributes equal amounts. Transport from warehouse to retailers in the four Scandinavian countries varies according to the distance travelled. Copenhagen is closest, and therefore represents the lowest climate-change impact. Transport to Helsinki, on the other hand, involves both truck and ferry, and therefore represents the largest contribution. However, the total result is not significantly affected by these various final stages, and their contribution is stable at less than 0.5 kg of CO_2 equivalent per functional unit (a 200g packet of crisps delivered to a retailer).

Table 2: Total result for eutrophication potential of crisps (g PO_4e/FU), FU = 200g of crisps in packet.

Final destination	At factory gate (g PO_4e/FE)	Transport to central warehouse, Malmö (g PO_4e/FE)	Transport to retailers in Scandinavian capital (g PO_4e/FE)	Total result at retailer (g PO_4e/FE)
Stockholm	0.93	0.005	0.005	0.95
Oslo	0.94	0.005	0.005	0.95
Copenhagen	0.94	0.005	0.0004	0.95
Helsinki	0.95	0.005	0.009	0.97

Results in the eutrophication impact category, Table 2, follow the same pattern as for greenhouse-gas emissions, with most of the contribution stemming from the stages before the product leaves the factory. The same relationships apply to the various onward journeys – the longer the journey, the greater the emissions – so Finnish consumption also makes the greatest impact here.

Table 3: Total result for energy use of crisps (MJe/FU), FU = 200g of crisps in packet.

Final destination	At factory gate (MJe/FE)	Transport to central warehouse, Malmö (MJe/ FE)	Transport to retailers in Scandinavian capital (MJe/ FE)	Total result at retailer (MJe/ FE)
Stockholm	4.8	0.08	0.09	4.9
Oslo	4.9	0.08	0.08	5.1
Copenhagen	4.8	0.08	0.006	4.9
Helsinki	5.04	0.08	0.14	5.3

In terms of primary energy use (Table 3), the distribution of impact between the phases prior to factory and onward transport resembles that for greenhouse-gas emissions and eutrophication potential. Transport does not make any major contribution to energy use either; most of the energy is consumed prior to and in the factory.

5.2 Sweets

5.2.1 Foam sweets

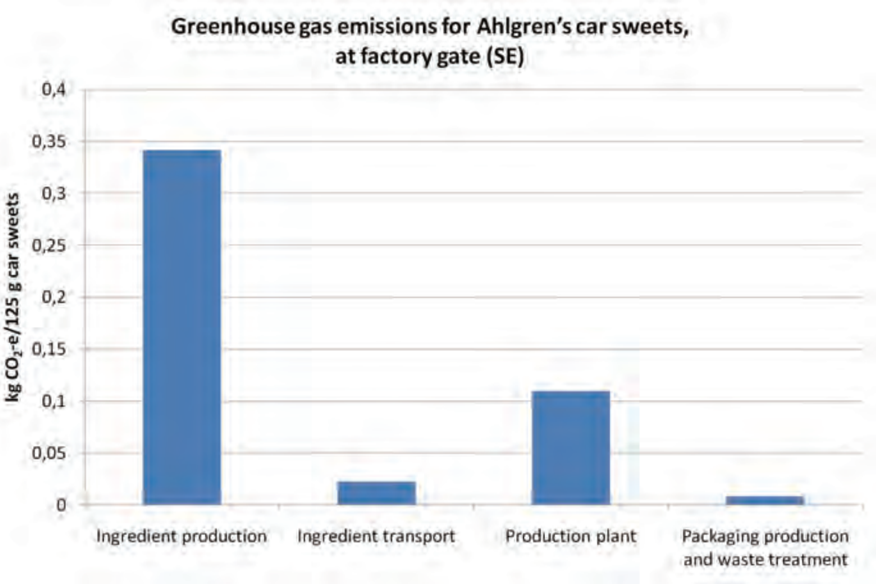

Illustration 8: Greenhouse-gas emissions in the life cycle of Ahlgren's car sweets, expressed as kg of CO_2 equivalent per 125gof car sweets at the factory gate.

The climate change contribution of a 125g packet of Ahlgren's car sweets at the factory gate is 0.48kg of CO_2 equivalents, Illustration 8. Even more so than for crisps, ingredients production for foam sweets is the life-cycle phase that makes the greatest climate-change contribution at the factory gate. The factory phase accounts for roughly one third of the ingredients contribution, mainly due to the high-energy consuming drying processes powered by fuel oil. Electricity use in the factory also makes a contribution, and accounts for around 30% of the total climate-change impact from energy use in the factory (of which oil accounts for around 65%). In terms of ingredients, ethanol makes the greatest contribution, followed by lactic acid and essences. The essences (ethanol-based) are used in relatively large quantities in foam sweets, and therefore also contribute to climate-change impact. Starch syrup also makes a significant contribution. Incoming transport comprises only a small part of the climate-change contribution in the life cycle, as do packaging production and waste management.

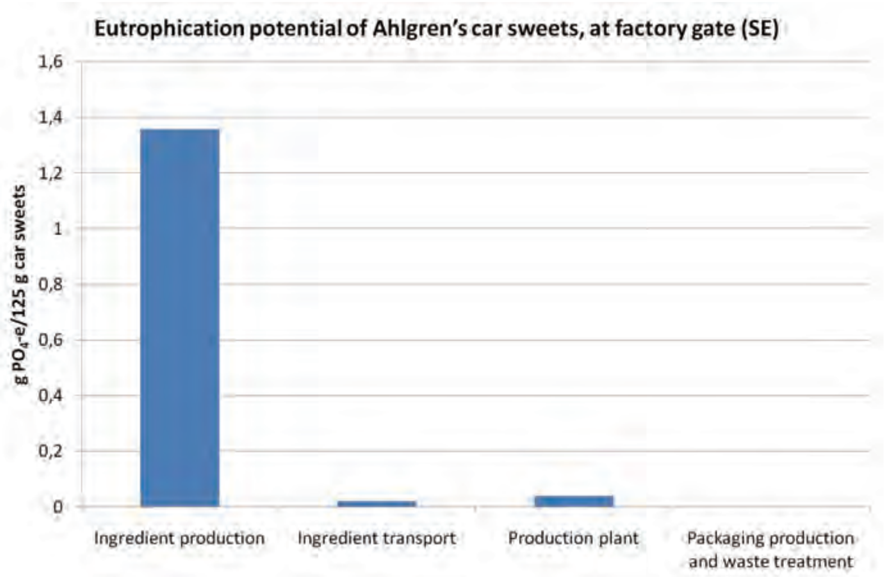

Illustration 9: Eutrophication potential in life cycle of Ahlgren's car sweets, expressed as g PO_4 equivalent per 125g of sweets at factory gate.

