LIFE CYCLE ASSESSMENT
VEGETARIAN DIET VERSES A NON-VEGETARIAN DIET

GROUP 05

Jesper Diebels, Victoria Johansson, Ingrid Wrisley

January 2014

Project Report
Department of Land and Water Resources Engineering
Royal Institute of Technology (KTH)
SE-100 44 STOCKHOLM, Sweden

ERRATUM

This Erratum was written in Januari 2014.

For 'Beef at supermarket' the following values where entered in SimaPro as can be found in Table 15:

Materials/fuels	Amount	Unit	Comments on data
Beef at slaughterhouse	1	kg	
Transport, lorry >28t, fleet average/CH S	100	tkm	To wholesale. Ecoinvent
Wholesale (5* C)	1	l*day	LCA Food DK
Transport, lorry >16t, fleet average/RER S	100	tkm	To supermarket. Ecoinvent
Retail (cooling counter, large store)	1	kg	LCA Food DK

The unit used for the transportation is tonne per km while the unit should have been kg per km as mentioned in Table 2. Due to this mistake the environmental impacts related to the transportation from slaughterhouse to supermarket are a factor 1000 higher than in reality.

The false high impact of beef transportation led to believe that a meat diet had a 2 times higher impact on climate change compared to a vegetarian diet. Perhaps due to biased assumptions these results were not questioned enough and considered true.

When using the correct unit for transportation the results change dramatically. In this new scenario the two diets have similar impacts on climate change which does not fit with the expected results.

When examining the data set in SimaPro further it is clear that no airborne emissions from land use and animal digestion were taking into account in the study. When data sets for pork and beef were revised, the final results became more representative, see *Table 1: Revised data in SimaPro*. Whith these corrections the magnitude for beef production is in the same order as the original data source. Pork production is five times better than beef production regarding climate change. This is mainly due to the methane release from cow rumination and from dinitrogen oxide release from cow manure. In order to draw any conclusions weather these results are representable in its own further investigations must be performed. However, for the comparison of the two weekly diets, these data sets can be used to show the magnitude of how much the environmental impact differs between the two diets. Characterized and normalized results and visible in *Figure 2* and *Figure 1* respectively.

Data sets for meat production are still simplified compared to the original LCA-studies. The data source for beef production does not cover activities and transport to the slaughterhouse, therefore the data set "Beef at slughterhouse" was changed in SimaPro, namely to "Beef at farm". The data set "Beef at supermarket" consequently does not include any transport to and from slaughterhouse. However, the lacking of transportation and activeties in the slaughterhouse do not affect the final results in the same order as the earlier lack of methane emissions. It is assumed though that the difference between the two diets will be slightly larger regarding climate impact than what it is now.

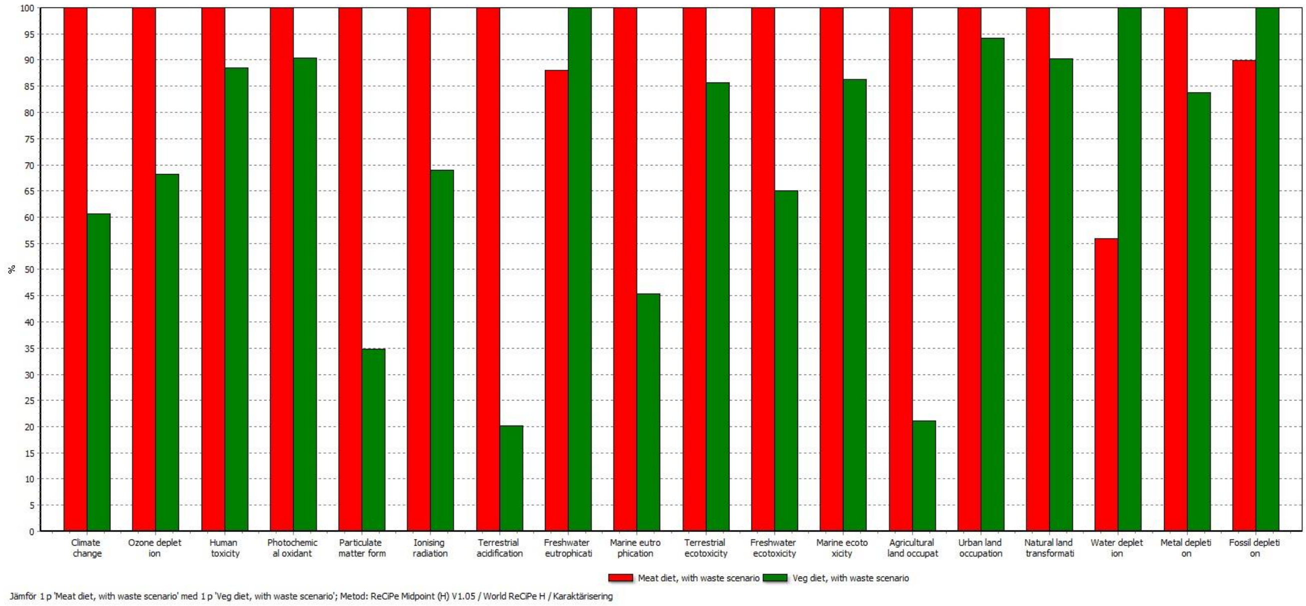

Figure 2: Picture of characterized results after data revision in SimaPro.

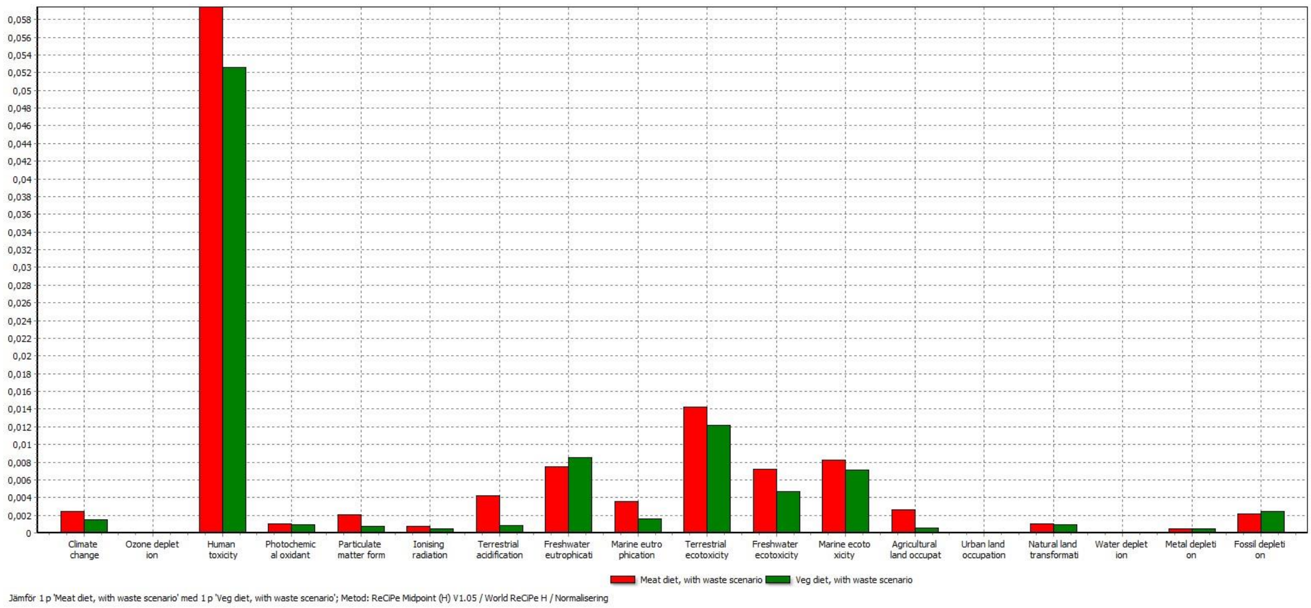

Figure 1: Picture of normalized results after data revision in SimaPro.

Table 1: Revised data in SimaPro

SimaPro 7.3	processer		Datum:	2014-01-13	Tid:	12:50
Projekt	Dietry comparison					
Beef at farm		1000	kg	100	inte definerad	Food
Data taken from the LCA-article "Environmental consequences of different beef production systems in the EU" by Thu Lan T. Nguyen, John E. Hermansen, Lisbeth Mogensen (Journal of Cleaner Production, 2010). Data for Suckler cow–calf (SCC.*						
Resources						
Land use (grassland, pasture and range)	land		4,28+3,01+0,68+0,6	ha		

Materials/fuels							
Grass from natural meadow extensive IP, at field/CH S	9021	kg		Ecoinvent			
Grass silage IP, at farm/CH S	5446	kg		Ecoinvent			
Silage maize IP, at farm/CH S	2404	kg		Ecoinvent			
Barley straw IP, at farm/CH S	2254	kg		Ecoinvent			
Straw IP, at farm/CH S	1726	kg		Ecoinvent			
Soy Meal	12	kg					
Mineral Feed, P	131	kg					
Nitrogen fertilizer, production mix, at plant/US	478	kg		USLCI			
Phosphorous fertilizer, production mix, at plant/US	21,5	kg		USLCI			
Electricity mix/SE S	1,71	MWh		Ecoinvent			
Diesel, burned in building machine/GLO S	14	MJ		Ecoinvent			
Transport, lorry >28t, fleet average/CH S	12	tkm		Ecoinvent, for soy meal			
Transport, transoceanic freight ship/OCE S	162	tkm		Ecoinvent, for soy meal			
Emissions to air							
Dinitrogen monoxide			26,2	kg			
Methane			476,1	kg			
Ammonia			95,6	kg			
Nitrate			1231	kg			
Phosphate			2,7	kg			
Pork at farm	1000	kg			100	inte definerad	Food
Life Cycle Assessment of pork production: A data inventory for the case of Germany							
Avoided products							
Nitrogen fertilizer, production mix, at plant/US	49	kg		USLCI			
Phosphorous fertilizer, production mix, at plant/US	13	kg		USLCI			
Potassium nitrate, as K2O, at regional storehouse/RER S	12	kg					
Materials/fuels							
Wheat IP, at feed mill/CH S	1090	kg		Ecoinvent			
Barley IP, at feed mill/CH S	440	kg		Ecoinvent			
Rye straw IP, at farm/CH S	161	kg		Ecoinvent			
Soybean meal, at oil mill/BR S	188	kg		Ecoinvent			
_25 Animal feeds, EU27	648	kg		EU & DK input output database			
Heat, light fuel oil, at industrial furnace 1MW/RER S	130,2	kWh		Ecoinvent			
Electricity mix/SE S	117,6	kWh		Ecoinvent			
Transport, transoceanic freight ship/OCE S	3375	tkm		Transport of feedstock. Ecoinvent			
Transport, lorry >28t, fleet average/CH S	868	tkm		Transport of feedstock. Ecoinvent			
Transport, tractor and trailer/CH S	108	tkm		Ecoinvent			
Tap water, at user/RER S	1000	kg		Ecoinvent			
Traction	206	MJ		LCA Food DK			
Emissions to air							
Methane			26,7	kg			
Dinitrogen monoxide			1	kg			
Nitrogen dioxide			-2,4	kg			
Ammonia			20,7	kg			
Emissions to water							
Nitrate			1,2	kg			
Phosphate			0,5	kg			

ABSTRACT

Increasing global welfare is one of the majour sources to environmental problems in the society of today. The consumptive behaviour of humans affects the world greatly, and about 20% of this impact origins from food consumption (Hertwich & Peters, 2009). In this study a Life Cycle Assessment (LCA) is carried out with the aim to evaluate differences in the environmental impacts caused by a meat based, and a vegetarian diet. The program SimaPro was used to evaluate data and to calculate the magnitude of the environmental burdens.

The study executed an accounting LCA where average data from existing databases in SimaPro primary have been used. The functional unit is an average daily meal that meets the Daily Recommended Intake (DRI) requirements. Due to the magnitude of inventory analysis, ingredients were aggregated together and general assumptions concerning transportation, waste disposal and use phase were made. The impact categories that considered to be the most relevant were "Climate change", "Terrestrial acidification", "Freshwater eutrophication", " Agricultural land occupation" and "Natural land transformation"; due to their relative extent and their link to agriculture.

As can be seen in *Figure 9: Dietary comparison characterized results,* the environmental burdens of the meat diet are significantly larger than those of the vegetarian diet. In the case of "Climate change" e.g. the burden is almost twice as big. For all impact categories burdens of the meat diet was higher, also in the categories considered to beless relevant. This confirms that a vegetarian diet is a better alternative from an environmental perspective.

The secondary results show that the ´hotspots´ in the weekly diets are "Freshwater eutrophication" and "Climate change". Transport and fertilizer use are the two processes contributing mostly to the identified hotspots. Hands-on solutions are suggested in order to decrease the environmental burden of the consumptive behaviours. These suggestions include consumption of more organic and locally produced food and less car use.

The presented results are based on assumptions of the current food system. Due to a lack of resources many assumption were made. This leads to uncertainties in the results. However the results tend to reflect a trustworthy picture of reality since they correspond to the outcomes of already existing studies.

The conclusion made in this assessment is that environmental burdens associated with food consumption differ significantly depending on origin, and whether or not the diet contains meat. This result shows that each person can reduce its environmental burdens by, for instance, consuming less meet and buy locally produced food.

