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Technical Report in English

Food Consumption, Land Use & Land Use Change Emissions

Second study on environmental effects of Austria's food consumption

Land Footprint

Land Use Change

GHG emissions

Sustainable consumption

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The calculations for the Austrian Land Footprint in this report have been carried out (on request) with the LANDFLOW model by G. Fischer and S. Tramberend of IIASA, Vienna. A similar approach has been carried out for the Land Footprint calculations of the EU-28 (Fischer et al. forthcoming), including a description of the LANDFLOW methodology.

Content

Glossary

Environmental impact: Changes to the environment, adverse or beneficial, resulting from external pressures are called environmental impacts. In this study, EU consumption of goods and services is considered an external pressure and the relationship between EU consumption and environmental impacts is one of cause and effect.

Land use: Land directly appropriated for the production of specific agricultural or forestry products.

Land use change (LUC): Land use changes driven by changes in the demand for food or non-food biomass products that can be linked to land conversions from e.g. forest to cropland, forest to grassland or grassland to cropland. In this study, LUC and LUC emissions refer to changes in the final demand for food products (and thus exclude non-food products) in Austria.

Land footprint: The Land Footprint (LF) is an indicator to assess the total domestic and foreign land required to satisfy the final consumption of goods and services of a country or world region. The Land Footprint is an area-based indicator measured in area units (e.g. hectares). In this report, the Land Footprint refers to food consumption activities in Austria.

GHG emissions: Emissions of the most important greenhouse gases with a global warming potential (CO_2, N_2O, NO_x, CH_4) calculated in CO_2 equivalents on the basis of their relative global warming potential.

Life Cycle: Assessment of GHG emissions into the air, soil and water, occurring during the different food production stages in the supply chain from primary production and farm inputs towards final consumption of food products; calculated on the basis of resource use categories such as land, materials and energy.

Direct GHG emissions: GHG emissions emerging from activities in agricultural production, food processing, trade and logistics up to the household level. Direct CO_2emissions are generated by energy use, as well as the management and use of fertilisers and manure, methane from ruminants, cooling gases etc.

Indirect GHG emissions: GHG emissions from sources outside the direct control of the economic actor. Concerning food, indirect GHG emissions mainly involve emissions generated though land use changes e.g. when forest areas are converted to cropland or to grassland, or when grassland is transformed to grassland. Land use changes (LUC) can be interpreted as an indicator reflecting the impact of collective biomass demand because it identifies the embodied land used by all stakeholders in a specific producing country.

Summary

Food related emissions estimated to account for 27% of Austria's carbon footprint

The average diet of an Austrian is rich in animal protein and fats and has negative impacts on health and the environment. The previous WWF study on Austrian food consumption and climate impact (de Schutter et al. 2015) showed that the carbon footprint of **direct emissions** for food supply amounted to a total of 22-24 million tonnes CO_2 equivalents for the country as a whole, or circa 20% of Austria's total carbon footprint. In this study, it is shown that **indirect emissions** – being the emissions related to land use change in response to changing food preferences and amounts over time – amount to 7 to 9 million tonnes of GHG emissions in CO_2 equivalents, depending on the calculation method. Including direct and indirect emissions, Austria's food related GHG emissions per year are calculated at 29 to 33 million tonnes, or 25 to 30% of Austria's total carbon footprint in the last decade.

Three reasons for the relatively high level of direct GHG emissions caused by food consumption can be mentioned. First, Austrians consume large quantities of meat and dairy products, which require large land areas and emission intensive activities such as fertiliser production, land management and livestock's methane emissions. Second, similar to other countries, there is a notable trend towards further processed foods requiring more energy in downstream stages of the food supply chain. Finally, Austria shows to have a particularly large share of foods consumed out of home, which is due to food at work (food service and canteens) and the large tourism sector with a preference for meat based dishes.