The eutrophication contribution of a 125g packet of Ahlgren's car sweets at the factory gate is 1.42g of PO_4 equivalent (Illustration 9). In terms of eutrophication potential, ingredients production (i.e. primary production) clearly accounts for the largest proportion. Subsequent life-cycle phases (factory processing, incoming transport of ingredients, packaging production and waste management) are insignificant in this context. The dominant ingredients in the eutrophication contribution are ethanol and essences.

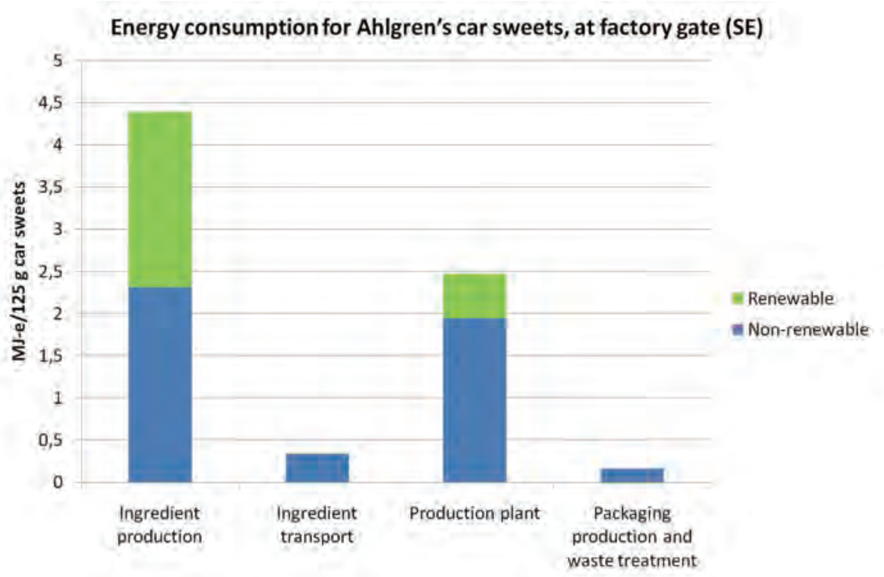

Illustration 10: Primary energy use (PE) in the life cycle of Ahlgren's car sweets, expressed as MJ equivalent per 125g of car sweets at factory gate.

Energy use for a 125g packet of Ahlgren's car sweets at the factory gate is 7.3 MJ equivalents. The greatest contribution is from the production of ingredients, from raw materials. The reason for the high proportion of renewable energy in energy use is that the ethanol used is produced using wood pellets as the dominant energy source. Energy use in the factory is mainly based on electricity and fuel oil in roughly equal proportions. The barely visible minus item, which can be discerned under packaging production and waste treatment (see Illustration 10), is due to energy savings from recycling packaging materials.

5.2.2 Total results: Foam sweets

The results are shown per functional unit (FU). The functional unit for Ahlgren's car sweets is 125g of packaged sweets. Deviations in the results for Ahlgren's car sweets at the factory gate are due to the use of country-specific statistics for waste management of packaging materials. Where the total sum does not appear to correspond to the various stages (factory gate, transport to warehouse, transport to retailer), this is due to rounding of the figures. The total sum does completely correspond with the calculations.

Table 4: Total results for Ahlgren's car sweets' greenhouse-gas emissions (kg CO_2-e/FU), FU = 125g packet.

Final destination	At factory gate (kg CO_2-e/FE)	Transport to central warehouse, Malmö (kg CO_2-e/FE)	Transport to retailers in Scandinavian capital (kg CO_2-e/FE)	Total result at retailer (kg CO_2-e/FE)
Stockholm	0.48	0.005	0.004	0.49
Oslo	0.48	0.005	0.003	0.49
Copenhagen	0.48	0.005	0.0003	0.49
Helsinki	0.48	0.005	0.008	0.49

According to Table 4, most of the climate-change impact arises in the stages up to and including factory processing. Transport from factory to central warehouse in Malmö is the same, irrespective of final destination, and therefore contributes equal amounts. Transport from warehouse to retailers in the four Scandinavian countries varies according to the distance travelled. Copenhagen is closest, and therefore represents the lowest climate-change impact. Transport to Helsinki, on the other hand, involves both truck and ferry, and therefore represents the largest contribution. However, the total result is not significantly affected by these various final stages, and their contribution is stable at less than 0.5 kilogrammes of CO_2 equivalent per functional unit (a 125g packet of car sweets delivered to a retailer).

Table 5: Total results for Ahlgren’s car sweets’ eutrophication potential (g PO_{4}-e/FU), FU = 125g packet of Ahlgren’s car sweets.

Final destination	At factory gate (g PO_4e/FE)	Transport to central warehouse, Malmö (g PO_4e/FE)	Transport to retailers in Scandinavian capital (g PO_4e/FE)	Total result at retailer (g PO_4e/FE)
Stockholm	1.42	0.004	0.003	1.42
Oslo	1.42	0.004	0.003	1.43
Copenhagen	1.42	0.004	0.0002	1.42
Helsinki	1.42	0.004	0.008	1.44

Results in the eutrophication impact category (Table 5) follow the same pattern as for greenhouse-gas emissions, with most of the contribution stemming from the stages before the product leaves the factory. The same relationships apply to the various onward journeys – the longer the journey, the greater the emissions – so Finnish consumption also makes the greatest impact here.

Table 6: Total results for Ahlgren’s car sweets energy use (MJe/FU), FU = 125g packet of Ahlgren’s car sweets.

Final destination	At factory gate (MJe/FE)	Transport to central warehouse, Malmö (MJe/ FE)	Transport to retailers in Scandinavian capital (MJe/ FE)	Total result at retailer (MJe/ FE)
Stockholm	7.3	0.07	0.05	7.5
Oslo	7.3	0.07	0.05	7.5
Copenhagen	7.3	0.07	0.004	7.4
Helsinki	7.4	0.07	0.11	7.6

In terms of primary energy use (Table 6), the distribution of impact between the phases prior to factory and onward transport resembles that for greenhouse-gas emissions and eutrophication potential. Transport does not make any major contribution to energy use either; most of the energy is consumed prior to and in the factory.