LIST OF CONTENTS

1. GOAL AND SCOPE

1.1. Goal of the study

Today's society is over-consuming and relatively few people look in to the compounds of the products they buy. This is an effect of the increasing welfare. With more money people have the possibilities to consume more, this also makes it possible for the consumers to be critical towards their consumption behaviour.

The lack of knowledge of which effects over-consuming has towards nature is a huge problem today. In this report a LCA is carried out on two different diets, one diet based on meat, and one vegetarian diet.

The main question this report aims to answer is if there are any differences in the environmental impacts of these two diets. If there are significant differences, are there any hands-on solutions? Since it is interesting to investigate the actual impact of each diet alone, this study is made up of two separate stand-alone LCAs. The objective of the study is to evaluate the effects of a varied diet, and not only one specific ingredient.

Today's recommendations from Svenska Livsmedelsverket are to vary the diet in order to fulfil the need of different nutritions, like vitamins and mineral.

The study aims is to evaluate the current state of the existing food systems instead of estimating possible changes in the systems. Thus an accounting LCA, where average data is used, is preferable in this case. A possible application of the results is to use the report to inform the general public about effects caused by their consumption behaviours. Potential arenas could be supermarkets, food magazines/programs and Svenska Livsmedelsverket (Livsmedelverket, 2005).

1.2. Functional unit

A daily-recommended intake (DRI) of nutrients needed is used to set the frame for the functional unit of the systems. Each studied meal contains about 25-30 % of DRI, which equals to about 500 kcal.. Since 1 meal does not represent an average eating habit, 5 meals are investigated instead. The functional unit is set to be 5 average daily meals corresponding to the DRI requirements.

1.3. System boundaries

The processes in the life cycle "Diet" consists of: *weekly meals, transports to the supermarket, cooking and storage* and *waste*. In *weekly meals* five main dishes that all fulfil the nutrition recommendations from Svenska Livsmedelsverket are included.

This system is divided in to two subsystems according to Figure 3, where the foreground system consists of the processes that the consumer can affect. In the contrary, the consumer has little effect on the background system. For instance, the consumer can affect how he/she composes a weekly menu and how he/she decides to travel to the supermarket, but little about how the food is produced and how it is transported from the farm etc.

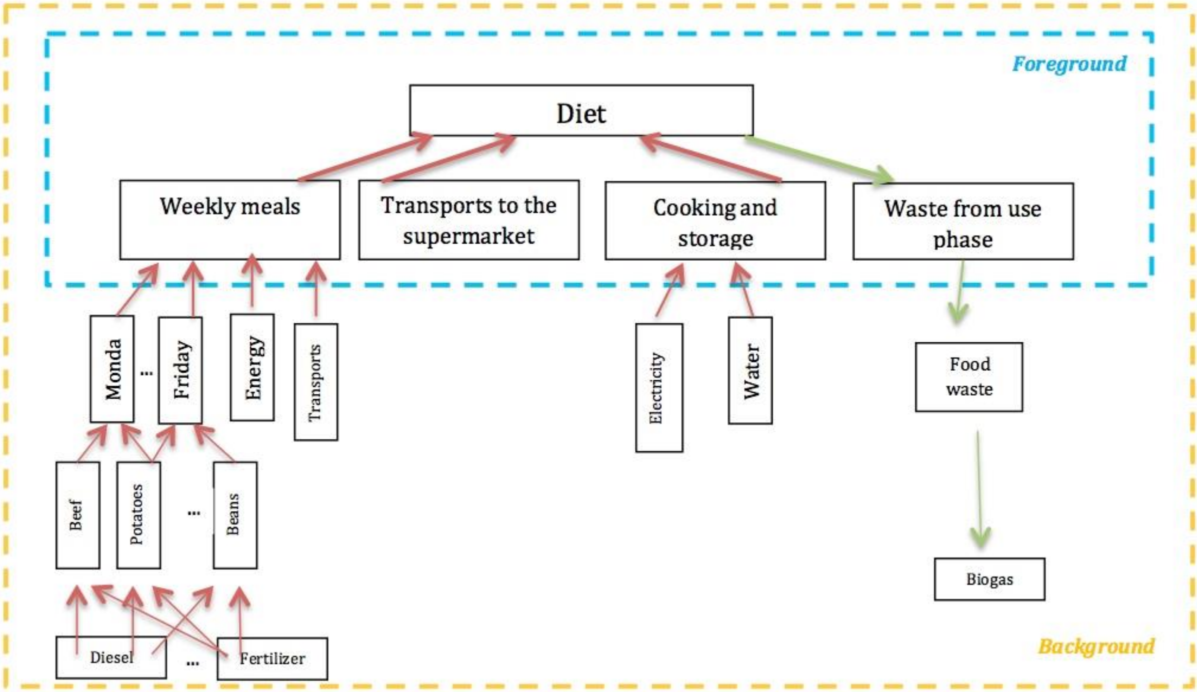

Figure 3: System boundaries for a weekly diet.

The boundaries in relation to nature are according to "cradle-to grave". The cradle is count as the extraction of raw materials including the cultivation of crops. The grave is the disposal of waste.

There are no specific geographical boundaries in an average person's daily eating habits. For instance, rice is mostly produced in Asia. However, when it is possible European data is used, and assumptions are made that agricultural conditions and environmental impacts from agriculture are similar in the whole of Europe. The supermarket is assumed to be located in Stockholm, and the user is asumed to live in the municipality of Solna. Waste from the use phase is assumed to be treated in Sweden. In the municipality of Solna all food waste goes to biogas production (Solna Stad, 2013).

Agricultural systems, waste treatment systems, peoples habits etc. are changing with time. Also the LCA-methodology will most likely be developed further in the future. This report will therefore only be applicable as long as no significant changes in the current systems are visible.

Regarding impacts from emissions to air and land, calculations are preformed according to the hierarchist model in ReCiPe. In this model the time perspective for climate change is 100 years (Goedkoop, et al., 2008).

1.3.1. **Waste scenario**

According to a study from SLU, households throw away 30 percent of the food they buy (Loxbo, 2011). In this study it is assumed there are no differences of the ammout of waste produced from different food products. Therefore the daily meels were accounted as 1,42 times the total mass of one meal. No packages were taking into account, since the amount of packages was assumed to be equal in the two diets. All food waste is assumed to become biogas. The remaining 70 percent of food is what a person eats. No accountings have been made for human work or sludge. This part is therefore seen as “DummyWasteTreatment” in SimaPro.

1.3.2. **Cut-off criteria**

The ingredients of the two diets, five meals each, are sorted according to their respectively mass. Ingredients with lower mass than 1% of the total mass are not taken into account in the calculations. The remaining ingredients of both diets embody more than 97% of the total mass which is considered to be representative. The reason for this cut-off criterion is to decrease the amount of data needed in this LCA. Exceptions to this rule are butter, oil and wheat flour, as the data for these ingredients already exists in SimaPro.

A cut-off has been made regarding what the biogas, produced from organic waste, is used for. Hence no attention towards the possible avoided burdens at the fuel market was taken. To include such areas in the analysis of weekly diets would draw too much focus from the main goal.

1.3.3. **Allocation procedures**

The identified allocation problem is within the waste treatment step. Since no packaging was taken into account, only food waste is treated. The system boundaries are expanded in order to solve the allocation problem that arises: the 30 % organic waste fraction is sent to a biogas plant. This plant has two functions, namely the disposal of organic waste, and the production of biogas. The associated environmental impacts should be devided between these two functions. All environmental burdens from the biogas plant are allocated to the weekly diet-system and no avoided burdens were taking into account.The waste treatment step is predefined in SimaPro and called “Disposal, bio waste, to anaerobic digestion/CH S”.

1.4. Assumptions and limitations

Databases existing in SimaPro are primary used. One limitation of this data is that it is not directly related to the Swedish market, and perhaps the imported goods do not come from the countries described in SimaPro. This data is used however in order to decrease the amount of work put into the data collection step.

The two weekly menus were designed by two different organizations in order to meet the DRI levels. Some ingredients have however been substituted with similar ingredients, due to the lack of data concerning the primary ingredients. The changes made in the menus can be found in Appendix A: *Weekly menus*.

The ingredient pasta was not found in SimaPro. According to a found recipe this product was created, see details in Appendix D: *Pasta recipe*.

The cut-off criterion is based on a mass percentage since assumptions were made that the mass of an ingredient is proportional to the environmental impacts. In reality this might not be the case since 1g of a certan spice might have a large environmental impact regardless to its limited mass.

For calculation of the total yearly food consumption per capita, it was assumed that there is a proportional relationship between the DRI and the mass of food.

For food transportations several distances between retailer, distributor, harbour and farm were assumed. These distances are displayed in Table 2: *Transportation factors used in SimaPro.*

Table 2: Transportation factors used in SimaPro

From	To	Distance	Type	Database
Farm	Whole-sale/ harbour	100 km	Transport, lorry >28t, fleet average/CH S	Ecoinvent
Whole-sale	Retail	100 km	Transport, lorry >16t, fleet average/RER S	Ecoinvent
Supermarket	Home	5 km (10km in total)	Transport, passenger car, petrol, fleet average 2010/RER S	Ecoinvent
Whole-sale	Whole-sale	Site specific	Transport, lorry >28t, fleet average/CH S	Ecoinvent
Harbour	Harbour/ whole-sale	Site specific	Transport, transoceanic freight ship/OCE S	Ecoinvent

For the cooking process several assumptions are made. These assumptions can be found in Table 3: *Cooking assumptions per meal.*

Table 3: Cooking assumptions per meal

Process	Quantity	SimaPro	Database
Cook water for rice/pasta/potatoes	0,5 L	Boiling of water in el. kettle	LCA food DK
Frying vegetables/ meat/ fish	100 g	Roasting of meat balls	LCA food DK
Baking vegetables/ meat/ fish	0,25 h / 0,5 p	Sustaining of temperature in hot air oven / Heating of hot air oven	LCA food DK
Dishwashing and other water usages in the kitchen	10 kg	Tap water, at user/CH S	Ecoinvent

For the storage of the food it is assumed that a refrigerator is used with a capacity of 145L with energy class A, see Table 4: *Food storage assumption for 5 days.*

Table 4: Food storage assumption for 5 days

Process	Quantity	SimaPro	Database
Food storage at home	5*145	Refrigerator, small, A	LCA food DK

In reality products comes from several places. To simplify the data collection one suitable origin was chosen, e.g. rice from Thailand, pasta from Italy and pork from Germany.

Asumptions were made concerning the required space and storage time regarding storage at harbour, whole-sale and retail. Assumed is that 1 kg of each ingredient uses a space of 1 L, that all ingredients were only stored for 1 day at each storage step and that the retail is a large store. Depending on the ingredient the storage temperature and time of storage were decided upon individually.

1.5. **ReCiPe methodology**

ReCiPe impact assessment method is a tool developed for interpretation of the inventory results in the life cycle assessment. The model is developed because the inventory results often are complex and difficult to analyse (Goedkoop, et al., 2008).

The model converts the results into a more compact indicator source, which describe the relative severity of an environmental impact category. This is done in two levels depending on the uncertainty level the user choses. The two levels are three endpoint indicators and eighteen midpoint indicators. The midpoint indicators are more difficult to interpret than the endpoints. These indicators give a low uncertainty and are often used for acidification, climate change and eutrophication (Goedkoop, et al., 2008).

Endpoint indicators are often used for categories such as damage to ecosystems, resource availability and human health. The endpoints are often easy to interpret but the uncertainty is higher because these models are not as complex as the midpoint models (Goedkoop, et al., 2008).

For predicting and preventing potential future damage each method for both endpoints and midpoints are divided in to three different categories representing different cultural values. The three categories are (Goedkoop, et al., 2008):

- *Hierarchist:* This model is the most common and is standardized when dealing with scientific models.
- *Individualist:* Has a short term perspectives as it looks in an optimistic approach - future problems can be avoided with the use of technology.
- *Egalitarian:* This model is based on a conservative approach in which long-term perspectives are in Focus.

In this project ReCiPe midpoints indicators are used in order to avoid the higher level of aggregation that comes with the use of endpoint indicators. In SimaPro the evaluation of these eighteen environmental categories are made automatically (Goedkoop, et al., 2008): *climate change, ozone depletion, terrestrial acidification, freshwater eutrophication, marine eutrophication, human toxicity, photochemical oxidant formation, particulate matter formation, terrestrial ecotoxicity, freshwater ecotoxicity, marine ecotoxicity, ionising radiation, agricultural land occupation, urban land occupation, natural land transformation, water depletion, mineral resource depletion, fossil fuel depletion.* However, only five of these indicators are chosen to be of specific interest for this study. These indicators are:

- *Climate impact*
  This category is one of the most debated ones in media. Also it is possible to find already existing information of the climate impact of food to compare the results with.
- *Natural land transformation*
- *Agricultural land occupation*
  Natural- and agricultural land use are of specific importance within ag-

riculture because there is always an ongoing debate of how to best use land.

- *Freshwater eutrophication*
- *Terrestrial acidification*
  Agriculture is one of the sources to be blamed for eutrophication and acidification. This is mainly why these two categories are chosen for the dietary comparison.