75% of Austria's Land Footprint relates to animal products

To calculate the indirect GHG emissions related to food consumption in Austria, a primary concern in this study, it is necessary to translate final consumption into required land areas which is captured by the Land Footprint. The food related Land Footprint amounted to 3.1 million hectares in 2010, of which 63% relates to cropland and the remaining 27% to grassland. With 75% of the total Land Footprint, animal products take by far the largest share. The Land Footprint over time shows a gradual decrease, largely in grassland, but increases take place in tropical regions related to the rising demand for vegetable oils and exotic products such as fruits and nuts.

Significant emissions caused by land use change in tropical regions

Changes in the geographical composition of Austria's Land Footprint over time have been analysed to calculate Austria's emissions related to land use change (LUC) in the countries of origin; any increase in the amount of required land in such a country will cause emissions related to the conversion of natural vegetation (mainly forests) to arable land and/or grassland. The occurring loss in stored carbon – either from the soil or from standing vegetation – is captured by the concept of indirect GHG emissions related to LUC. This report shows that indirect GHG emissions of the Austrian food consumption

amount to 7 to 9 million tonnes of GHG emissions annually: 7 million tonnes when the land use change between 2008 and 2009 in the countries of origin is allocated to the LUC of 'land users' in that particular country of origin, and 9 million tonnes when historically grown LUC emissions in the country of origin (1995-2010) are allocated to the total area of 'land users' in the country of origin. The main countries or regions of where Austrian food consumption caused LUC emissions are Tropical South America (mainly Brazil) and Sub Saharan Africa. Historically, land conversions and related emissions have also been significant in Southeast Asia.

28% of food related emissions potentially saved in a healthy diet

In this study, the same scenario as in the previous WWF report on Austria's food related direct GHG emissions (de Schutter et al. 2015) is applied: the environmental impact of the current diet is being compared with that of a healthy diet based on nutritional recommendations and reduced consumption levels of, among others, meat products (-69%) and dairy products (-20%). A certain part of the reduced animal proteins are compensated by an increase in vegetables and plant based protein (grains, pulses and nuts). It is shown that land use would reduce by 28% from the current 0.36 hectare to a level of 0.26 hectare per capita/per year in the healthy diet.

In total, direct and indirect GHG emissions associated with Austria's food consumption amount to an estimated 29 to 33 million tonnes CO_2 equivalents in 2010/11. The majority, 22 to 24 million tonnes, are the direct emissions related to energy use in primary production and food chain activities (de Schutter et al. 2015).

Indirect emissions related to land use change cannot be calculated for the healthy diet scenario, as this would require assumptions or projections of land use changes caused by all other countries in a specific country where crops or final products for Austria are produced. Assuming indirect emissions to become negligible in a healthy diet scenario, largely as a result of a reduction in animal products and vegetable oil consumption, food related GHG emissions could potentially come down to a level of 19 million CO_2 equivalents (i.e. direct emissions only).

Consumption based policies urgently needed

It can be concluded that, together with mobility, food consumption accounts for the largest share in Austria's global Carbon Footprint. Furthermore, as land use is positively correlated with other environmental pressures such as water use, nutrient pollution and biodiversity loss, it can be concluded that food is a priority sector with respect to policy efforts that help Austria attain a 80-95% reduction in GHG emissions by 2050; consumption based policies and measures should support shifting Austrian food consumption towards more sustainable consumption patterns based on lower intake levels of animal products.

1. Aim of this study: quantifying food related land use and GHG emissions

1.1 Land use and direct emissions in the food chain

How much pressure do we put on the global climate by following established food consumption patterns? And to what extent can we reduce the pressure by changing our food diet in a responsible way? These questions have been central in a recent WWF study[1] on the direct GHG emissions of Austrian food consumption patterns.

The study reveals that Austrians are the largest meat and animal fat consumers in the EU, which not only poses a threat to their health, but also makes them particularly large contributors to global climate change. This is due to the fact that most products of animal origin, largely meat and cheese, require large quantities of feeding stuff. Animal feed embodies large amounts of nitrogen and carbon emissions because of the use of organic and inorganic fertiliser. Furthermore, the energy loss in the conversion from plant to animal product is contributing to increasing emissions (Goodland, 1997). In addition, cattle and other ruminants emit large amounts of methane, one of the stronger greenhouse gases in our atmosphere. Considering all animal and plant based foods together, farm inputs and on-farm production generate ca. 40 to 50% of the food related emissions in developed countries like Austria.