5.3 Jelly sweets

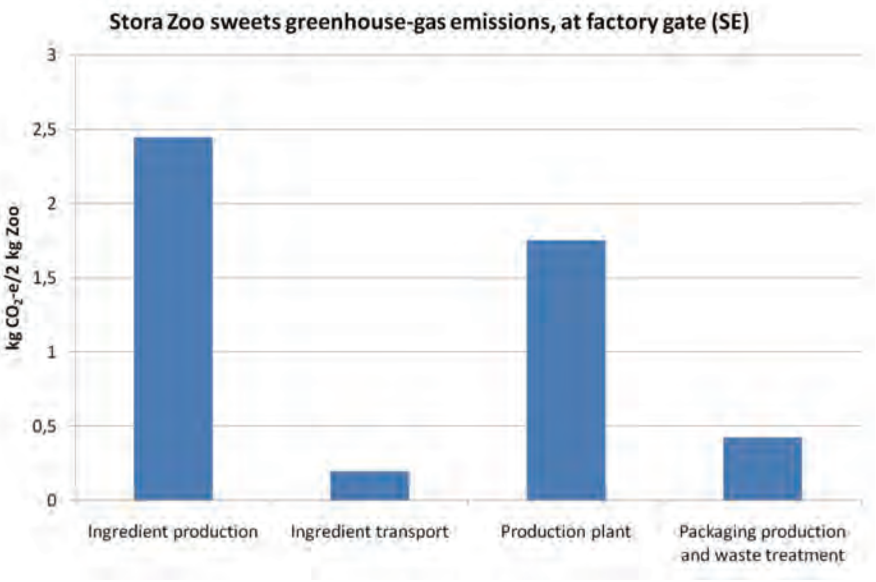

Illustration 11: Greenhouse-gas emissions in life cycle of Stora Zoo sweets, expressed as CO_2 equivalent per 2 kg of Stora Zoo at factory gate.

The climate-change contribution of a 2 kg container of Stora Zoo sweets at the factory gate is 4.8kg of CO_2 equivalent. Ingredient production makes the greatest contribution to greenhouse-gas emissions (Illustration 11). Lactic acid and starch syrup are the ingredients that make the greatest contribution to climate-change impact. Factory activities also make a significant contribution. As with Alhgren’s car sweets, the Zoo sweets have to be dried, which requires energy. In this analysis, allocation of energy usage is based on production volumes for the various products, and not on the actual energy usage for the particular product. However, it can be assumed that drying accounts for a significant proportion of energy use, and since the energy in question largely stems from fossil fuels, the climate-change contribution is significant.

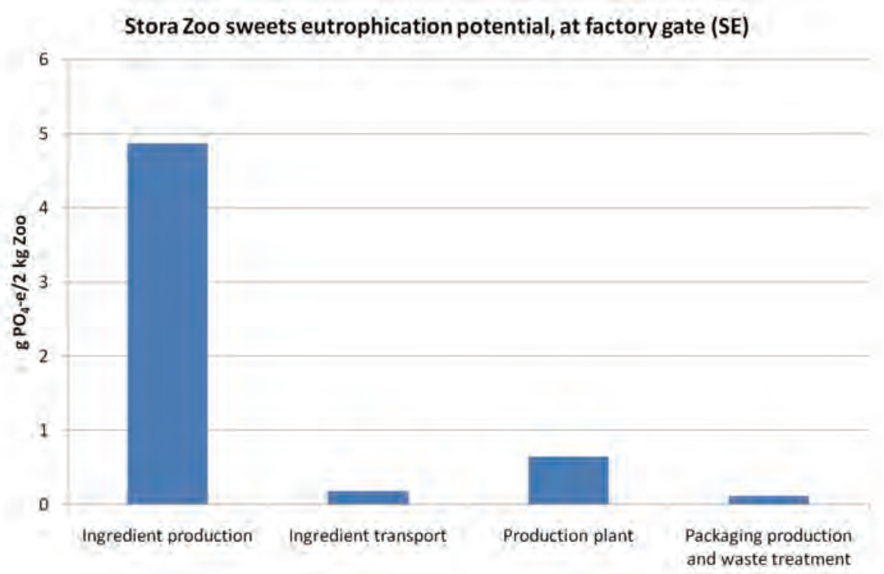

Illustration 12: Eutrophication potential in life cycle of Stora Zoo sweets, expressed as g PO_4 equivalent per 2 kg of Stora Zoo sweets at factory gate.

The eutrophication contribution of a 2 kg container of Stora Zoo sweets at the factory gate is 4.8g of PO_4 equivalents (Illustration 12). The dominant element in the contribution is ingredient production, most of which is accounted for by the production of sugar and starch syrup. Within the factory, consumption of fuel oil, electricity and cornflour (used for moulding) contribute to eutrophication potential.

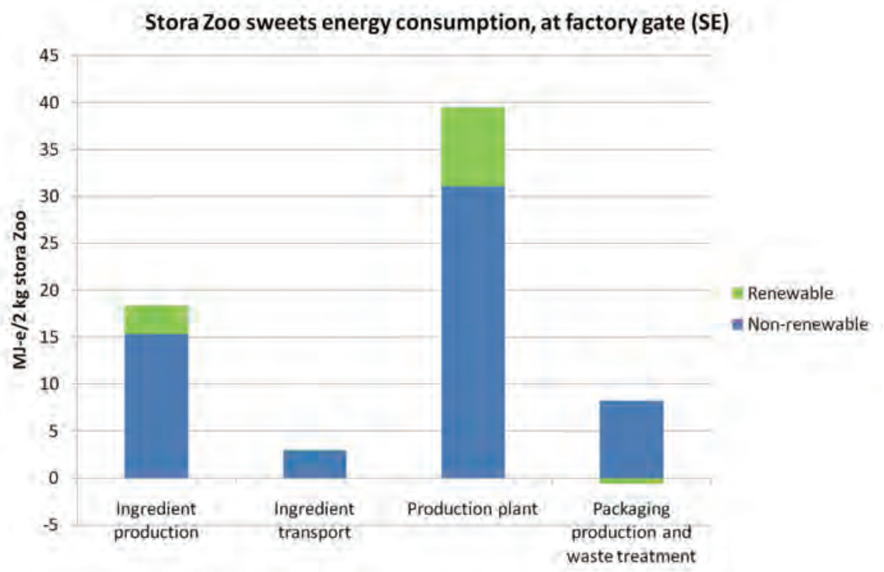

Illustration 13: Primary energy use (PE) in life cycle of Stora Zoo sweets, expressed as MJ equivalent per 2 kg of Stora zoo sweets at factory gate.

Energy use for a 2 kg container of Stora Zoo sweets at the factory gate is 68 MJ equivalents. Again, the largest proportion of total energy consumption for the product occurs during the factory process. Energy use in ingredient preparation is lower than that in the factory process expressed per functional unit. The renewable element of factory energy use comes from that part of the electricity mix derived from renewable sources, e.g. wind and hydropower. The potential exists to expand the proportion of renewable energy in the factory process. The barely visible minus item, which can be discerned under packaging production and waste management (see Illustration 13), is due to energy savings from recycling packaging materials.

5.3.1 Total results: Jelly sweets

The results are shown per functional unit (FU). The functional unit for Stora Zoo sweets is 2 kg of the product packed in a plastic container. Deviations in the result for Stora Zoo sweets at the factory gate are due to the use of country-specific statistics for waste management of packaging materials. Where the total sum does not appear to correspond to the various stages (factory gate, transport to warehouse, transport to retailer), this is due to the rounding of the figures. The total sum corresponds completely with the calculations.

Table 7: Total results for Stora Zoo greenhouse-gas emissions (kg CO_2-e/FU), FU = 2 kg of Stora Zoo sweets in plastic container.