It can be questioned why toxicological effects were not chosen to be analyzed in this LCA. This is due to the complexity of the assessment methods used for these indicators. As can be seen in Appendix I: Characterized results vegetarian diet and Appendix J: Characterized results meat diet, the waste treatment step accounts for most of the environmental burdens. This can be allocated to the uncertainty concerning these indicators. Also the waste phase in this project includes the data "Disposal, bio waste, to anaerobic digestion/CH S". By using this data, the waste phase becomes exaggerated relative to other phases in the life cycle for these impact categories.

1.6. Normalisation and weighting

For the normalization step the same methodology was used, namely ReCiPe Midpoint (Hierarchist). Data was collected on both a European and a global level with 2000 as a reference year. Due to the lack of useful available data the normalisation factors have a large uncertainty, but they are still considered to be useful for LCA studies (Sleeswijk, et al., 2008). No weighting was carried out within this research.

2. LIFE CYCLE INVENTORY ANALYSIS

2.1. Process flowchart

The process flowchart can be found in Appendix C: *Flowchart*. As can be seen in Figure 3: *System boundaries*, the use phase produces two waste flows, namely ´food waste´ and ´package waste´. However, package waste is not taken into account in the SimaPro model, as it is hard to define the amount of packaging used and the assumption can be made that these amounts are similar within both diets.

2.2. Data

2.2.1. Databases

Data for the use phase and the waste disposal were all found in the databases available in SimaPro. Most of the ingredients of the menus were also found in these databases, although some ingredients had to be entered manually using LCA studies. In *Table 5: Ingredient aggregation* the columns ´SimaPro´ and ´Comments´ show whether the data was found in SimaPro and if not, what source was used.

Data inputs in SimaPro are exported and shown in Appendix F: *SimaPro entries*.

The following databases in SimaPro are used for the calculations:

1. **LCA Food Database**
   This Danish database is a result of the project "Lifecycle Assessment of Basic Food" (2000 to 2003). Where the Faculty of Agricultural Science and the Danish Technology institute are two of the cooperation partners with in the project (LCA Food Database, 2007).

2. **Ecoinvent**
   Ecoinvent is the world leading competence centre for Life Cycle Inventories which belongs to a number of Swiss federal institutes and universities. The data is considered as up-to-date and transparent (Swiss Centre for Life Cycle Inventories, 2013).

3. **Industry data 2.0**
   Industry data 2.0 is a database produces by professional associations within different industries. Data is n this database data is defined from cradle to gate. All versions of SimaPro contain data from this database (Earthshift Inc., 2011).

4. **USLCI**
   U.S. Life Cycle Inventory Database (USLCI) is an up-to-date and critically reviewed LCI-database created to cover products processes and material flows that are commonly used in the United States. The data is developed to handle questions about environmental impacts for individual flows from cradle-to-gate gate-to-gate, and cradle-to-grave (NREL, 2012).

2.2.2. Data simplification

In order to simplify data collection, some ingredients were grouped together according to their origin or production method. The aggregated ingredients, and the LCA value the respective group is based on, can be found in*Table 5: Ingredient aggregation*.

Some recepies were also changed in order to simplify data collection. It can be questioned weather some of these substituted ingredients have a larger environmental impact than the original ones. However, this was not taken into account. Only practical reasons, like weather one ingredient can be used in the recipe, lie behind the substitution. See Appendix A: Weekly menus to see the original menues.

Table 5: Ingredient aggregation

Name	Aggregated	Data based on	Data in SimaPro?	Comments
Beans	Green beans Kidney beans Red lentils	Soy beans from Brazil	Yes, at farm.	Transport from Brazil to Europe with transoceanic tanker + road transport in Europe
Beef	Beef Deer Lamb	From slaughter-house	No	(Nguyen, et al., 2010) Transport from farm to whole sale + transport from whole sale to retail is added.
Cheese (Semi-hard cheese, Ängsgården, at supermarket)	Cheese 17 % Feta cheese		No	(Berlin, 2002) Transport from farm to whole sale + transport from whole sale to retail is added.
Citrus fruits	Lemon Lime	Cucumber	Yes, at farm.	Same climate impact as cucumber based on Appendix E: Relative global warming potential. Transport from farm to whole sale + transport from whole sale to retail
Fish (cod fillet)	Salmon Tuna	Cod fillet	Yes, at store.	Change of recipe, see Appendix A: Weekly menus. Transport distances set to 70 kgkm by LCA food DK.
Flour	Wheat flour	Wheat flour	Yes, at store.	Transport distances set to 70 kgkm by LCA food DK.
Maize	Maize	Maize	Yes, at farm.	Transport from farm to whole sale + transport from whole sale to retail
Milk	Butter Cream Crème fraîche Milk Yoghurt	Milk	No	(Cederberg & Mattsson, 2000) Transport from farm to whole sale + transport from whole sale to retail is

				added.
Oil	Olive oil Rape seed oil	Rape seed oil from supermarket	Yes, at store.	Transport distances set to 70 kgkm by LCA food DK.
Onion (Red/yellow onion, garlic)	Chive Garlic Leek Red/yellow onion	Onion from farm	Yes, at farm.	Transport from farm to whole sale + transport from whole sale to retail
Pasta	Bulgur Couscous Filled pasta Lasagne Pasta	Wheat flour Egg Oil Water Salt	Yes	Recipe was built up from ingredients existing in SimaPro
Peas	Chick peas Haricot verts Peas	Protein peas conventional, Saxony-Anhalt, at farm/DE S	Yes, at farm.	Transport from farm to whole sale + transport from whole sale to retail
Pork	Pork	Pork	No	(Reckmann, et al., 2013) Transport from farm to whole sale + transport from whole sale to retail is added.
Potatoes	Potatoes	Potatoes from supermarket	Yes, at store.	Transport distances set to 70 kgkm by LCA food DK.
Rice	Rice	Rice from farm in Asia	No	(Kasmaprapruet, et al., 2009) Transport from farm to whole sale + transport from whole sale to retail is added.
Root vegetables	Beetroot Carrot Celery Fennel White cabbage	Carrot from farm	Yes, at farm.	Transport from farm to whole sale + transport from whole sale to retail
Tomato products	Crushed tomato Pasta sauce Paprika Tomato paste	Tomato from farm	Yes, at farm.	Transport from farm to whole sale + transport from whole sale to retail
Water	Tap water	Tap water at user	Yes, at user.	
Wine	Wine	Wine, at farm in Italy.	No	(Pizzigallo, et al., 2008) Transport from farm to whole sale + transport from whole sale to retail is added. See more details in Appendix F: SimaPro entries.
Zucchini & Egg-plant	Aubergine Chard Mushrooms Spinach Zucchini	Zucchini	No	(Cellura, et al., 2012) Transport from farm to whole sale + transport from whole sale to retail is added.

3. LIFE CYCLE INTERPRETATION

3.1. Results

3.1.1. Characterized results

Appendix G: *Characterized comparison results* shows the characterized results of comparison between the two diets. The red column to the left shows the meat diet and the green column to the right shows the vegetarian diet. Each result in the impact categories are shown in Table 6 as a numerical value with three decimal figures and with its respectively unit. From an environmental perspective, the vegetarian diet is preferable and has less impact in all categories except for the category "water depletion". The process that has the greatest contribution to this category is "tap water, at user". This is because the chosen vegetarian recipes contain more water than the meat recipes. If other recipes would have been chosen, the opposite situation could also have appeared.

Table 6: Characterization results of the dietary comparison using ReCiPe

Impact category	Unit	Meat diet, with waste scenario	Veg diet, with waste scenario
Climate change	kg CO2 eq	19,030	10,245
Ozone depletion	kg CFC-11 eq	0,000	0,000
Human toxicity	kg 1,4-DB eq	8,181	6,200
Photochemical oxidant formation	kg NMVOC	0,137	0,044
Particulate matter formation	kg PM10 eq	0,040	0,010
Ionising radiation	kg U235 eq	1,785	0,667
Terrestrial acidification	kg SO2 eq	0,119	0,032
Freshwater eutrophication	kg P eq	0,003	0,002
Marine eutrophication	kg N eq	0,063	0,023
Terrestrial ecotoxicity	kg 1,4-DB eq	0,094	0,079
Freshwater ecotoxicity	kg 1,4-DB eq	0,056	0,020
Marine ecotoxicity	kg 1,4-DB eq	0,047	0,017
Agricultural land occupation	m2a	14,434	3,027
Urban land occupation	m2a	0,171	0,072
Natural land transformation	m2	0,016	0,011
Water depletion	m3	0,099	0,108
Metal depletion	kg Fe eq	0,718	0,191
Fossil depletion	kg oil eq	6,416	3,281

In Figure 4: *Characterized results of the chosen impact cathegories* the characterized results of the chosen impact categories are displayed. The climate change category differs with 46 percent between the two diets. The meat diet releases almost the double amount of CO_2-equivalents compared to the vegetarian diet. About the same number of electricity is used in both systems, see

Table 7. This is also the process that contributes the most for the vegetarian diet. After that heat for greenhouse production is the second largest process in the vegetarian diet. For the category "agricultural land occupation" the largest difference in total be-

tween the two diets is found, see figure 3. For terrestrial acidification the main contributing processes are grass silage and transportation for the meat diet and egg and personal transportation for the vegetarian diet. The difference in freshwater eutrophication is only about 18 percent according to figure 3. The main processes contributing to this impact category are phosphorous fertilizer use, disposal bio waste and transportation. Soybean productions together with transportation are the largest processes contributing to natural land transformation.

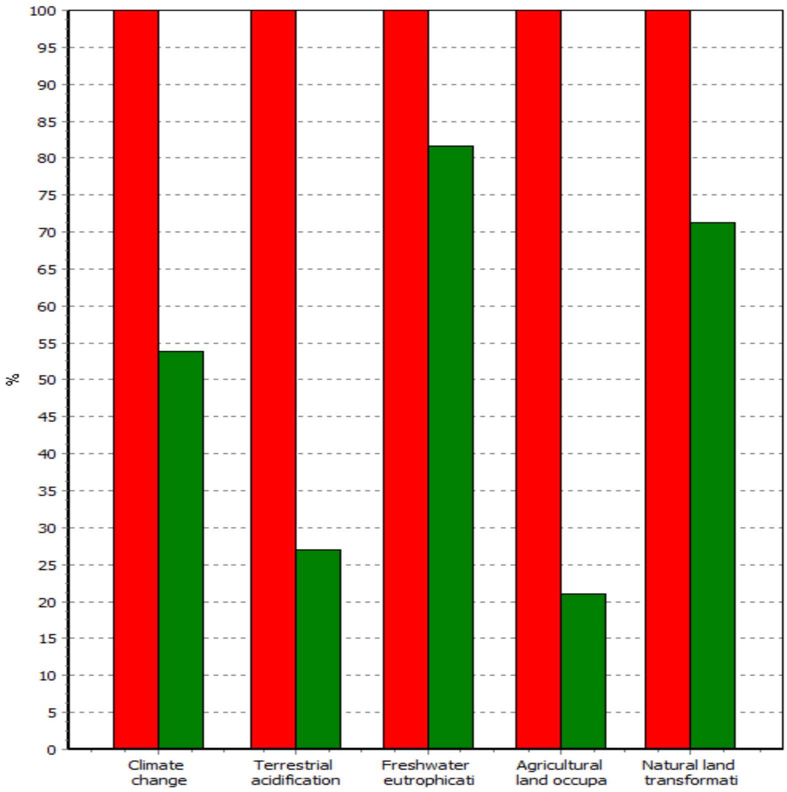

Figure 4: Characterized results of the chosen impact cathegories

Table 7: Hot spots processes climate change

Process	Meat diet *(kg CO_2-equivalents)*	Veg diet *(kg CO_2-equivalents)*
Transport, lorry (28t & 16t)	4,88+4,56=9,44	0,421+0,0396=0,4496
Electricity (natural gas)	3,07	3,35
Heat for greenhouse production	0,873	2,57
Transport, passenger car, petrol	1,8	1,8
Sum	**15,18**	**8,17**
Percentage of total	**80 %**	**80 %**

Table 8: Hot spots processes freshwater eutrophication

Process	Meat diet *(kg P eq)*	Veg diet *(kg P eq)*
Disposal, bio waste, to anaerobic digestion	0,000662819	0,000578229

Phosphorous fertilizer, production mix	0,000471	0,00123
Transport, lorry (28t & 16t)	0,000906696	0,0000442
Transport, passenger car, petrol	0,000254875	0,000254875
Sum	**0,0023**	**0,00211**
Percentage of total	76%	86%

3.1.2. Normalized results

Appendix H: *Normalized comparison results* shows the normalized results of the comparison between the two diets. The red column to the left shows the meat diet and the green column to the right shows the vegetarian diet. Each result in the impact categories are shown in Table 9 as a percent of the total impact to an environmental category. In Figure 5 the normalized results of the five chosen impact categories are displayed.

Since the normalized number relates the impacts from the diets to the total impact to an environmental category from all activities in a region during a year, the normalized results do not give any information about what environmental impact that is representative for five weekly meals. If a yearly diet would have been analysed, the results would have been of greater interest. However by multiplying for instance the normalized number of the impact climate change with the number of weeks within a year, the result is of the same magnitude as the global average, which is about 20% (Hertwich & Peters, 2009).