Secondly, the Austrian lifestyle increasingly involve processed and ready to eat meals, which often require heating or cooled storage. Besides that, energy use in the supply chain tends to rise due to the increasing number of processing steps.

Finally, a growing share of food is consumed out of home, a trend that is also supported by the large tourism sector in Austria. Out of home consumption further contributes to Austria's food related GHG emissions as relatively high levels of meat, as well as alcoholic and alcohol free drinks are being consumed in restaurants and work related canteens. Together with the emissions that occur at the household level, consumer activities account for ca. 17 to 30% GHG emissions in the food chain.

For Austria, it has been shown that the annual food consumption of an 'average consumer' generates more than 2.500 kg CO_2 equivalents per year: a volume that equals a car trip from Vienna to Peking and back. Thereof, 67% are associated with the consumption of animal products. Meat – with only 9% of the consumed volume – takes the majority share with 43% of food related emissions per capita. With the aim to reduce both our impact on climate change and the potentially negative effects on human health, in particular overweight and diabetes, the mentioned WWF study developed a healthy diet, based on existing diet recommendations (Elmadfa et al. 2012). The healthy diet, projecting reduced animal product intake levels, is used to compare the associated GHG emissions with the emissions of the current diet. The study clearly reveals the positive effects of a diet shifting from high levels of animal products towards a more plant based diet. It is shown that food consumption related GHG emissions will be reduced by 22% if animal product consumption would decline to 54 grams of meat and 0,5kg milk equivalents of dairy products per day. Consequently, the food intake has to be complemented with an increasing amount of products from grains and pulses. (de Schutter et al., 2015)

[1] WWF Study 2015. Achtung: Heiß und Fettig – Klima und Ernährung in Österreich. Auswirkungen der Österreichischen Ernährung auf das Klima.

1.2 Land use and indirect emissions

The previous section summarised the emissions that can be directly related to production and consumption activities in the food supply chain, i.e. from the production of agricultural inputs, farming, processing and distribution towards the emissions occurring with the storage and preparation of the final product in restaurants and at home. These direct emissions involve carbon, nitrogen and methane emissions emerging from material and energy use in food supply chains, which can be attributed to a unit of final product (kilogramme in this case).

In addition to the life cycle approach to attribute direct emissions, there are other methods needed to quantify the significant amount of emissions that occur due to the expansion of agricultural land use at the global level. These emissions result from land use changes, LUC in short, necessary to meet our growing or shifting demand for food and other agricultural based products. In practice, this means that forests, or other natural areas, are cleared and converted to cropland or grassland. IPCC estimates these indirect emissions at the global level, calculated as the difference between emissions from gross deforestation and forest regrowth, at around 4 Gton CO_2 equivalents annually between 2000 and 2007 (Smith et al. 2014). The UN Food and Agricultural Organisation (FAO) shows that the expansion of the global land system, in terms of deforestation, is slowly levelling off and estimates LUC emissions at a level of 3.7 Gton in 2010 (Tubiello et al. 2014). LUC emissions largely occur at the agricultural frontier in tropical and subtropical regions where they can be directly linked to the products harvested from the cleared land. But, as land use change is driven by global changes in demand, efforts are made to attribute these emissions more fairly to land users across the globe.

In this report, we will apply two approaches to calculate the share of Austrian food consumption in these indirect (LUC) emissions: one based on the total land use in countries with deforestation, and one on the basis of the scale of Austrian land use change from one year to the next (2008-2009). By calculating these indirect emissions and adding them to the direct emissions as calculated in the WWF report (2015), we will be able to scale the global GHG emissions - carbon footprint - related to Austrian food consumption.