Final destination	At factory gate (kg CO_2-e/FE)	Transport to central warehouse, Malmö (kg CO_2-e/FE)	Transport to retailers in Scandinavian capital (kg CO_2-e/FE)	Total result at retailer (kg CO_2-e/FE)
Stockholm	4.8	0.07	0.06	4.9
Oslo	4.8	0.07	0.05	4.9
Copenhagen	4.8	0.07	0.004	4.9
Helsinki	4.8	0.07	0.12	5.0

According to Table 7, most of the climate-change impact arises in the stages up to and including factory processing. Transport from factory to central warehouse in Malmö is the same, irrespective of final destination, and therefore contributes equal amounts. Transport from warehouse to retailers in the four Scandinavian countries varies according to the distance travelled. Copenhagen is closest, and therefore represents the lowest climate-change impact. Transport to Helsinki, on the other hand, involves both truck and ferry, and therefore represents the largest contribution. However, the total result is not significantly affected by these various final stages; their contribution is stable at around 5 kg of CO_2 equivalent per functional unit, which is 2 kg of Stora Zoo sweets packed in a plastic container and delivered to a retailer.

Table 8: Total results for Stora Zoo eutrophication potential (g PO_4e/FU), FU = 2 kg of Stora Zoo sweets in plastic container.

Final destination	At factory gate (g PO_4e/FE)	Transport to central warehouse, Malmö (g PO_4e/FE)	Transport to retailers in Scandinavian capital (g PO_4e/FE)	Total result at retailer (g PO_4e/FE)
Stockholm	4.8	0.06	0.05	4.9
Oslo	5.9	0.06	0.05	6.0
Copenhagen	5.8	0.06	0.004	5.9
Helsinki	6.0	0.06	0.13	6.2

Results in the eutrophication impact category (Table 8) follow the same pattern as for greenhouse-gas emissions, with most of the contribution stemming from the stages before the product leaves the factory. The same relationships apply to the various onward journeys – the longer the journey, the greater the emissions – so Finnish consumption also makes the greatest impact here.

Table 9: Total results for Stora Zoo energy use (MJe/FU), FU = 2 kg Stora Zoo sweets in plastic container.

Final destination	At factory gate (MJe/FE)	Transport to central warehouse, Malmö (MJe/ FE)	Transport to retailers in Scandinavian capital (MJe/ FE)	Total result at retailer (MJe/ FE)
Stockholm	68.4	1.1	0.9	70.4
Oslo	69.4	1.1	0.8	71.3
Copenhagen	68.6	1.1	0.06	69.8
Helsinki	70.4	1.1	1.8	73.3

In terms of primary energy use (Table 9), the distribution of impact between the phases prior to factory and onward transport resembles that for greenhouse-gas emissions and eutrophication potential. Transport does not make any major contribution to energy use either; most of the energy is consumed prior to and in the factory.

5.4 Soft drinks

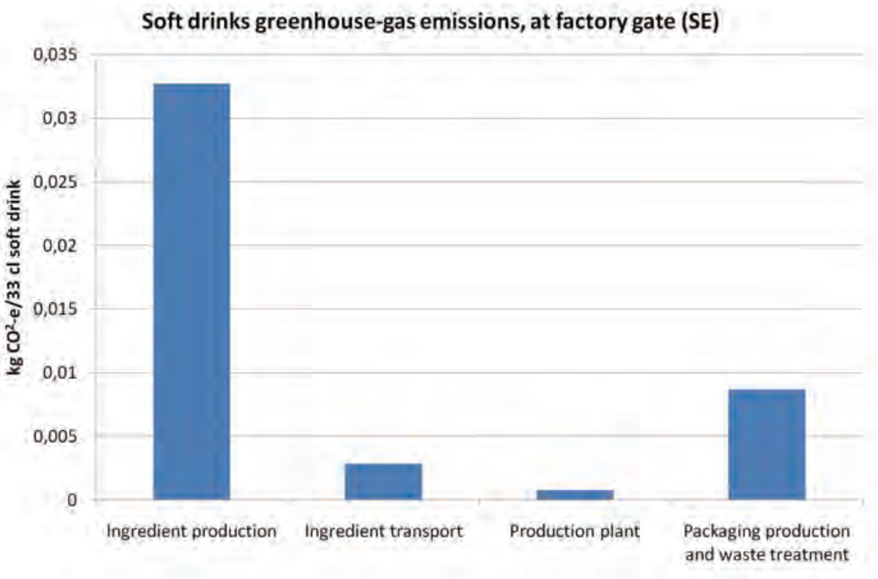

Illustration 14 Greenhouse-gas emissions in the life cycle of cola-type soft drinks, expressed as CO_2-equivalent per 33 cl of cola at factory gate.

The climate-change contribution of a cola-type soft drink (33 cl in returnable glass) at the factory gate is 0.04 kg of CO_2 equivalent (Illustration 14). Greenhouse-gas emissions are dominated by the contribution from ingredient production, with starch syrup and sugar accounting for the biggest shares. The climate-change contribution of packaging – glass bottles – is relatively high compared to the packaging contributions of the other products studied. The reason for this is that the bottle uses a large quantity of glass compared to the amount of plastic in a sweet packet. However, as the 33 cl bottle is returnable, and is therefore reused, the climate-change impact is lower than if the bottle was only used once. Recycling is included in the calculations – 58% of recycled glass is the database value for glass used in production for bottles. This closely matches the recycling rate in Swedish glass production, where around 60% of recycled materials are used in the manufacture of new white packaging glass.

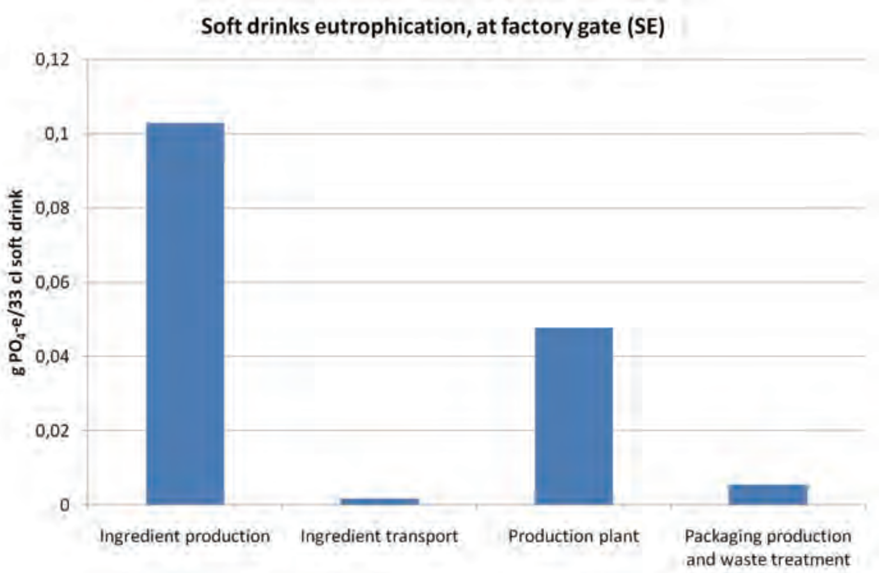

Illustration 15: Eutrophication potential in life cycle of cola-type soft drink, expressed in PO_4 equivalent per 33 cl of cola at factory gate.