Table 9: Normalized results of the dietary comparison using ReCiPe

Impact category	Meat diet, with waste scenario (percent)	Veg diet, with waste scenario (percent)
Climate change	0,28	0,15
Ozone depletion	0,01	0,00
Human toxicity	6,94	5,26
Photochemical oxidant formation	0,28	0,09
Particulate matter formation	0,28	0,07
Ionising radiation	0,14	0,05
Terrestrial acidification	0,31	0,08
Freshwater eutrophication	1,04	0,85
Marine eutrophication	0,45	0,16
Terrestrial ecotoxicity	1,44	1,22
Freshwater ecotoxicity	1,30	0,47
Marine ecotoxicity	2,00	0,71
Agricultural land occupation	0,27	0,06
Urban land occupation	0,02	0,01
Natural land transformation	0,13	0,09
Water depletion	0,00	0,00
Metal depletion	0,16	0,04
Fossil depletion	0,47	0,24

3.1.3. Identification of hotspots

As seen in Figure 5 the impact category with the largest normalized burden is "Freshwater eutrophication" and "Climate change". These categories are therefor considered to be crucial and extra focus should be spent to improve these categories. From
Table 7 and

Table 8 some particular environmental burdens can be identified to which improvements can be seen as specifically important.

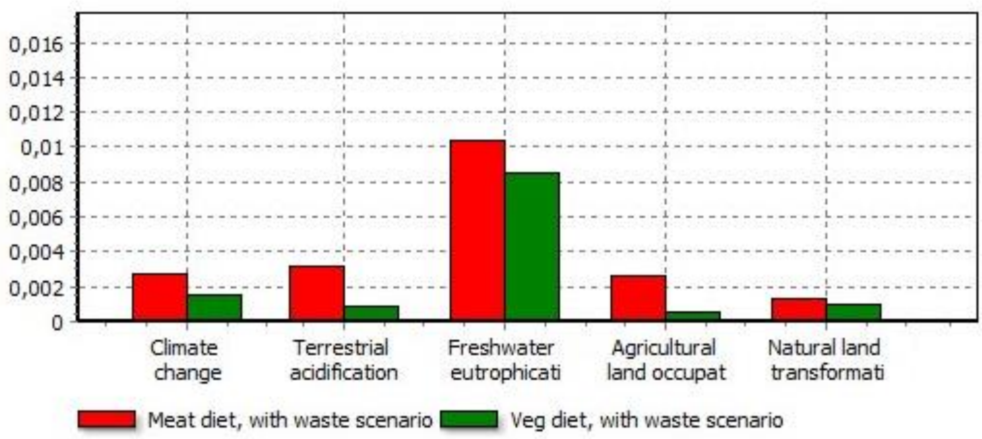

Figure 5: Normalized results of the chosen impact categories.

4. CONCLUSIONS AND RECOMMENDATIONS

The goal of the study was to investigate whether or not there are differences in the environmental burdens of two different, but general diets, and evaluate weather there are any hands-on solutions in order to decrease the environmental burdens of a society's food consumption.

As shown in the results section, e.g. Figure 4, there are some major relative differences between the two diets. For instance, a meat based diet emits almost 2 times CO_2 compared to a vegetarian diet. While the effects on "terrestrial acidification" (3,7 times), "freshwater eutrophication" (1,2 times), "agricultural land occupation" (4,8 times) and "natural land transformation" (1,4 time) are all higher for the meat diet. These results confirm what was expected at the start of the study, namely that a vegetarian diet is more environmental friendly compared to a meat diet. However, the magnitude of the difference between the relative effects is much larger than expected.

The second result of the study was the identification of the so called ´hotspots´ within both diets. The identification of these hotspots allows actors to focus on the environmental burdens that matter the most, and thereby lowering the total environmental burden in an effective manner. As seen in

Table 7 and

Table 8 the main hotspots for the impact categories "Freshwater eutrophication" and "Climate change" are quite similar. The average contribution of these hotspots is about 80% of the total contribution. To tackle these hotspots consumers could for example take the following actions:

- Buy locally produced and organic food; this will decrease effect of transportation by truck, the use of fertilizer and the heat for greenhouse production.
- Walk/cycle to the supermarket; this will decrease the effect of the passenger car usage.

The presented case study entailed large data quantities and in order to decrease the amount of work many assumption were made. For the calculation of transportation, storage, use etc. general assumptions were made. Also for several ingredients, many non-site specific numbers were used, basically any trustworthy LCA paper on a specific ingredient was considered as true. The generalization of the input data can be justified by the goal of the study, namely to highlight the main environmental aspects of food consumption and to compare two general diets to each other.

The life cycle stage for which the largest assumptions were made was the disposal step. For both diets the amount of food waste was considered to be 30%, a very general number that easily can be disclaimed. Also there might be variances between vegetarian and meat diets and their waste production. Another assumption on this matter was that there is no waste from packaging, while in real life there is obviously, and it might even entail a large part of the total waste. However, as can be seen in

Appendix I: *Characterized results vegetarian diet* and Appendix J: *Characterized results meat diet*, the Waste Disposal life stage only contributes to the effect "Freshwater eutrophication" and the effect in both cases is less than 25%. The made assumption concerning Waste Disposal will therefore not have an enormous effect.

The large amount of CO_2 released from greenhouse production in the vegetarian diet, is due to a great amount of tomato products used for the vegetarian cooking. The transportation differs significantly between the two diets and in the same time this is the process that contributes the most to the total release of CO_2 in the meat diet. The release of CO_2 from transportation in the vegetarian diet is alarmingly low since the products in this diet depend on transportation too. Possible reasons for this large difference of CO_2-equivalents between the two diets can perhaps be explained by that breeding cattle includes more transportation. The huge amount of agricultural land needed for the meat diet is a cause of large areas needed to produce food for the cattle.

The two main conclusions that can be drawn from this case study is that

1. A meat diet has a larger environmental burden than a vegetarian diet.
2. The main climate change burden of food consumption is transportation.

In the case of general food consumption the decision makers are the consumers who buy the products, the retailers who sell the products and the policy makers. Policy makers can have a large influence on the matter, for example by putting taxation on imported products and meat. Also they could start educational programs in order to teach people what the effects of their consumption patterns are. In the same way retailers can have an effect on the consumers. They could educate them by putting more information on their products, for example of their origin and/or the emissions related to it. Also they could offer more locally produced and more vegetarian alternatives.

In the end the only real decision maker is the consumer itself, since only the consumer can change its consumptive behaviour. But both policy makers and retailers can have a large impact and ´push´ the consumer in the right direction.

BIBLIOGRAPHY

Berlin, J., 2002. Environmental life cycle assessment (LCA) of Swedish semi-hard cheese. *International Dairy Journal,* Volume 12, pp. 939-953.

Cederberg, C. & Mattsson, B., 2000. Life cycle assessment of milk production — a comparison of conventional and organic farming. *Cleaner Production,* Volume 8, pp. 49-60.

Cellura, M., Longo, A. & Mistretta, M., 2012. Life Cycle Assessment (LCA) of protected crops: an Italian case study. *Cleaner Production,* Volume 28, pp. 56-62.

Earthshift Inc., 2011. *SimaPro Inventory Databases.* [Online] Available at: http://www.earthshift.com/software/simapro/databases#industry-data [Accessed 15 12 2013].

Franke, U., 2013. *Food waste in Sweden,* Jönköping: Jordbruksverket.

Goedkoop, M. et al., 2008. *ReCiPe: A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level,* The Hague: Ministry of Housing, Spatial Planning and the Environment, the Netherlands.

Hertwich, E. & Peters, G., 2009. Carbon Footprint of Nations: A Global, Trade-Linked Analysis. *Environmental Science Technology,* Volume 43, pp. 6414-6420.

ICA, 2013. *Billiga Veckan - lättlagade veckomenyer.* [Online] Available at: http://www.ica.se/smarta-mattjanster/billiga-veckan/ [Accessed 18 11 2013].

Jarl, S., n.d. *recepten.se.* [Online] Available at: http://www.recepten.se/artiklar/maatt_enheter [Accessed 10 11 2013].

Kasmaprapruet, S., Paengjuntuek, W., Saikhwan, P. & Phungrassami, H., 2009. Life Cycle Assessment of Milled Rice Production: Case Study in Thailand. *European Journal of Scientific Research,* 30(2), pp. 195-203.

LCA Food Database, 2007. *LCA Food Database.* [Online] Available at: http://www.lcafood.dk/ [Accessed 15 12 2013].

Livsmedelverket, 2005. *Svenska näringsrekommendationer,* Uppsala: Livsmedelverket.

Loxbo, H., 2011. *Hållbar konsumtion av jordbruksvaror: Matsvinn – ett slöseri med resurser?,* Jönköping: Svenska Jordbruksverket.

Mums Miljömat, 2011. *Veckans mat - vegetarisk matsedel.* [Online] Available at: http://www.miljomat.se/html/fyraveckorsmatsedel.aspx?Sn=18 [Accessed 11 2013].

Nguyen, T. L. T., Hermansen, J. E. & Mogensen, L., 2010. Environmental consequences of different beef production systems in the EU. *Journal of Cleaner Production,* Volume 18, pp. 756-766.

NREL, 2012. *U.S. Life Cycle Inventory Database.* [Online] Available at: http://www.nrel.gov/lci/ [Accessed 15 12 2013].

Pizzigallo, A., Granai, C. & Borsa, S., 2008. The joint use of LCA and emergy evaluation for the analysis of two Italian wine farms. *Journal of Environmental Management,* Volume 86, pp. 396-406.

Reckmann, K., Traulsen, I. & Krieter, J., 2013. Life Cycle Assessment of pork production: A data inventory for the case of Germany. *Livestock Science,* Volume 157, pp. 586-596.

Sleeswijk, A. et al., 2008. Normalisation in product life cycle assessment: An LCA of the global and European economic systems in the year 2000. *SCIENCE OF THE TOTAL ENVIRONMENT,* Volume 390, pp. 227-240.

Solna Stad, 2013. *Matavfall blir biogas.* [Online] Available at: https://www.solna.se/sv/boende-miljo/avfall-atervinning/sortera-lamna-avfall/matavfall/matavfall-blir-biogas/ [Accessed 05 12 2013].

Stoessel, F., Juraske, R., Pfister, S. & Hellweg, S., 2012. Life Cycle Inventory and Carbon and Water FoodPrint of Fruits and Vegetables: Application to a Swiss Retailer. *Environ Sci Technol.,* 46(6), pp. 3253-3262.

Swiss Centre for Life Cycle Inventories, 2013. *Ecoinvent centre.* [Online] Available at: http://www.ecoinvent.org/ [Accessed 15 12 2013].

Tasteline, 2012. *Tasteline.* [Online] Available at: http://www.tasteline.com/Recept/Att_gora_egen_pasta [Accessed 10 12 2013].

APPENDICES

Appendix A: Weekly menus

The vegetarian menu is found in Table 10 and the conventional menu in Table 11. In the tables the respectively original recipes are shown together with the substituted ingredients used in the calculation. The amounts of different ingredients are all converted into grams using a Swedish recipe website (Jarl, u.d.).

The vegetarian recipes are taken from a Swedish website called Mums Miljömat (2011). Some of the original recipes include desserts and complement salad, but these are left out from Table 10 and from the calculation. The menu is taken from Mums Miljömat, week 1-4 and is supposed to fulfil all nutrient recommendations according to Svenska Livsmedelsverket.

The conventional menu comes from a Swedish food concern, ICA. They make weekly menus and the one analysed is from week 47 (ICA, 2013).