The report will first quantify the amount of land that is embodied in Austrian food consumption, both in terms of products and in terms of the origin of the land, i.e. Austria's food related Land Footprint (Chapter 2). Chapter 3 will look at Austria's land use over time (land use change) and, based on that, two distinct calculations of indirect emissions related to land use change will be given. In chapter 4, land use needed to produce the current diet will be calculated and compared with land use embodied in a healthy diet. Finally, in chapter 5, environmental impacts of the Austrian food consumption patterns will be discussed in relation to climate change and biodiversity loss.

2 Austria's food related Land Footprint

2.1 Land use at food product level

Land use for food production can be considered one of the most important pressure mechanisms of humanity on its natural environment (Steffen et al. 2015, Rockström, 2009). Researchers accumulate evidence that six out of nine planetary boundaries that should be respected to maintain a safe planet, are threatened by land use: there is land-system change itself (mainly through deforestation), but also freshwater use, biogeochemical flows (i.e. nitrogen and phosphorous pollution), biosphere integrity (biodiversity loss), ocean acidification, and (in connection with other planetary boundaries) climate change. In this context, several studies show that diets with high levels of animal protein require considerably more land than (more healthy) diets rather relying on plant based proteins (van Dooren et al. 2014; Fazeni et al. 2011; Meier and Christen 2012, Nijdam et al. 2012; Temme et al. 2011; Zessner et al. 2011).

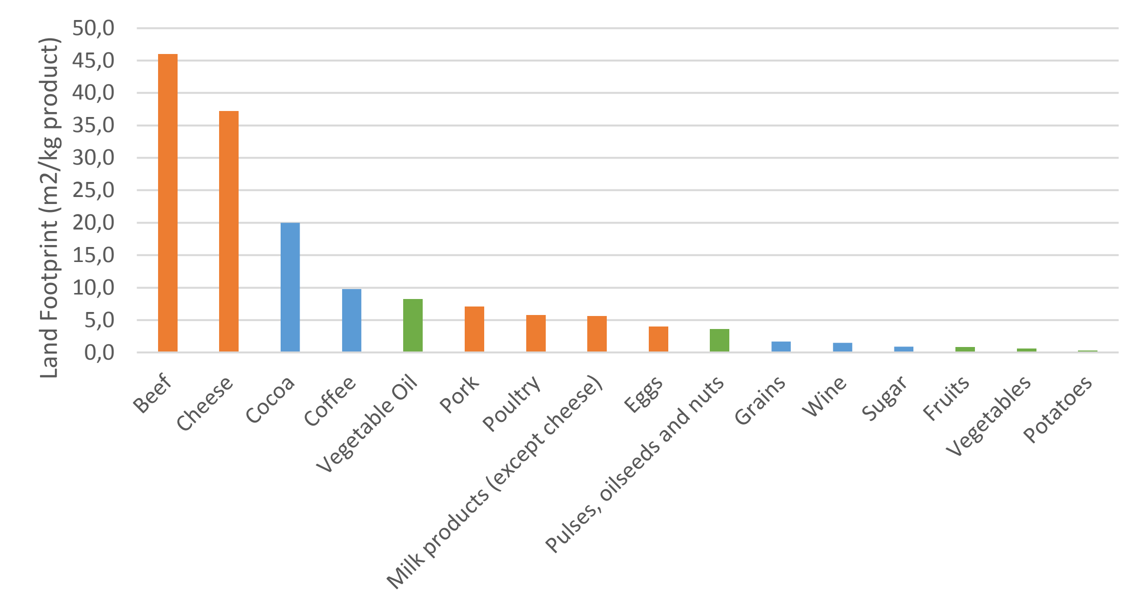

Figure 1: Land requirements per kilogram final product in Austria (Statistik Austria 2014 a and 2014b, FAOSTAT 2015, multiple LCA Studies and land flow calculations by G. Fischer and S. Tramberend (IIASA, 2015)).

Figure 1 shows the Land Footprint of different food components of the Austrian diet. The Land Footprint represents the globally required land area (cropland and/or grassland) per kilogram of final product, including all land areas necessary for the production of animal feed. Beef tops the list with more than 45 square meters per kilogram, followed by cheese. It should be noted that, in this study, beef has a relatively limited and cheese (and other dairy products) a relatively large Land Footprint compared to LCA results from specialised supply chains. This is related to the large share of more extensive Alpine dairy production with mixed breeds in Austria, which also supply beef. Cacao, coffee, vegetable oils and other animal products are in the middle range in terms of land use per kilogram final product, whereas plant based products for direct human consumption as well as sugar and beverages have a low Land Footprint per kilogram.