The eutrophication contribution for a cola-type soft drink (33 cl in returnable glass) at the factory gate is 0.16g of PO_4 equivalent. The total life-cycle eutrophication contribution of the soft drink is dominated by the contribution from the production of ingredients (see Illustration 15). Eutrophication arising from factory processing is also significant, and stems mainly from the discharge of liquid waste (in the form of organic materials) from the factory.

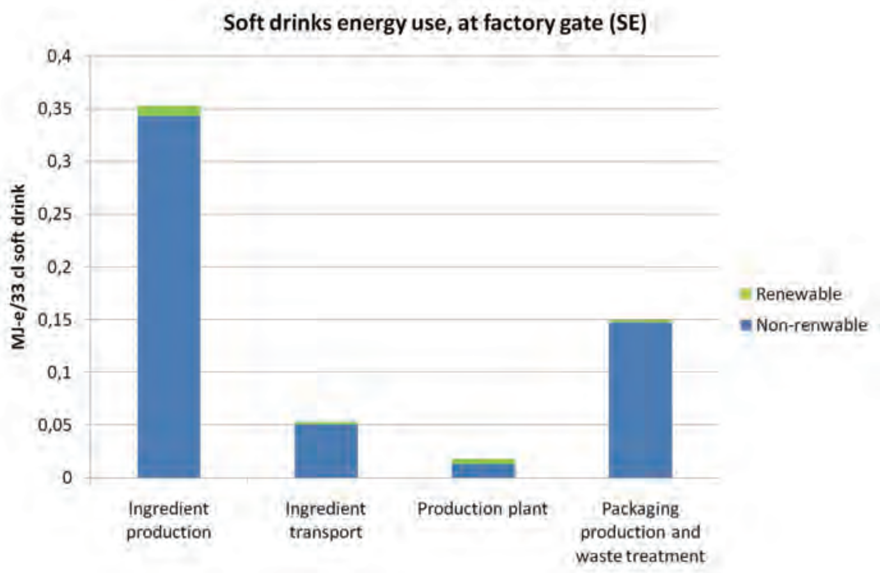

Illustration 16: Primary energy use (PE) in life cycle of cola-type soft drink, expressed in MJ equivalent per 33 cl of cola at factory gate.

Energy use for a cola-type soft drink (33 cl in returnable glass) at the factory gate is 0.59 MJ equivalents. Energy use for soft drinks differs from that of the other products in that a very small proportion of the energy used stems from the factory. This is because soft drinks production is not a particularly energy-intensive process, but mainly consists of mixing ingredients and water. The fuel oil consumed in the factory is used to produce steam, which is used, among other things, to pasteurise syrup. Fossil-based fuel oil accounts for the proportion of non-renewable energy used in the factory (Illustration 16). The reason for the relatively large proportion of energy use in the packaging phase is that soft drinks use more packaging materials than the other snack-food products studied.

5.4.1 Total results: Soft drinks

The results are stated per functional unit (FU) (33 cl of Nygårda cola in a returnable glass bottle). The results for Nygårda cola at the factory gate differ between the various countries, which is due to the fact that the glass bottles in the other Scandinavian countries are regarded as non-returnable, and also that country-specific statistics have been used for waste management of packaging materials. Where the total sum does not appear to correspond to the various stages, this is due to the rounding of the figures. The total sum does in fact correspond with the calculations. The reason why the result for Sweden differs so significantly from the other Scandinavian countries is that a Swedish bottle is reused 33 times before being disposed of, while in the other Scandinavian countries the material in a bottle is recycled after a single use. However, account has been taken of recycling in relation to the production of new glass for bottles in all countries. The export scenario for soft drinks is completely hypothetical, as this particular product is not exported in reality. The production of this particular soft drink is regarded as being quite representative of soft drinks production in general.

Table 10: Total results for Nygårda cola greenhouse-gas emissions (kg CO_2-e/FU), FU = 33 cl Nygårda cola in returnable glass bottle

Final destination	**At factory gate**	**Transport to central warehouse, Malmö**	**Transport to retailers in Scandinavian capital**	**Total result at retailer**
	(kg CO_2-e/FE)	**(kg CO_2-e/FE)**	**(kg CO_2-e/FE)**	**(kg CO_2-e/FE)**
Stockholm	0.04	0.006	0.06	0.11
Oslo	0.32	0.006	0.06	0.38
Copenhagen	0.32	0.006	0.004	0.33
Helsinki	0.32	0.006	0.081	0.41

According to Table 10 a high proportion of the total climate-change impact arises after the factory phase, during transport. This is largely because the climate-change contribution from ingredients is so low but the product is relatively heavy compared to, e.g. crisps. Transport from factory to central warehouse in Malmö is the same, irrespective of final destination, and therefore contributes equal amounts. Transport from warehouse to retailers in the four Scandinavian countries varies according to the distance travelled. Copenhagen is closest, and therefore represents the lowest climate-change impact. Transport to Helsinki, on the other hand, involves both truck and ferry, and therefore represents the largest contribution. The total results are affected by the different final stages, and the transport contribution is between 0.1 and 0.4 kg of CO_2 equivalent, depending on the waste-management scenario used.

Table 11: Total results for Nygårda cola's eutrophication potential (g PO_4e/FU)), = 33 cl Nygårda cola in returnable glass bottle.

Final destination	At factory gate (g PO_4e/FE)	Transport to central warehouse, Malmö (g PO_4e/FE)	Transport to retailers in Scandinavian capital (g PO_4e/FE)	Total result at retailer (g PO_4e/FE)
Stockholm	0.16	0.006	0.03	0.19
Oslo	0.33	0.006	0.03	0.37
Copenhagen	0.33	0.006	0.002	0.34
Helsinki	0.33	0.006	0.05	0.38

Results in the eutrophication impact category (Table 11) show that the majority of emissions stem from the phase prior to the product being transported from the factory. The same relationships apply to the various onward journeys – the longer the journey, the greater the emissions – so Finnish consumption also makes the greatest impact here.