Table 10: Vegetarian menu

	Average weight per day [g]			**478,36**										
Monday			**Tuesday**			**Wednesday**			**Thursday**			**Friday**		
Vegetarian lasagne			**Zucchini stew with green beans and peas**			**Aubergine, cabbage and tomatoes (Kabu-ki)**			**Soup with red lentills, coco and lime**			**Fresh filled pasta with tomato sauce**		
Original ingredients	*Mass [g]*	*Substituted ingredients or aggrega-tion group*	*Original ingredients*	*Mass [g]*	*Substituted ingredients or aggrega-tion group*	*Original ingredients*	*Mass [g]*	*Substituted ingredients or aggrega-tion group*	*Original ingredients*	*Mass [g]*	*Substituted ingredients or aggrega-tion group*	*Original ingredients*	*Mass [g]*	*Substituted ingredients or aggrega-tion group*
Lasagne	34,0	Pasta	Zucchini	100	Aubergine	Aubergine	100	Aubergine	Red lentils, dried	50,4	Beans	Fresh filled pasta	125	Pasta
Red lentils, dried	30,4	Beans	Onion, red or yellow	12,5	Onion	White cabbage, shred	47,25	Root vegetables	Carrot	25	Root vegetables	Crushed tomatoes	100	Tomato products
Onion, red or yellow	12,5	Onion	Garlic	1,25	Onion	Onion, yellow	12,5	Onion	Beetroot	25	Root vegetables	Onion, red or yellow	12,5	Onion
Garlic	1,3	Onion	Green beans	37,5	Beans	Garlic	2,5	Onion	Celery root	25	Root vegetables	Garlic	2,5	Onion
Carrot	25,0	Root vegetables	Rapeseed oil	11,7	Oil	Tomato	80	Tomato products	Onion, red	25	Onion	Carrot	25	Root vegetables
Rapeseed oil	10,1	Oil	Chick peas, boiled	26,67	Peas	Rapeseed oil	10,125	Oil	Garlic	2,5	Onion	Fennel	62,5	Root vegetables
Crushed tomatoes	100,0	Tomato products	Crushed tomatoes	100	Tomato products	Feta cheese (fat 25 %)	50	Cheese	Paprika, red	37,5	Tomato products	Rapeseed oil	6,75	Oil
Red wine 12 vol. %	25,0	Red wine	Chard	37,5	Aubergine	Pasta	100	Pasta	Rapeseed oil	10,125	Oil	Tomato paste	7,5	Tomato products
tomato paste	7,5	Tomato products	Peas	25	Peas	~~Salt~~			Crushed tomatoes	125	Tomato products	Spinach, frozen	62,5	Aubergine
Spinach, frozen	62,5	Aubergine	Couscous	75	Pasta	~~Kryddpeppar~~			Lime	40	Citrus fruits	~~Parsley~~	~~3~~	
Wheat flour	7,5	Wheat flour	Butter (fat 80 %)	15	Milk	~~Chili flakes~~			Cocunut milk	25	Milk	~~Salt, pepper~~		
Milk (fat 1,5 %)	200,0	Milk	Water	100		~~Basil~~			Tomato paste	7,5	Tomato products			
Cheese (fat 17 %)	18,8		~~Green bullion~~	~~2,5~~					~~Coconut flakes~~	~~5~~				
Water	100,0		~~Chili flakes~~						~~Chili pepper~~					
~~Salt, pepper~~			~~Salt, pepper~~						~~Salt, pepper~~					
									~~Ginger, basil~~					
Sum [g]	**634,525**		**Sum [g]**	**544,62**		**Sum [g]**	**402,375**		**Sum [g]**	**403,025**		**Sum [g]**	**407,25**	
Originally "Grön-sakslasagne", from Sunday w. 2			Originally "Zuccinigryta med gröna bönor och ärtor" from Tuesday w. 3			Originally "Aubergine, kål och tomat - kabeji" from Sunday w. 3			Originally "Röd linssoppa med kockos och lime" from Friday w. 3			Originally "Färsk fylld pasta med tomatsås" from Friday w. 4		

Table 11: Conventional menu

	Average weight per day [g]					552,38								
Monday			**Tuesday**			**Wednesday**			**Thursday**			**Friday**		
Minced meat chili			**Grilled salmon**			**Lamb sausage**			**Pasta al tonno**			**Deer Stew**		
Original ingredients	*Mass [g]*	*Substituted ingredients*	*Original ingredients*	*Mass [g]*	*Substituted ingredients*	*Original ingredients*	*Mass [g]*	*Substituted ingredients*	*Original ingredients*	*Mass [g]*	*Substituted ingredients*	*Original ingredients*	*Mass [g]*	*Substituted ingredients*
Rice	75	Rice	Potato	225		Bulgur	75	Pasta	Pasta	100		Rice	75	
Carrots	35	Root vegetables	Lemon	31,3	Citrus fruits	Paprika, red	60	Tomato products	Leek	22,5	Onion	Mushrooms	62,5	Aubergine
Red onion	25	Onion	Cream	61,4	Milk	Zucchini	49	Aubergine	Maize	85		Leek	22,5	Onion
Oil	3,4	Oil	Haricots verts	37,5	Peas	Red onion	25	Onion	Tuna	92,5	Fish: cod	Deer	120	Beef (cow)
Pasta sauce	100	Tomato products	Salmon file	137,5	Cod	Oil	3,4		Garlic	6	Onion	Oil	3,4	
Minced beef	125	Pork	Oil	3,4		Yoghurt	50	Milk	Tomato paste	7,5	Tomato products	Crème fraiche	50	Milk
Chive	20	Onion	~~Salt & pepper~~			Lamb sausage	120	Beef	Cream	61,4	Milk	Chive	20	Onion
Kidney beans	95	Beans	~~Maizena~~	~~3,8~~		~~Salt & pepper~~			Water	100		Water	300	
Olive oil	3,4	Oil				~~Timjan~~	~~1,3~~		~~Bouillon~~	~~0,6~~		~~Salt & pepper~~		
Water	250					~~Pepperpowder~~	~~0,6~~		~~Curry~~	~~3,8~~		~~Maizena~~	~~3,8~~	Wheat flour
~~Wine vinegar~~	~~3,8~~					~~Pesto~~	~~3,8~~		~~Salt & pepper~~			~~Soya~~	~~3,8~~	
~~Bouillon~~	~~1,3~~											~~Bouillon~~	~~1,8~~	
~~Salt & pepper~~														
~~Sugar~~														
Sum	**735,6**		**Sum**	**499,9**		**Sum**	**384,3**		**Sum**	**479,3**		**Sum**	**662,8**	
Originally: "Köttfärschili"			Originally: "Stekt lax"			Originally: "Lammkorv"			Originally: "Pasta al tonno"			Originally: "Hjortskavsgryta"		

Appendix B: Cut-off criteria

Table 12: Vegetarian menu cut-off method

Name	Aggregation	Mass (g)	%
Zucchini and egg-plant	Aubergine (eggplant), zucchini, Spinach, chard	200	8,36
Beans	Green beans + kidney beans+ lentils	119	4,95
Cheese	Cheese (fat 17 %) + feta	69	2,87
Milk	Cream, milk, butter	240	10,03
Lime	Citrus fruit	40	1,67
Onion	Red/yellow onion + garlic	85	3,55
Pasta	Pasta, lasagne, fresh filled pasta, couscous, bulgur	334	13,95
Peas	Peas, chick peas, haricot verts	52	2,17
Rape seed oil	Oil	49	2,04
Leaf vegetables	Spinach, chard	163	6,81
Red wine 12 vol. %		25	1,04
Root vegetables	Beetroot, Carrot, Celery, Fennel, white cabbage	235	9,82
Tomato products	Tomato, crushed tomato, tomato paste, paprika	505	21,10
Water		238	9,94
Sub-total		**2 353**	**98,31**
Ingredients left out			
Coconut flakes		5	0,21
Bouillon		3	0,10
Parsley		3	0,13
Salt, pepper			0,00
Tomato paste		23	0,94
Wheat flour		8	0,31
Sub-total			**1,69**
Total		**2 394**	**100**

Table 13: Conventional menu cut-off method

Name	Aggregation	Mass (g)	%
Beans	Green beans, kidney beans, hari-cots verts	133	4,80
Milk	Cream, crème fraiche, milk, yo-ghurt	223	8,05
Lemon	Citrus fruit	31	1,13
Maize		85	3,07
Meet from pork	Minced meet	125	4,52
Meet from rumi-nants	Lamb, deer, beef	240	8,67
Onion	Red/yellow onion, garlic, leek, chive	141	5,09
Pasta	Pasta, bulgur	175	6,32
Tomato products	Pasta sauce, tomato, tomato paste, paprika etc.	160	5,78
Potato		225	8,13
Rice		150	5,42
Root vegetables	Carrot	35	1,26
Fish	Salmon, tuna = cod	231	8,33
Water		650	23,48
Zucchini	zucchini, aubergine, mushrooms	112	4,05
Sub-total		**2 716**	**98,09**
Ingredients left out			
Bouillon		4	0,13
Curry		4	0,14
Maizena		8	0,27
Oil	Oil + olive oil	17	0,61
Pepper powder		1	0,02
Pesto		4	0,14
Salt & pepper			0,00
Soya		4	0,14
Sugar			0,00
Timjan		1	0,05
Tomato puree		8	0,27
Wine vinegar	Red wine	4	0,14
Sub-total			**1,91**
Total		**2 769**	**100**

Appendix C: Flowchart

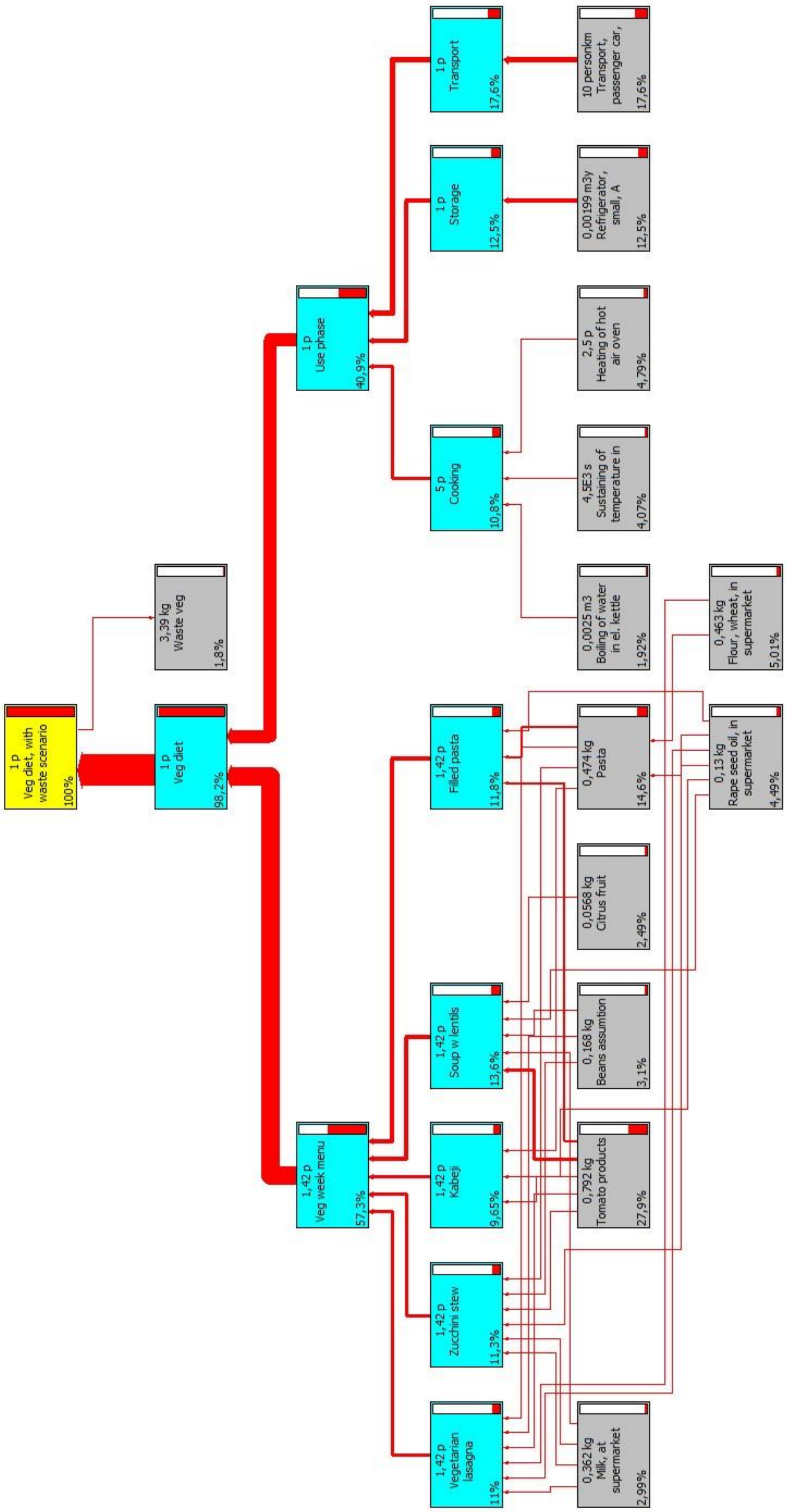

Figure 6: Flow chart of the climate impact for the vegetarian diet in SimaPro with 1% cut off and only the top processes

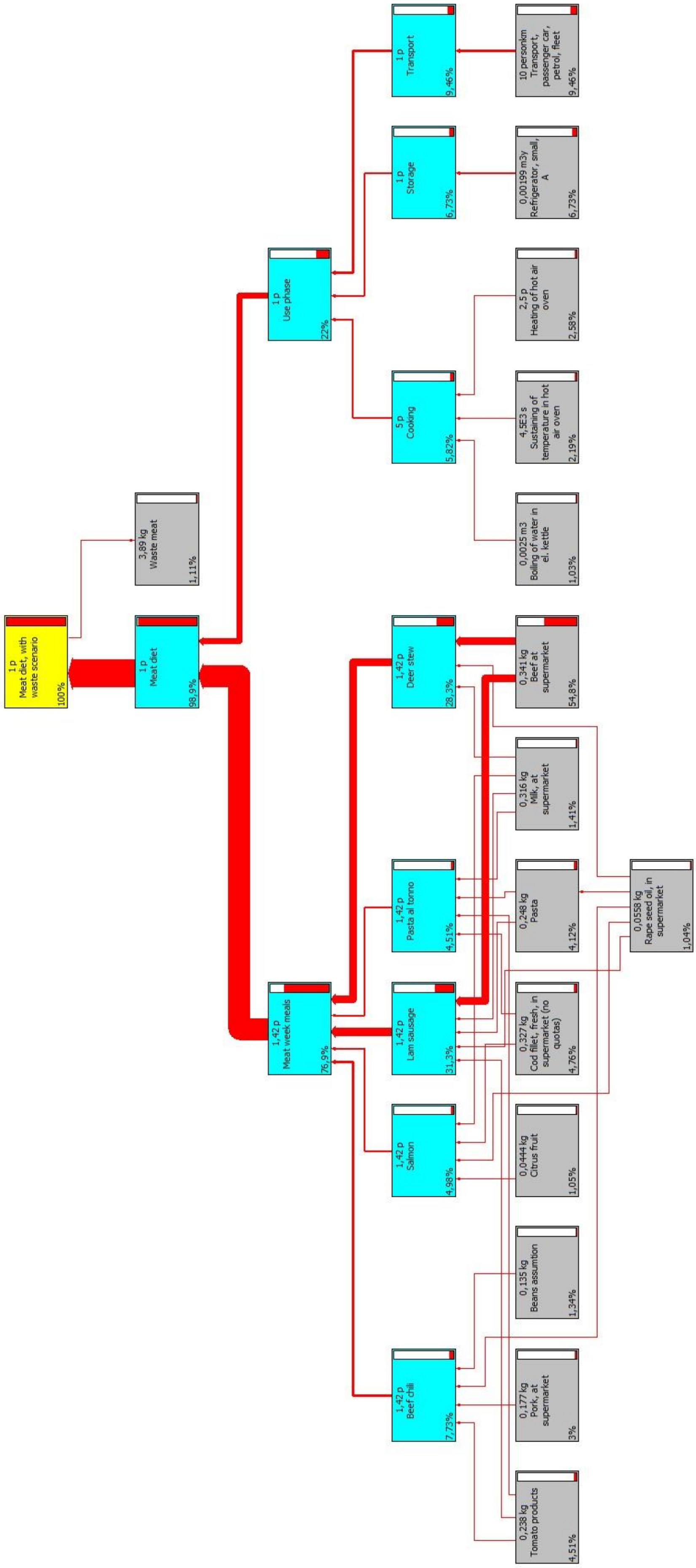

Figure 7: Flow chart of the climate impact for the meat diet in SimaPro with 1% cut off and only the top processes shown.