2.2 Austria's Land Footprint in 2010

The Land Footprint per kilogram food product has been multiplied by the average annual consumption of each food product or category in Austria. The result thus shows the Land Footprint related to the Austrian food consumption at the wholesale level - based on food supply statistics of food production plus imports minus exports minus non-food use minus waste in primary and secondary production (FAOSTAT, 2015, Statistik Austria 2014 a and 2014b). **In total, Austria's food related Land Footprint amounted to 3.05 million hectare in 2010, whereof 1.9 million hectare (63% of the total) are cropland and the remaining 1.2 million hectare (37%) are used as grassland.**

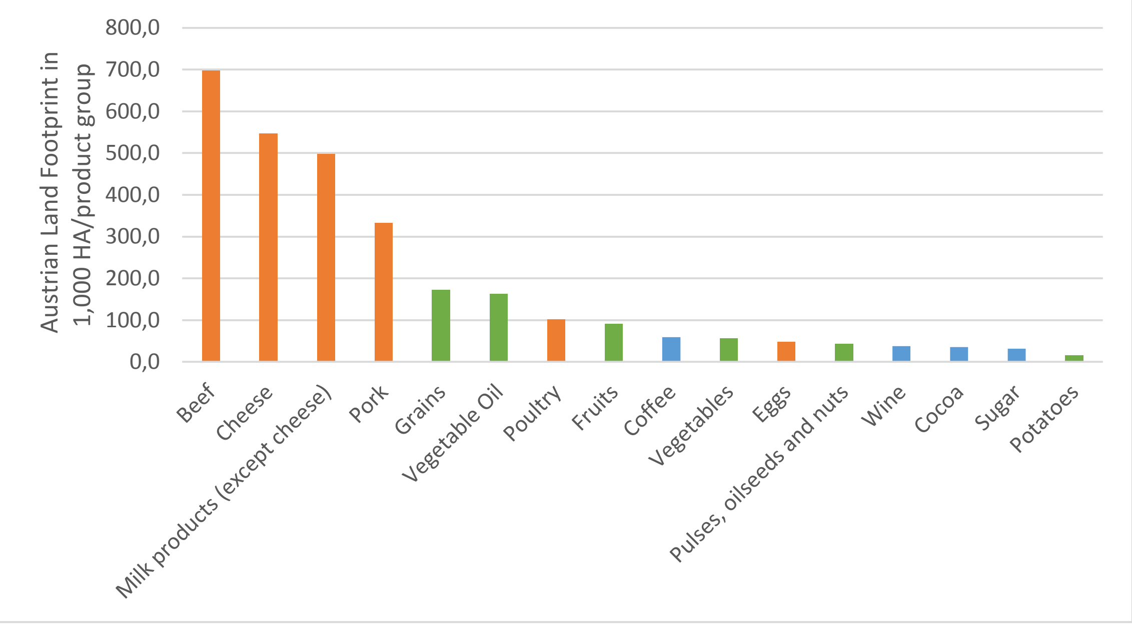

Figure 2: Austria's Land Footprint in 2010, per product group (Own calculations based on Statistik Austria 2014a and 2014b, FAOSTAT 2015, multiple LCA Studies and land flow calculations by G. Fischer and S. Tramberend (IIASA, 2015)).

With 75%, animal products account for the majority share of the food related Land Footprint in Austria (see figure 3 and section 2.3 in this report). Meat and meat products take up 38% of Austria's global land requirements, while the production of dairy products is responsible for a land appropriation of slightly over 1 million embodied hectare (34% of the total). Plant based food accounted for 18% of Austria's Land Footprint and sugar and beverages for the remaining 7%.