Table 12: Total results for Nygårda cola's energy use (MJe/FU), FU = 33 cl Nygårda cola in returnable glass bottle.

inal destination	At factory gate (MJe/FE)	Transport to central warehouse, Malmö (MJe/ FE)	Transport to retailers in Scandinavian capital (MJe/ FE)	Total result at retailer (MJe/ FE)
Stockholm	0.59	0.1	0.9	1.6
Oslo	5.79	0.1	0.8	6.73
Copenhagen	5.79	0.1	0.07	5.96
Helsinki	5.79	0.1	1.33	7.22

The result for energy use (Table 12) for Swedish retail is considerably lower than the results for the other countries, which is due to the difference in glass bottle use. It is estimated that a bottle in Sweden is reused 33 times before it leaves the returnable bottle system. For the other countries, the calculations assume non-renewable use, with glass-crushing as a waste-management method and the crushed glass being recycled in production. In the case of Sweden, energy consumption in transport is greater than in the actual production process. This does not apply to any of the other products studied, and can be taken as an indication that soft drinks production is relatively resource-efficient, while transport is energy-intensive per kilogramme of product.

6. Discussion and proposed improvements

The latter part of the 1990s saw an intensification of life-cycle assessments of foodstuffs and food production, which led to an increase in knowledge of the environmental impact of food-production systems. The initial focus of the analyses was on the eutrophication contribution from primary production, but over the last four years this has shifted to food production's impact upon climate change. It has been found that the greatest environmental impact stems from primary production – i.e. fish farming or the cultivation of crops or animal fodder – and that the relative contribution from this first stage in the life cycle is generally greater for animal than for vegetable products. Primary production often accounts for 90% or more of the eutrophication impact. When life-cycle assessments of food production began to be carried out on a larger scale, their focus was mainly on staple foods. It remains the case today that there are relatively few studies of products in the snack-food category, so the results of this study represent new knowledge.

Walkers Crisps in the UK were the first in that country to introduce climate labelling for food with their Carbon Footprint logo (http://www.walkerscarbonfootprint.co.uk/). A "carbon footprint" is the same as climate-change impact, and is arrived at via a life-cycle assessment. The methodology for carrying out the analyses is also the same (ISO 14040 and 14044, which is more specific to climate-change impact, is also found in a BSI standard formulation; PAS 2050), but the carbon footprint focuses solely on the climate-change contribution.

The climate-change contribution for Walkers Crisps is 3.2 kg of CO_2 equivalent per kilogramme of crisps. This is a rather higher value than the result for the crisps in this analysis, which is 2.2 kg of CO_2 equivalent per kilogramme. This deviation in results is not surprising, and reflects the variations that arise when different production systems are analysed. These two products source their potatoes from different cultivation areas and do not use the same oil for frying. However, a more detailed comparison of results is not possible because those for Walkers Crisps are only presented in aggregated form.

The climate-change contributions for the two confectionery products covered in this analysis are respectively 2.4 and 3.8 kg of CO_2 equivalent per kilogramme of product, which is higher than for many of our staple food products (see Illustration 16, below). One reason for this is that these sweets are dried, which means that the input quantity of raw material ingredients is greater than the output quantity of product. Jelly sweets use 2 kg of ingredients for every 1 kg of product, while foam sweets use 3.6 kg of ingredients for every 1 kg of product. The climate-change contribution of raw materials is therefore distributed over a smaller quantity of final product, resulting in a relatively high climate-change contribution for confectionery products. We have not come across any previous life-cycle assessments for jelly sweets or foam sweets. SIK has carried out an analysis of the climate-change impact of chocolate production, and the published summary shows that the climate-change contribution from chocolate is 0.9 kg of CO_2 equivalent per kg of dark chocolate and 2.7 kg of CO_2 equivalent per kg of milk chocolate (http://www.sik.se/matoklimat). The higher climate-change contribution from milk chocolate is due to the quantities of milk used.

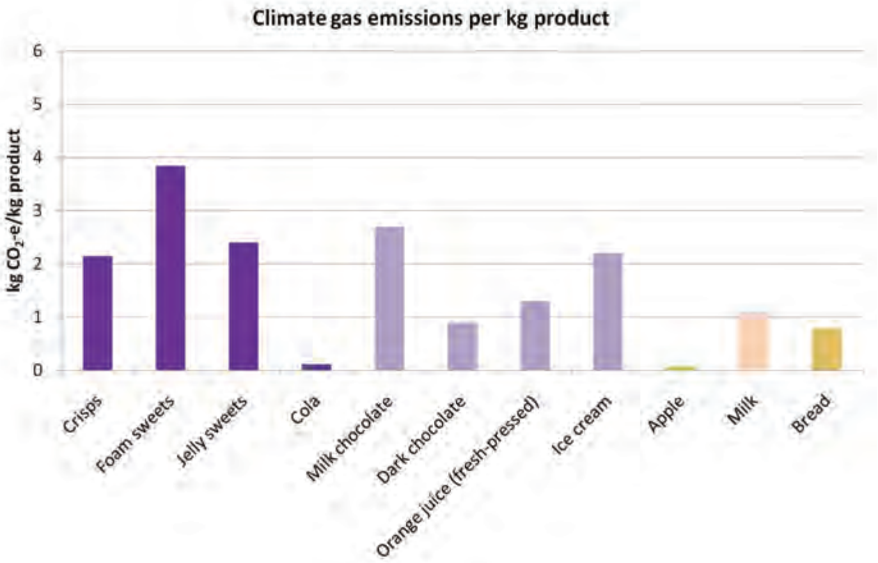

Illustration 17: Climate-change contribution of products at factory gate. The snacks and soft drinks studied are shown in dark purple; light purple represents previous results for this type of food; and the other colours depict the results for staple foodstuffs. References: Chocolate, orange juice, ice cream and bread: SIK website (http://www.sik.se/matoklimat,) Milk: SR 793 (SIK website: http://www.sik.se/matoklimat under Library/Reports – Environment). Apples: SR 630 (can be ordered in hard copy from the library at SIK).

For the production of cola-type soft drinks covered in this study, the ingredients production stage of the life cycle represents the greatest contribution to climate change and eutrophication, and the greatest energy use. However, the ingredients contributions for drinks are small compared to the other snack-food products studied. The packaging contribution for drinks sold in Sweden is relatively small because of the bottle-return system. The environmental impact contribution for the bottle, in terms of both materials and production, is spread over the number of times the bottle is reused. The packaging contribution for drinks sold in Norway, Denmark and Finland is much greater, as they are sold in what are regarded as non-returnable bottles.