Appendix D: Pasta recipe

Table 14: Pasta recipe (Tasteline, 2012)

	4-6 port	Gram	Per person	Dry weight
Wheat flour	3,5 dl	210	42	42
Egg	1,5	90	18	1,8
Oil	2 msk	27,9	5,58	0,0558
Water	30 ml	30	6	0
Salt			71,58	43,8558
3 MJ to produce 500 g pasta	0,42948			

Appendix E: Relative global warming potential

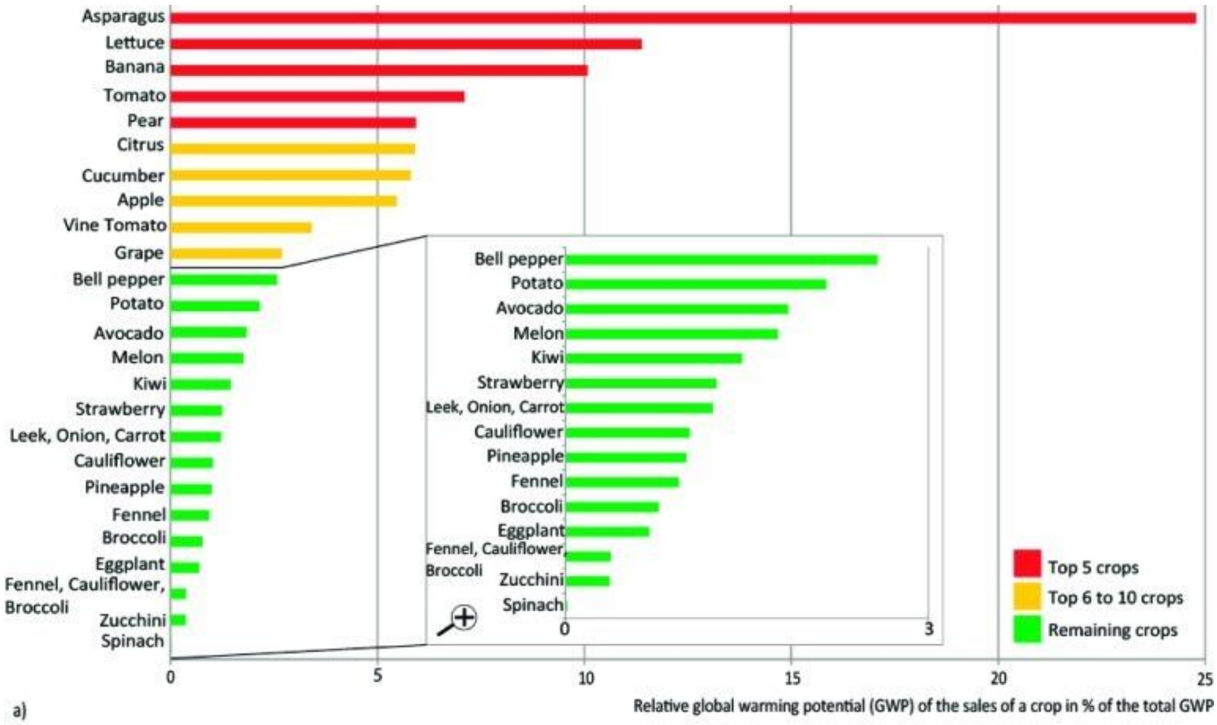

Figure 8: Relative global warming potential (Stoessel, et al., 2012)

Appendix F: SimaPro entries

The following products used in the evaluation are created by this project group, see Table 15: Products created in SimaPro for the project "Dietary Comparison". Some of them are based on data already existing in the databases in SimaPro, others on already existing LCAs. For some products data in SimaPro were sufficient and no adjustment were made (cod, flour (wheat), potato, rape seed oil), see more details in **Error! Reference source not found.**.

Table 15: Products created in SimaPro for the project "Dietary Comparison"

SimaPro 7.3, Table collected: 2013-12-11, 12:29				
Project: Dietary comparison				
	Amount	**Unit**	**Comments on data**	
Beans assumption	1	kg	Waste type not defined. From materials/Food	Green beans, kidney beans, lentils are assumed to have the same impact.
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Soybeans, at farm/BR S	1	kg	BR=Brazil, Feels more like the general case than taking beans produced in Europe. Ecoinvent	
Wholesale (+20* C)	1	l*day	LCA Food DK, whole sale in Brazil.	
Transport, lorry >28t, fleet average/CH S	100	kgkm	Transport from farm in Brazil to wholesale/harbour in Brazil. Ecoinvent	
Transport, transoceanic freight ship/OCE S	10000	kgkm	Assume 10 000 km transatlantic transport to Germany, 1 kg of beans. Ecoinvent	
Transport, lorry >28t, fleet average/CH S	1000	kgkm	Transport from Germany to Stockholm. Ecoinvent	
Wholesale (+20* C)	1	l*day	LCA Food DK	
Transport, lorry >16t, fleet average/RER S	100	kgkm	Transport from wholesale to retail in Stockholm. Ecoinvent	
Retail (long time stor., room temp., large store)	1	kg	Retail in Stockholm. LCA Food DK	
	Amount	**Unit**	**Comments on data**	
Beef at slaughterhouse	1000	kg	Waste type not defined. From materials/Food	Suckler cow–calf (SCC) Data taken from the LCA-article "Environmental consequences of different beef production systems in the EU" by Thu Lan T. Nguyen*, John E. Hermansen, Lisbeth Mogensen (Journal of Cleaner Production, 2010)
Resources	**Type**	**Amount**	**Unit**	
Land use (grassland, pasture and range)	land	4.28	ha	
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Grass from natural meadow extensive IP, at field/CH S	9021	kg	Ecoinvent	
Grass silage IP, at farm/CH S	5446	kg	Ecoinvent	
Silage maize IP, at farm/CH S	2404	kg	Ecoinvent	
Barley straw IP, at farm/CH S	2254	kg	Ecoinvent	
Straw IP, at farm/CH S	1726	kg	Ecoinvent	
Nitrogen fertilizer, production mix, at plant/US	478	kg	USLCI	
Phosphorous fertilizer, production mix, at plant/US	21.5	kg	USLCI	
Electricity mix/SE S	1.71	MWh	Ecoinvent	
Diesel, burned in building machine/GLO S	14	MJ	Ecoinvent	
Transport, lorry >28t, fleet average/CH S	12	kgkm	Ecoinvent	
	Amount	**Unit**	**Comments on data**	
Beef at supermarket	1	kg	Waste type not defined. From	Dietary comparison, see beef at slaughterhouse.

			materials/Food	
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Beef at slaughterhouse	1	kg		
Transport, lorry >28t, fleet average/CH S	100	tkm	To wholesale. Ecoinvent	
Wholesale (5* C)	1	l*day	LCA Food DK	
Transport, lorry >16t, fleet average/RER S	100	tkm	To supermarket. Ecoinvent	
Retail (cooling counter, large store)	1	kg	LCA Food DK	
	Amount	**Unit**	**Comments on data**	
Citrus fruit	1	kg	Waste type not defined. From materials/Food	Based on cucumber. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3394405/figure/fig2/
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Cucumber, standard	1	kg	LCA Food DK	
Transport, lorry >28t, fleet average/CH S	100	kgkm	Farm to shipyard warehouse. Ecoinvent	
Wholesale (+20* C)	1	l*day	LCA Food DK	
Transport, transoceanic freight ship/OCE S	7000	kgkm	Distance over sea italy-sweden. Ecoinvent	
Wholesale (+20* C)	1	l*day	LCA Food DK	
Truck 16t	100	kgkm	Ecoinvent	
Retail (short time stor., room temp., large store)	1	kg	LCA Food DK	
	Amount	**Unit**	**Comments on data**	
Maize	1	kg	Waste type not defined. From materials/Food	
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Grain maize IP, at farm/CH S	1	kg	Ecoinvent	
Transport, lorry >28t, fleet average/CH S	100	kgkm	Farm to harbour. Ecoinvent	
Wholesale (+20* C)	1	l*day	Intermediate storage. LCA Food DK	
Transport, transoceanic tank-er/OCE S	7000	kgkm	Distance to US. Ecoinvent	
Wholesale (+20* C)	1	l*day	Intermediate storage. LCA Food DK	
Transport, lorry >16t, fleet average/RER S	100	kgkm	Harbour to retail. Ecoinvent	
Retail (long time stor., room temp., large store)	1	kg	LCA Food DK	
	Amount	**Unit**	**Comments on data**	
Milk, at supermarket	1	kg	Waste type not defined. From materials/Food	
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Milk, conventional, at diary	1	kg	From project "Diary comparison"	
Transport, lorry >28t, fleet average/CH S	100	kgkm	Transport from dairy to wholesale. Assume 100 km of transport. Data from Ecoinvent.	
Transport, lorry >28t, fleet average/CH S	100	kgkm	Transport from farm to dairy. Assume 100 km of transport. Data from Ecoinvent.	
Transport, lorry >16t, fleet average/RER S	100	kgkm	Transport from whole sale to retail. Assume 100 km of transport. Data from Ecoinvent.	
Wholesale (5* C)	1	m3day	This is the same number as the one found for "milk, conventional, from wholesale" in LCA food DK. Data from LCA food DK	
Retail (cooling counter, large store)	1	kg	Data from LCA food DK	
	Amount	**Unit**	**Comments on data**	
Milk, conventional, at diary	1000	kg	Waste type not	Swedish milk production. Data is taken from the LCA report: "Life Cycle assessment of milk production - a comparison of conventional and organic

			defined. From materials/Food	farming" by Christer Cederberg, Berit Mattsson. Article is taken from "Journal of Cleander Production 8 (2000) 49-60". Buildings and machinery were left out. The conventional milk production is taken into account. Inputs from technosphere are taken from table 2 and from the text in the source above. This source only covers processes on the farm. No data was found for the processes in the dairy, so these were left out.
Resources	**Type**	**Amount**	**Unit**	
Land use (grassland, pasture and range)	land	1925	m2	
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Hard coal, at regional storage/WEU S	4.87	kg	Data from Ecoinvent	
Crude oil, production NL, at long distance transport/RER S	47.1	kg	Ecoinvent NL data	
Natural gas E	25.7	kg	Industry data 2,0	
Uranium natural, in uranium hexafluoride, at conversion plant/CN S	0.00204	kg	Ecoinvent	
Electricity, hydropower, at power plant/SE S	0.28	MJ	Ecoinvent	
Phosphorous fertilizer, production mix, at plant/US	2.37	kg	USLCI	
Potassium sulphate, as K2O, at regional storehouse/RER S	2.88	kg	Ecoinvent	
Limestone, milled, packed, at plant/CH S	35.8	kg	Ecoinvent	
	Amount	**Unit**	**Comments on data**	
Pasta	44	g	Waste type not defined. From materials/Food	1 port pasta, dry weight. Since there were no data available on pasta making, we tried to make pasta from its ingredients.
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Tap water, at user/CH S	6	g	data from Ecoinvent	
Egg	18	g	from farm, data from LCA food DK	
Rape seed oil, in supermarket	5.6	g	data from LCA food DK	
Flour, wheat, in supermarket	42	g	data from LCA food DK	
Electricity/heat	**Amount**	**Unit**	**Comments on data**	
Transport, lorry >28t, fleet average/CH S	=0,044*100	kgkm	Transportation, from whole sale to fabric in Italy. Assume 100 km, 0,044g. Data from Ecoinvent	
Baking of bread	=1/10	p	Assumes baking pasta is about the same as baking 1/10 of bread. Data from LCA food DK	
Retail (long time stor., room temp., large store)	44	g	Data from LCA food DK	
Transport, lorry >28t, fleet average/CH S	0,044*2549	kgkm	Transport from fabric in Italy to Sweden.2549 km from Rome to Stockholm. Data from Ecoinvent.	
Wholesale (+20* C)	1	l*day	LCA food DK	
Transport, lorry >16t, fleet average/RER S	0,044*100	kgkm	Transport from whole sale to retail in Sweden. Ecoinvent.	
Retail (long time stor., room temp., large store)	0.044	kg	LCA Food DK	
	Amount	**Unit**	**Comments on data**	
Peas	1	kg	Waste type not defined. From materials/Food	
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Protein peas conventional, Saxony-Anhalt, at farm/DE S	1	kg	Ecoinvent	
Wholesale (+20* C)	1	l*day	Intermediate storage. LCA food DK	
Transport, lorry >28t, fleet average/CH S	100	kgkm	From farm to wholesale in Germany. Ecoinvent.	
Transport, lorry >28t, fleet average/CH S	1000	kgkm	From Germany to Stockholm. Ecoinvent	
Wholesale (+20* C)	1	l*day	1L = 1kg. LCA Food DK	
Transport, lorry >16t, fleet average/RER S	100	kgkm	Ecoinvent	