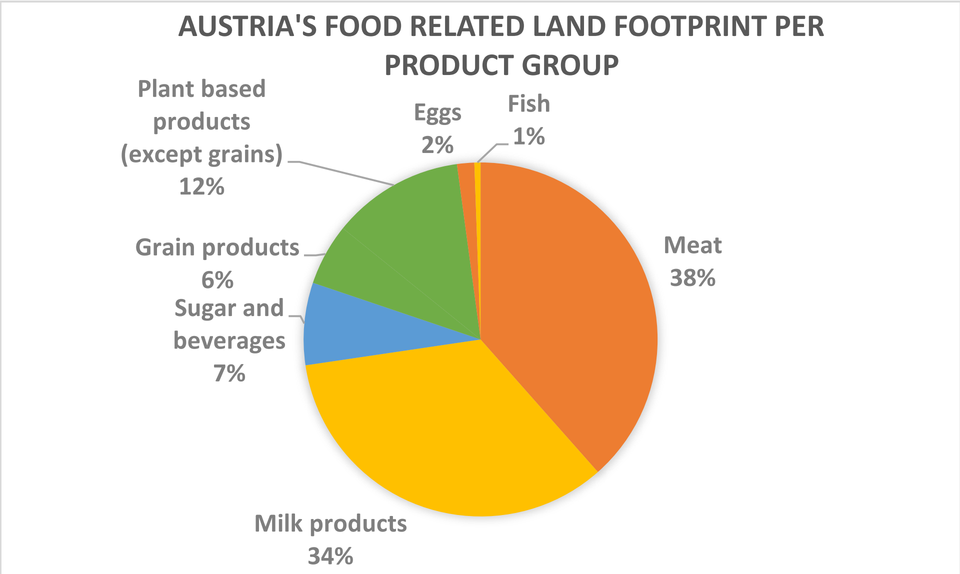

Figure 3: Shares of food product groups in Austria's Land Footprint in 2010 (Own calculations based on Statistik Austria (2014a and 2014b), FAOSTAT (2015), multiple LCA studies and land flow calculations by G. Fischer and S. Tramberend (IIASA, 2015)).

In terms of land cover and land use, the largest area embodied in Austria's food consumption relates to permanent grassland for ruminant products (meat and dairy products from grass-fed cattle, sheep and goats) (see figure 4). Grain areas accounted for 25% of the total Land Footprint in 2010, whereof the majority share (19% of the total LF) is used for animal feed. Therefore, in addition with the required cropland for protein crops and fodder (14%), it can be calculated that an additional 9% of arable land is appropriated for the supply of animal products.