Coca-Cola in the UK has a strategy in place for reducing their climate-change impact, to which end it has calculated the carbon footprint for Coca-Cola products. A 33 cl Coca-Cola in a glass bottle (non-returnable, including beverage) has a climate-change contribution of 360g of CO_2 equivalent (http://www.coca-cola.co.uk/environment/what-s-the-carbon-footprint-of-a-coca-cola.html) which corresponds to the climate-change contribution of the cola-type drink in a non-returnable bottle in this study. Just 6% of the climate-change contribution stems from the ingredients in Coca-Cola, while the remainder is mainly accounted for by packaging, with some contribution from the production process. For a corresponding bottle of Diet Coke, i.e. sugar-free cola, the climate-change contribution from ingredients is even smaller – just 2% of the total contribution. A 33 cl Coca-Cola in an aluminium can has a climate-change contribution of 170g of CO_2 equivalent (inclusive of packaging), around half that of a Coca-Cola in a glass bottle, which illustrates the significance of packaging in terms of climate-change contribution. Coca-Cola in the UK has also reduced the quantity of glass in their 33 cl bottles from 263g to 210g. According to the company's calculations, this has resulted in a reduction of 3,500 tonnes of glass per year, leading to a reduction in greenhouse-gas emissions of 2,200 tonnes of CO_2 equivalent per year. The results of our analysis of cola products sold in the other Scandinavian countries show the same relationship between the climate-change contributions of glass packaging and ingredients (where bottles are regarded as non-returnable). Coca-Cola's carbon-footprint analysis also compared the product in PET bottles (0.5- and 2-litre) with its other products. The results showed that the use of larger bottles and PET as a packaging material both give a lower carbon footprint per volume of packaged soft drink compared with glass bottles and aluminium cans. Their study also included contributions from waste management and recycling of materials under the prevailing conditions in the UK.

6.1 Suggested improvements for industry

Fuel oil (which is used in many industrial processes) and LPG (which is used in crisp production) could be replaced by renewable energy sources in order to reduce greenhouse-gas emissions from these high-impact processes. Electricity also has a large impact, which could be reduced by switching to environmentally certified electricity from renewable sources, as renewable electricity has a lower contribution in terms of greenhouse-gas emissions. This would also reduce dependency on fossil fuels, which would be good preparation for the future. The production of ingredients and the agricultural processes behind them account for the major part of the carbon footprint of snack food, so reducing waste in these processes could be more effective in terms of reducing the impact of climate change than implementing energy-efficiency measures in factories.

6.2 Consumption

In 2007, Swedes consumed 1.6 kg of crisps, 15.2 kg of chocolate and sweets, and 87.7 litres of soft drinks per capita (Swedish Board of Agriculture, 2009a). The climate-change contribution from this consumption was around 450,000 tonnes of CO_2 equivalent (calculated on the basis of the 2007 population – 9,182,927 according to Statistics Sweden), according to the methods for measuring climate-change contributions outlined in this report (result at factory gate, excluding packaging), and assuming that the consumption of chocolate and sweets is divided 50/50 between chocolate (half dark and half light) and sweets (half jelly and half foam). In a report to the Swedish Board of Agriculture (Swedish Board of Agriculture, 2009b), SIK provided an estimate of the size of the climate-change contribution of total food consumption in Sweden: around 17.3 million tonnes of CO_2 equivalent (based on primary production only). Consumption of snack food therefore accounts for around 2.6% of the total climate-change contribution of food consumption in Sweden. The corresponding climate-change contribution figures for meat, dairy products and eggs are approx. 35%, 20% and 1% respectively. The climate-change contributions for meat, dairy products and eggs were acquired from SIK Report 794 (http://www.sik.se under Library/Reports – Environment).

7. Conclusions

Few studies are available on the environmental impact of snack foods, and no previously published life-cycle assessments of sweets have been found. The results of this analysis therefore represent new knowledge in this field.

The analyses looked at products produced and subsequently consumed in Sweden, using Stockholm as a calculation base, as well as products exported to the capitals of the other Scandinavian countries. The contribution of the products' transport from Malmö to their final destinations is mainly dependent on the distance travelled, with longer journeys making a greater impact. However, the environmental impact contribution from transport is relatively small, particularly compared to the contribution from ingredients, but also from processing (except for soft drinks, where the transport of heavy bottles significantly increases the impact).

The climate-change contribution from the production of crisps is 2.2 kg of CO_2 equivalent per kg of product – around 20 times higher than the raw material (potatoes). This also includes the contribution from the process of turning the raw materials into crisps. Vegetable oil is used for frying. In the crisp production studied, palm oil was used, which accounts for 70% of the climate-change contribution from ingredients. The eutrophication contribution is completely dominated by the contribution from ingredients, which is the norm when we look at the eutrophication impact of food from a life-cycle perspective. The processing of crisps, i.e. the factory stage of the life cycle, accounts for the greatest energy use.

Of the products covered by this analysis, the sweets have the greatest environmental impact per kg of product. Foam sweets have a higher climate-change contribution, eutrophication contribution and energy use than jelly sweets, and the relative contribution from ingredients accounts for the greatest proportion of the various stages of the life cycle. Weight loss occurs during the manufacture of both types of confectionery, mainly through evaporation, which condenses a greater mass of processing mixture into a smaller volume of finished product. Foam sweets have a lower product yield, so a smaller quantity of finished product carries the environmental impact contribution of the raw materials and ingredients. Grain and sugar beet are the raw materials for many of the ingredients (sugar, starch syrup, ethanol and lactic acid) of both types of sweets, and so the ingredients carry the environmental impact from the cultivation of raw materials. The eutrophication contributions for both types of confectionery are completely dominated by the contributions from ingredients.

Soft drinks have a relatively low climate-change and eutrophication contribution, as well as lower energy use per kg of product compared to the other products studied. The environmental impact of packaging is greater for soft drinks compared to the other products, especially when the bottles are non-returnable.

Changing energy use to renewable energy sources (both electricity and other energy sources) during the factory stage should reduce the climate-change contributions from all of the products in the study.

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Personal communication: Christel Cederberg, agronomist SIK, 2010.09.01

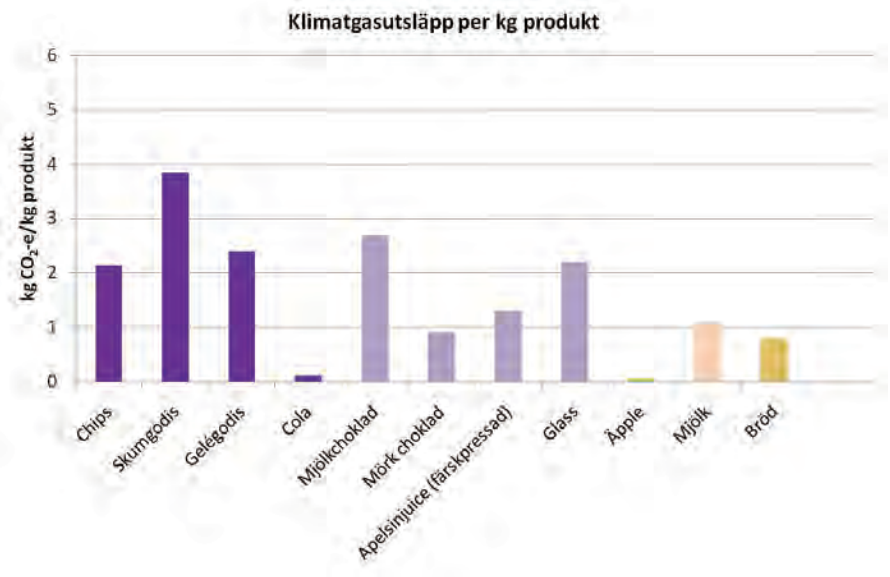
Sammanfattning

SIK har på uppdrag av Livsmedelverket gjort en livscykelanalysstudie (LCA) av den så kallade ”utrymmesmatens” miljöpåverkan utifrån påverkanskategorierna växthusgasutsläpp, övergödning och primär energianvändning. De produkter som studerats är potatischips, godis och läsk, alla producerade i Sverige med tänkt konsumtion i de skandinaviska huvudstäderna. De livscykelfaser som inkluderats i studien är råvaru- och ingrediensproduktion, intransport av råvaror och ingredienser, processningsindustri (fabrik), transport till centrallager och transport till butik.