Retail (long time stor., room temp., large store)	1	kg	LCA Food DK	
	Amount	**Unit**	**Comments on data**	
Pork at farm	1000	kg	Waste type not defined. From materials/Food	Data taken from "Life Cycle Assessment of pork production: A data inventory for the case of Germany"
Avoided products	**Amount**	**Unit**	**Comments on data**	
Nitrogen fertilizer, production mix, at plant/US	49	kg	USLCI	
Phosphorous fertilizer, production mix, at plant/US	13	kg	USLCI	
Potassium nitrate, as K2O, at regional storehouse/RER S	12	kg		
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Wheat IP, at feed mill/CH S	1090	kg	Ecoinvent	
Barley IP, at feed mill/CH S	440	kg	Ecoinvent	
Rye straw IP, at farm/CH S	161	kg	Ecoinvent	
Soybean meal, at oil mill/BR S	188	kg	Ecoinvent	
_25 Animal feeds, EU27	648	kg	EU & DK input output database	
Heat, light fuel oil, at industrial furnace 1MW/RER S	130.2	kWh	Ecoinvent	
Electricity mix/SE S	117.6	kWh	Ecoinvent	
Transport, transoceanic freight ship/OCE S	3375	tkm	Transport of feedstock. Ecoinvent	
Transport, lorry >28t, fleet average/CH S	868	tkm	Transport of feedstock. Ecoinvent	
Transport, tractor and trailer/CH S	108	tkm	Ecoinvent	
Tap water, at user/RER S	1000	kg	Ecoinvent	
Traction	206	MJ	LCA Food DK	
	Amount	**Unit**	**Comments on data**	
Pork, at slaughter house	94.7	kg	Waste type not defined. From materials/Food	
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Pork at farm	120	kg	Dietary comparison	
Electricity mix/SE S	26.8	kWh	Ecoinvent	
Tap water, at user/CH S	0.4	ton	Ecoinvent	
Diesel (kg)	0.8	kg	LCA Food DK	
Transport, lorry >28t, fleet average/CH S	120*350	kgkm	Ecoinvent	
Emissions to air		**Amount**	**Unit**	
Carbon monoxide		0.3	g	
Carbon dioxide		4537	g	
Nitrogen oxides		3	g	
Nitrogen dioxide		0.08	kg	
Methane		0.09	g	
Emissions to water		**Amount**	**Unit**	
BOD5, Biological Oxygen Demand		94.7	g	
COD, Chemical Oxygen Demand		2462	g	
Nitrogen		322	g	
Phosphorus		28.4	g	
	Amount	**Unit**	**Comments on data**	
Pork, at supermarket	1	kg	Waste type not defined. From materials/Food	
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Pork, at slaughter house	1	kg	Assume slaughter house=wholesale, Dietary comparison.	

Transport, lorry >16t, fleet average/RER S	1*100	kgkm	Assume 100 km transport to retail. Ecoinvent	
Retail (cooling counter, large store)	1	kg	LCA Food DK	
	Amount	**Unit**	**Comments on data**	
Red/yellow onion, garlic	1	kg	Waste type not defined. From materials/Food	
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Onion, dried, stored and packed	1	kg	From wholesale	
Transport, lorry >16t, fleet average/RER S	100	kgkm	Assume the same as for "potatoes, in supermarket". Ecoinvent	
Retail (long time stor., room temp., large store)	1	kg	LCA Food DK	
	Amount	**Unit**	**Comments on data**	
Rice	1	kg	Waste type not defined. From materials/Food	
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Rice at farm	1	kg	Dietary comparison	
Transport, lorry >28t, fleet average/CH S	100	kgkm	Farm to harbour. Ecoinvent	
Wholesale (+20* C)	1	l*day	Storage in harbour china. LCA Food DK	
Transport, transoceanic freight ship/OCE S	20000	kgkm	Harbour in China to harbour/wholesale in Sweden. Ecoinvent	
Wholesale (+20* C)	1	l*day	Storage in harbour Sweden. LCA Food DK	
Transport, lorry >16t, fleet average/RER S	100	kgkm	Wholesale to retail. Ecoinvent	
Retail (long time stor., room temp., large store)	1	kg	LCA Food DK	
	Amount	**Unit**	**Comments on data**	
Rice at farm	1	kg	Waste type not defined. From materials/Food	Life Cycle Assessment of Milled Rice Production: Case Study in Thailand
Resources	**Type**	**Amount**	**Unit**	
Land use (cropland)	land	3.49	m2	110400000000 m2 (Life Cycle Assessment of Milled Rice Production: Case Study in Thailand) and 31650632000 kg per year (2008) http://faostat.fao.org/site/339/default.aspx = 3,49 m2/kg
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Diesel	0.048705	MJ	LCA Food DK	
Electricity, oil, at power plant/CS S	0.006375	kWh	Electricity from oil (china). Ecoinvent	
Diesel, at refinery/l/US	0.1655	l	For transport. USLCI	
Husked nuts harvesting, at farm/PH S	0.11156	kg	Rice husk is assumed to be the same. Ecoinvent	
Ammonium sulphate, as N, at regional storehouse/RER S	0.000255	kg	Ecoinvent	
Pesticide unspecified, at regional storehouse/CH S	0.0079688	kg	Ecoinvent	
	Amount	**Unit**	**Comments on data**	
Root vegetables, aggregation	1	kg	Waste type not defined. From materials/Food	Beetroot, Celery, Fennel are all assumed to have about the same impact as a carrot. Therefore these four ingredients are clumped together.
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Carrots, cold store	1	kg	These carrots are stored in cold store instead of under straw. This data set seems to be "from packaging" since transport to packaging is including in the data set. The report "Miljøvurdering af konventionel og økologisk avl af grøntsager" from the Danish "miljöstyrelsen" is observed. LCA Food DK	
Transport, lorry >28t, fleet average/CH S	100	kgkm	Ecoinvent	
Wholesale (+20* C)	1	l*day	LCA Food DK	
Transport, lorry >16t, fleet average/RER S	100	kgkm	Ecoinvent	

Retail (long time stor., room temp., large store)	1	kg	LCA Food DK	
	Amount	**Unit**	**Comments on data**	
Semi-hard cheese, Äng-sgården, at supermarket	1	kg	Waste type not defined. From materials/Food	This process is based on data found in "Environmental life cycle assessment of Swedish semi-hard cheese" (Berlin, Johanna, 2002, published in "International Dairy Journal 12 2002). Berlin based her milk data on another LCA made from Cederberg and Mattson. That LCA is put into this system (Dietary comparison) as "Milk, conventional". The cheese from Ängsgården is "Hushållsost". Berlin made her investigation based on mainly Swedish processes. No data could be found for the ingredient ´Rennet´.
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Milk, conventional, at diary	10.1	kg	Cederberg and Mattsson, see dietary comparison "Milk, conventional"	
Calcium chloride, CaCl2, at regional storage/CH S	1	g	Ecoinvent	
Potassium nitrate, as K2O, at regional storehouse/RER S	0.65	g	Ecoinvent	
Sodium chloride, powder, at plant/RER S	15	g	Ecoinvent	
Tap water, at user/CH S	1.2	kg	Ecoinvent	
Nitric acid, 50% in H2O, at plant/RER S	7.4	g	Ecoinvent. 50% instead of 62%	
Sodium hydroxide, 50% in H2O, production mix, at plant/RER S	10.8	g	Ecoinvent	
Transport, lorry >28t, fleet average/CH S	100	kgkm	Transport from diary to whole sale, Ecoinvent	
Wholesale (5* C)	1	l*day	LCA food DK	
Transport, lorry >16t, fleet average/RER S	100	kgkm	Transport from whole sale to retail, Ecoinvent	
Retail (cooling counter, large store)	1	kg	LCA food DK	
	Amount	**Unit**	**Comments on data**	
Tomato products	1	kg	Waste type not defined. From materials/Food	Tomato, crushed tomato, tomato paste, in supermarket
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Tomato, standard	1	kg	Green house production. LCA Food DK	
Transport, lorry >28t, fleet average/CH S	100	kgkm	Green house to whole sale in the Netherlands LCA food DK	
Wholesale (5* C)	1	l*day	In the Netherlands. LCA food DK	
Transport, lorry >28t, fleet average/CH S	1000	kgkm	Transport from the Netherlands. Ecoinvent	
Wholesale (5* C)	1	l*day	LCA Food DK	
Transport, lorry >16t, fleet average/RER S	100	kgkm	Ecoinvent	
Retail (short time stor., room temp., large store)	1	kg	LCA Food DK	
Waste scenario	**Amount**	**Unit**	**Comments**	
Waste meat	5*552/0,7	g	All waste types	
Separated waste		**Percentage**		
DummyWasteScenario	All waste types	70	%	
Disposal, bio waste, to anaero-bic digestion/CH S	All waste types	30	%	
Remaining waste		**Percentage**		
DummyWasteScenario		100	%	
Waste scenario	**Amount**	**Unit**	**Comments**	
Waste veg	1,42*478	g	All waste types	

Separated waste		**Percentage**		
DummyWasteScenario	All waste types	70	%	
Disposal, bio waste, to anaerobic digestion/CH S	All waste types	30	%	
Remaining waste		**Percentage**		
DummyWasteScenario		100	%	
	Amount	**Unit**	**Comments on data**	
Wine, at store	1	ton	Waste type not defined. From materials/Food	Table 3 from the article listed below is used as input. Only purchased inputs are taken into account and for "loss of topsoil" the input "land use (cropland)" is used in SimaPro. To that it is stated in the article that 120 ha of the semi-industrial farm is used to grow crops and that the yield of those hectares is 6,25 ton of wine. Of those 6,25 t only 50 % can be used for winemaking. Of those 50 % there is a conversion factor of 0,568 l wine/ton of grapes. This conversion factor is taken from Chris Gerling at the Cornell University. No chemicals were added as inputs except of fertilizers. It is too difficult to list all the chemicals used in wine making and the article only gives data for "chemicals". This number is not as big as the other inputs either and therefore we assume that this can be neglected. (A.C.I Pizzigallo, C. Granai, S. Borsa, "The joint use of LCA and energy evaluation for the analysis of two Italian wine farms", Journal of Environmental Management 86, 2008, 396-406; Chris Gerling, Cornell University, "GRAPES 101 - Conversion Factors: From Vineyard to Bottle", taken from http://grapesandwine.cals.cornell.edu/appellation-cornell/issue-8/grapes-101-vineyard-to-bottle.cfm, collected 2013-12-02)
Resources	**Type**	**Amount**	**Unit**	**Comments**
Land use (cropland)	land	120/(0,5*6,25*0,568)	ha	0,568 l vin/kg grapes
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Potassium nitrate, as N, at regional storehouse/RER S	18400	g	Ecoinvent	
Single superphosphate, as P2O5, at regional storehouse/RER S	2*1,84E4	g	Ecoinvent	
Diesel	4520000000	J	LCA Food DK	
Steel, converter, chromium steel 18/8, at plant/RER S	18500	g	Ecoinvent	
Raw cork, at forest road/RER S	257000	g	Ecoinvent	
Pesticide unspecified, at regional storehouse/CH S	4770	g	Ecoinvent	
Tap water, at user/RER S	120000	g	Ecoinvent	
Electricity, low voltage, at grid/IT S	126000000	J	Italian average production. Ecoinvent	
Truck 28t	100	tkm	Assume that the wine firstly is stored in a whole sale in Italy and therefore transported there at first. Ecoinvent	
Wholesale (+20* C)	7	m3day	Assumption for the wholesale in Italy. LCA Food DK	
Transport, transoceanic freight ship/OCE S	7000	tkm	Transport from Rome to Stockholm over sea. Assume the next best standard (4). Ecoinvent	
Wholesale (+20* C)	7	m3day	Wholesale in Stockholm. LCA Food DK	
Retail (long time stor., room temp., large store)	1	ton	Retail (Systembolaget) in Stockholm. LCA Food DK	
Transport, lorry >16t, fleet average/RER S	100	tkm	Transport from wholesale to retail in Stockholm. Ecoinvent	
	Amount	**Unit**	**Comments on data**	
Zucchini & eggplant (after packaging)	1	kg	Waste type not defined. From materials/Food	
Materials/fuels	**Amount**	**Unit**	**Comments on data**	
Tap water, at user/RER S	129.7	kg	Ecoinvent	
Phosphorous fertilizer, production mix, at plant/US	101.9	g	USLCI	
Manure for vegetables (from farming on sandy soil)	78.5	g	LCA Food DK	
Pesticide unspecified, at regional	38	g	Ecoinvent	

storehouse/CH S			
Diesel (kg)	93	g	LCA Food DK
Waste to treatment	**Amount**	**Unit**	**Comments on data**
Composting organic waste/RER S	50	g	
Disposal, used mineral oil, 10% water, to hazardous waste incineration/CH U	0.07	g	
Disposal, hazardous waste, 25% water, to hazardous waste incineration/CH U	6.2	g	
	Amount	**Unit**	**Comments on data**
Zucchini and eggplant	1	kg	Waste type not defined. From materials/Food
Materials/fuels	**Amount**	**Unit**	**Comments on data**
Zucchini & eggplant (after packaging)	1	kg	
Transport, lorry >28t, fleet average/CH S	100	kgkm	Farm to wholesale in the Netherlands. Ecoinvent
Wholesale (+20* C)	1	l*day	Wholesale in the Netherlands. LCA food DK
Transport, lorry >28t, fleet average/CH S	1000	kgkm	From the Netherlands. Ecoinvent
Wholesale (+20* C)	1	l*day	LCA Food DK
Transport, lorry >16t, fleet average/RER S	100	kgkm	Ecoinvent
Retail (short time stor., room temp., large store)	1	kg	LCA Food DK

Appendix G: Characterized comparison results

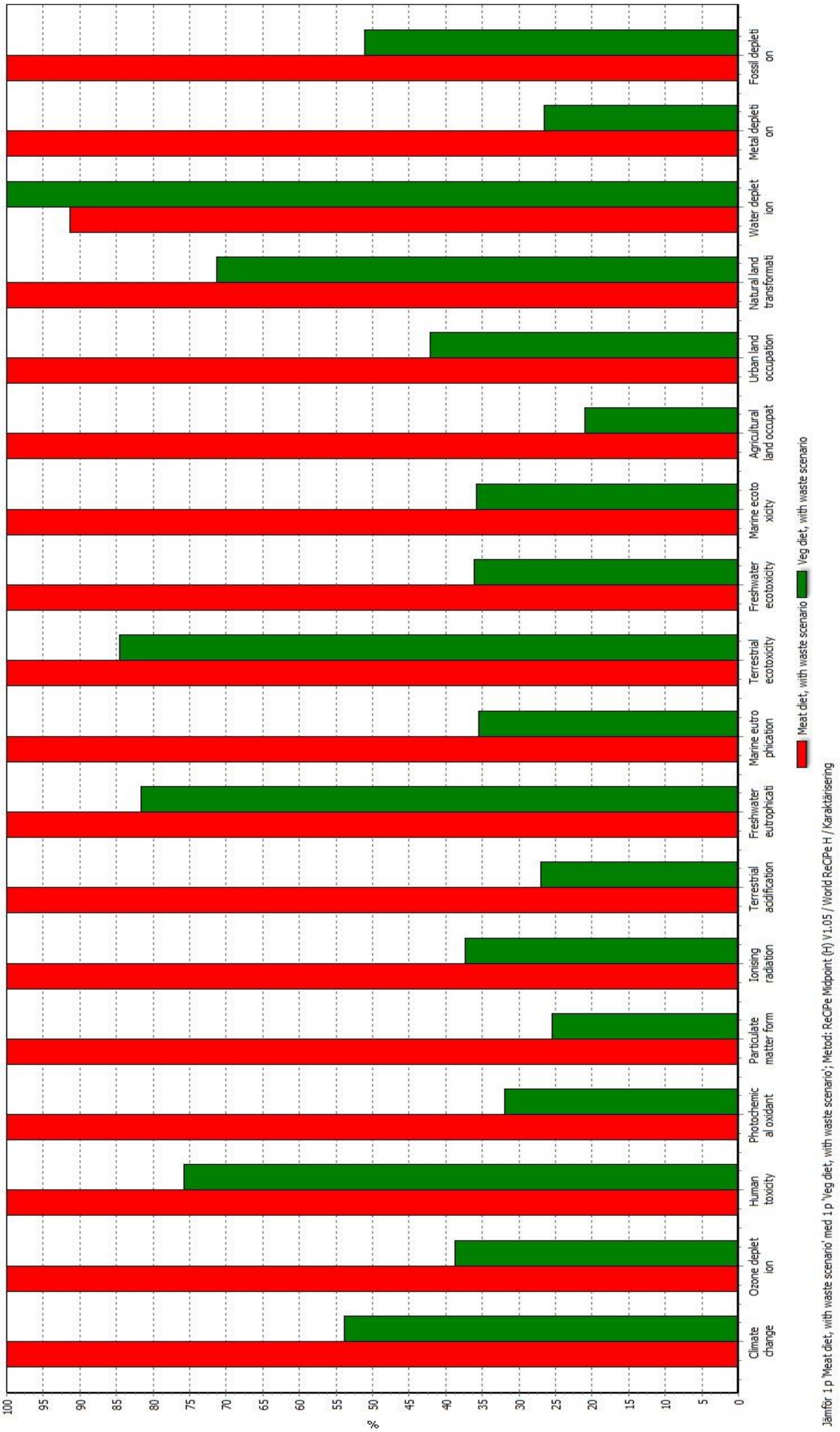

Figure 9: Dietary comparison characterized results

Appendix H: Normalized comparison results

Figure 10: Dietary comparison normalization results

Appendix I: Characterized results vegetarian diet

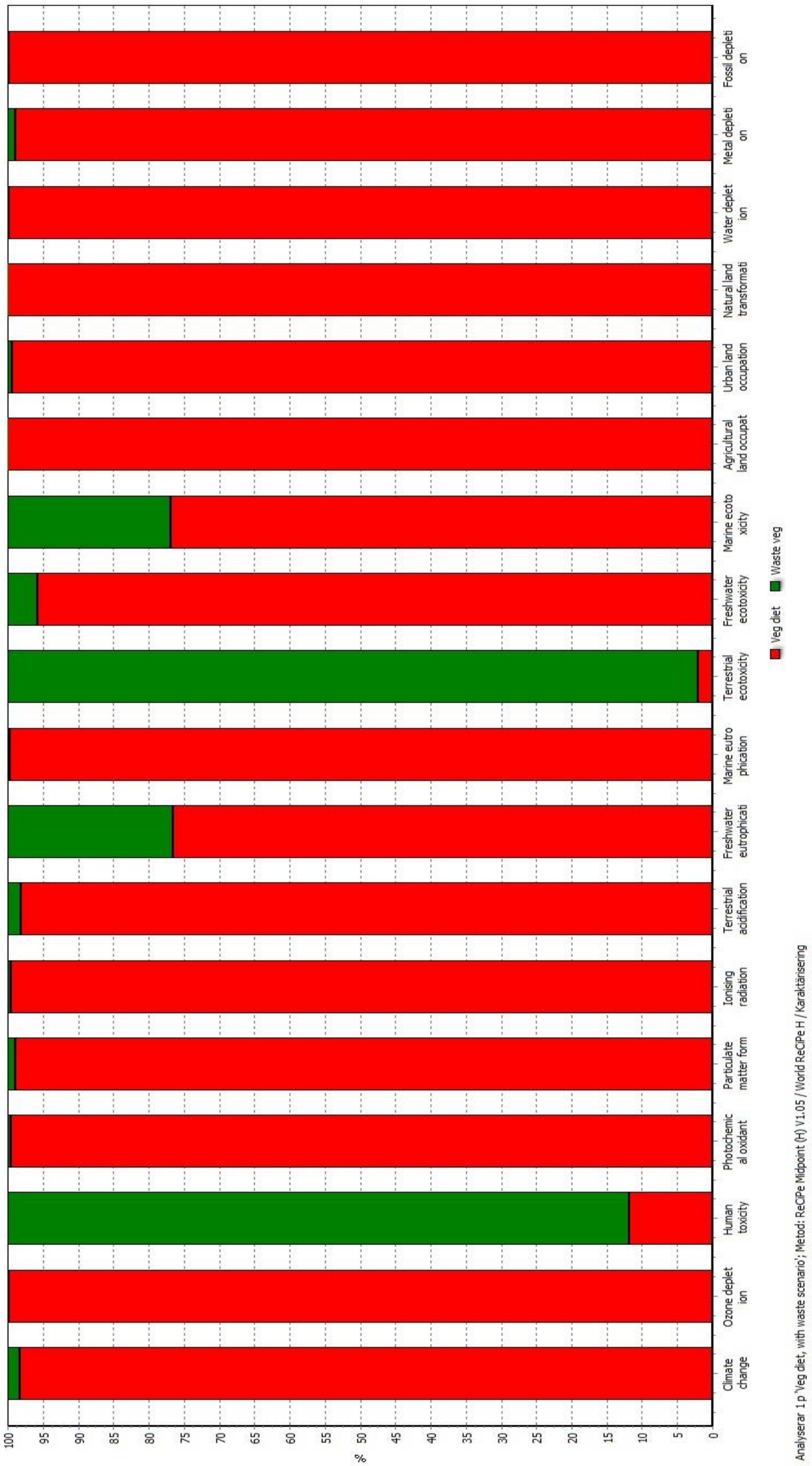

Figure 11: Characterized results vegetarian diet

Appendix J: Characterized results meat diet

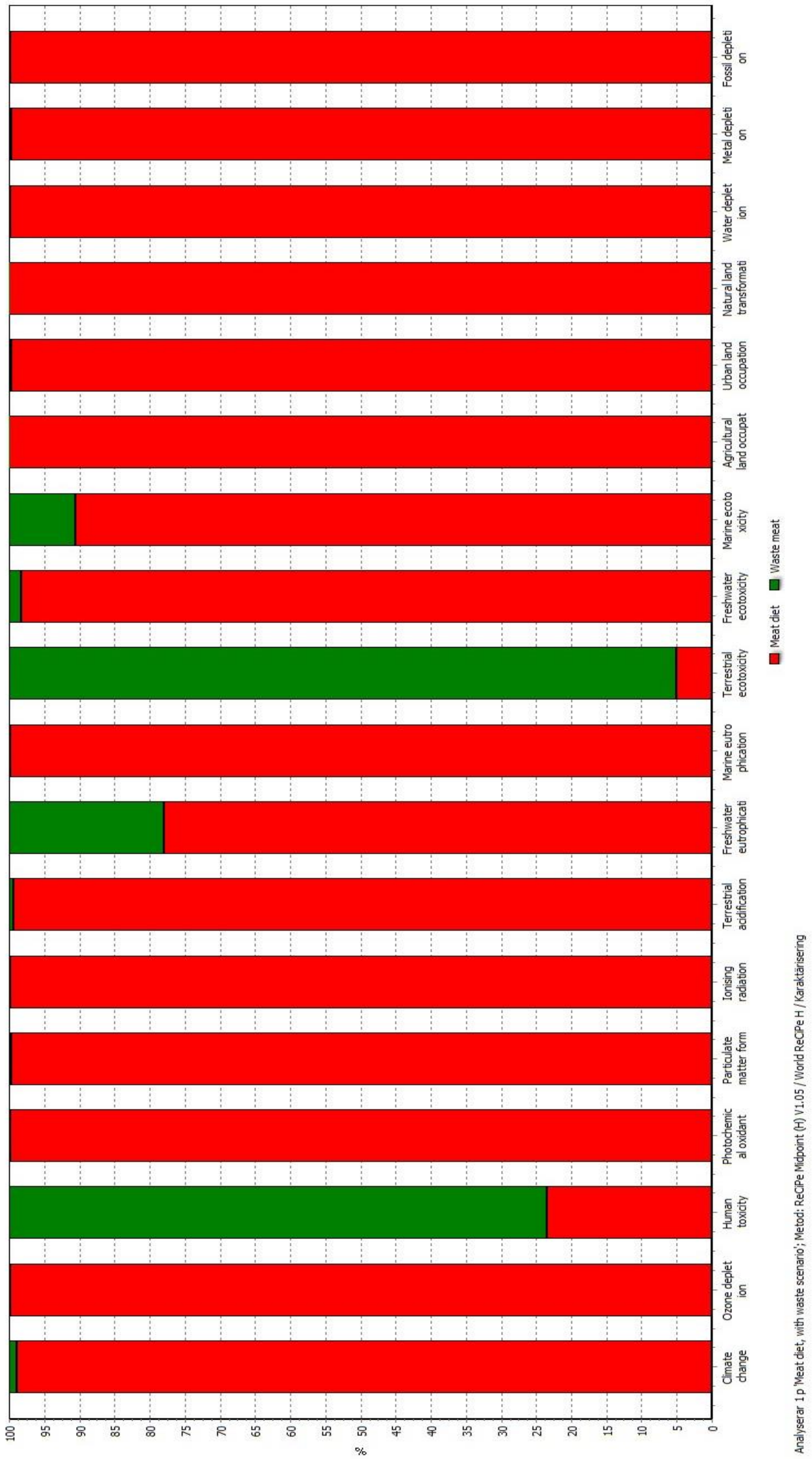

Figure 12: Characterized results meat diet