Studien har gjorts i samarbete med företagen Svenska lantchips, Leaf och Spendrups. Inventering har gjorts på deras anläggningar så att specifika processdata i stor utsträckning har kunnat användas. När data varit bristfällig har antaganden gjorts, som specificeras för varje system.

Aggregerade resultat från studien gällande växthusgasutsläpp presenteras i diagrammet nedan. Här visas utrymmesmatsprodukternas växthusgasutsläpp per kg produkt i jämförelse med några andra utrymmesmatprodukter samt några vanliga baslivsmedel, som kan ha samma funktion som utrymmesmatprodukterna. Alla produkter har inte samma funktion och självklart inte samma näringsinnehåll, och äts inte heller i samma mängder, så jämförelsen, som gäller ett kg av respektive produkt, talar inte om vilket livsmedel som ska favoriseras ur klimatsynpunkt, utan visar på spridningen inom segmentet utrymmesmat.

Resultaten från denna analys tillför ny kunskap om miljöpåverkan av livsmedel då det inte finns många andra studier av miljöpåverkan av utrymmesmat. Inga tidigare publika livscykelanalyser har hittats på godis.



Figur a Klimatbidrag för produkter vid industrigrind. I mörklila visas de studerade utrymmesmatprodukterna, i ljuslila presenteras tidigare resultat av utrymmesmats klimatpåverkan och de andra färgerna visar resultat för baslivsmedels klimatpåverkansbidrag. Referenser: choklad, juice och glass samt bröd: SIKs hemsida (www.sik.se/matoklimat). Mjölk: SR 793 (SIKs hemsida www.sik.se under Bibliotek/Rapporter - Miljö). Äpple: SR 630, kan beställas i pappersform från biblioteket på SIK.

Walkers Crisps, England var först med att i England klimatmärka ett livsmedel; de redovisar Carbon Footprint på en chipsprodukt (http://www.walkerscarbonfootprint.co.uk/). Klimatbidraget för de engelska chipsen är 3,2 kg CO_2-ekvivalenter/kg chips. Detta är ett något högre värde än resultatet för chips i denna analys, som ligger på 2,2 kg CO_2-ekvivalenter/kg chips. Att resultaten skiljer sig är inte förvånande utan speglar variationen som uppstår när olika produktionssystem analyseras. De båda chipssorterna får potatis från olika odlingsområden och använder heller inte samma frityrolja. Någon mer detaljerad jämförelse av resultaten är inte möjlig då resultaten av Walkers Crisps endast presenteras i aggregerad form.

Godisprodukterna har störst miljöpåverkan per kg produkt av de produkter som studerats i denna analys. Skumgodis har ett högre klimatbidrag, övergödningsbidrag och en högre energianvändning än gelégodis och bidraget från ingredienserna står för störst andel av de olika livscykelstegen. Båda godissorterna har viktsförluster under tillverkningen, främst avdunstning, och utgår från en större massa smet än vad man får ut i färdig produkt. Skumgodis har lägre ingrediens/produktutbyte vilket innebär att mindre mängd färdig produkt får bära miljöpåverkansbidraget från råvaror och ingredienser. Spannmål och sockerbetor utgör råvaror till många av ingredienserna (socker, stärkelsesirap, etanol och mjölksyra) till de båda godissorterna och ingredienserna har med sig miljöpåverkan från odlingen av råvarorna. Övergödningsbidraget från båda godissorterna domineras helt av bidraget från ingredienserna.

Läsk har ett relativt lågt klimat- och övergödningsbidrag samt en lägre energianvändning per kg produkt jämfört med de övriga produkterna. Förpackningens miljöpåverkan har större betydelse för läsken än vad den har för övriga produkter, framförallt när flaskan inte är en retur- utan engångsflaska. Coca Cola i England har beräknat Carbon Footprint på sina Coca Cola-produkter. En 33cl Coca Cola i glasflaska (engångs, inklusive dryck) har ett klimatbidrag på 360 g CO_2-ekvivalenter (http://www.coca-cola.co.uk/environment/what-s-the-carbon-footprint-of-a-coca-cola.html) vilket motsvarar klimatbidraget från colaläsken i engångsflaska från denna studie. Av detta kommer endast 6 % av klimatbidraget från ingredienserna i Coca-Colan, resten av klimatbidraget utgörs av främst förpackningen men även av bidrag från läskproduktionen.

Att byta energislag till förnyelsebar energi (både elektricitet och andra energikällor) i fabrikssteget skulle ge ett lägre klimatbidrag, vilket gäller för alla studerade produkter.

I Sverige konsumerade vi år 2007 1,6 kg potatischips, 15,2 kg choklad och konfektyr samt 87,7 liter läsk per person (SJV, 2009a). Klimatbidraget från denna konsumtion blir ca 450 000 ton CO_2-ekvivalenter (beräknat på befolkningsmängd 2007 som var 9 182 927 enligt SCB 2008) om man använder klimatbidragen vi fått fram i denna rapport (resultat vid industrigrind, exklusive förpackning) samt antar att hälften av den choklad och konfektyr som konsumeras är choklad (hälften mörk och hälften ljus) och hälften godis (hälften gelé- och hälften skumgodis). I en rapport till Jordbruksverket (SJV, 2009b) gjorde SIK en uppskattning av hur stort klimatbidrag den sammanlagda livsmedelskonsumtionen i Sverige gav upphov till och kom fram till ca 17,3 miljoner ton CO_2-ekvivalenter (enbart primärproduktionen inräknad). Konsumtionen av utrymmesmaten står då för ca 2,6 % av den totala livsmedelskonsumtionens klimatbidrag i Sverige. Motsvarande klimatbidragssiffra för konsumtionen av kött, mejeriprodukter och ägg är ca 35 %, ca 20 % respektive ca 1 % av bidraget från totalkonsumtionen. Klimatbidraget från konsumtionen av kött, mejeriprodukter och ägg är hämtade från SIK rapport 794 (www.sik.se under Bibliotek/Rapporter – Miljö).