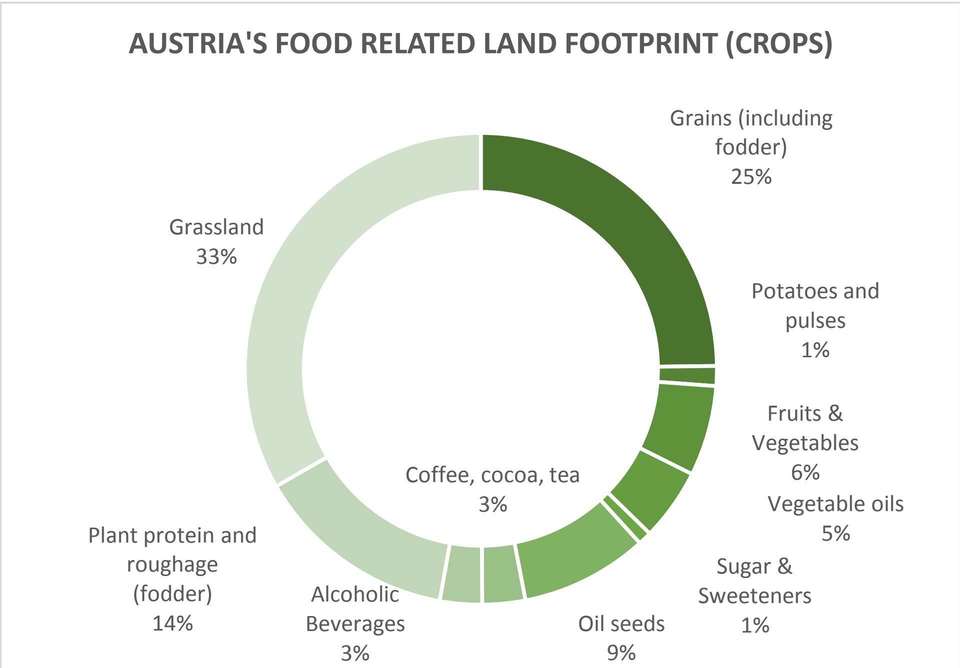

Figure 4 Austria's food related Land Footprint by land use (crops). Source: Land flow calculations by G. Fischer and S. Tramberend (IIASA, 2015), own calculations based on FAOSTAT 2015 (grassland).

2.3 Austria's food related Land Footprint in the countries of origin

In 2010, 40% of Austria's food related Land Footprint was located abroad. The foreign share is particularly high for plant based food crops, with up to 60% of foreign land requirements, whereas foreign land needed for animal feed or final animal-based products, amounted to 34% of the land requirements (see figure 6).

Austria's Land Footprint per product according to country of origin in 1,000 HA, 2010

	Austria	Europe	West Asia	Russia	North America	Central America	South America	North Africa	Sub Saharan Africa	South Asia	Southeast Asia	Central & East Asia	Australia & Oceania
Wheat	79,4	50,1	0,3	4	0,8	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,1
Rice	0,0	3,4	0,0	0	0,5	0,0	0,5	0,0	0,0	1,0	3,3	0,0	0,0
Maize	7,8	4,8	0,0	0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Other cereals	24,1	7,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2
Roots & pulses	13,3	2,2	0,2	0,4	0,2	0,0	0,1	0,0	0,2	0,0	0,2	0,3	0,0
Sugar & Sweetener	20,8	8,6	0,1	0	0,0	0,3	1,7	0,0	0,5	0,0	0,1	0,0	0,0
Oil crops (primary)	6,5	5,1	0,7	0,8	1,4	0,2	3,7	0,0	1,1	3,9	1,1	0,8	0,0
Vegetable oil	51,8	87,4	0,3	4,3	1,3	0,0	1,9	1,7	1,8	2,3	10,1	0,2	0,2
Fruit, vegetables, spices	37,5	62,8	24,7	0,2	4,3	2,2	9,0	2,1	4,7	4,1	4,6	4,5	0,4
Stimulants (Cocoa, Coffee, Tea)	0,0	0,0	0,0	0	1,9	9,7	29,5	0,0	34,5	4,7	19,7	0,5	0,0
Alcohol	75,2	20,4	0,1	0,2	0,4	0,0	0,3	0,0	0,2	0,0	0,0	0,0	0,4
Total Land Footprint of Food crops inlcuding Beverages	316,4	251,8	26,4	10,0	10,8	12,4	46,7	3,8	43,0	16,0	39,1	6,5	1,3
Total Land Footprint of Feed crops	634,8	483,8	0,5	0,6	1,9	0,0	5,2	0,4	0,2	0,0	0,6	0,1	1,2
Total Land Footprint of Grassland	871,0	252,3	0,0	0,0	0,3	0,0	9,6	0,0	2,7	0,0	0,0	0,0	1,8
Total Land Footprint in 1,000 HA	**1822,2**	**987,9**	**26,9**	**10,6**	**13,0**	**12,4**	**61,5**	**4,2**	**45,9**	**16,0**	**39,7**	**6,6**	**4,3**
% of total Area	**59,7**	**32,4**	**0,9**	**0,2**	**0,4**	**0,4**	**2,0**	**0,1**	**1,5**	**0,5**	**1,3**	**0,2**	**0,1**

Figure 5: Austria's Land Footprint according to country of origin, 2010 (Land flow calculations by G. Fischer and S. Tramberend (IIASA, 2015), own grassland calculations based on FAOSTAT 2015)

Figure 6 shows that the majority of foreign land resources originate from within the EU: mainly from neighbouring member states. Further away, Sub Saharan Africa (coffee, cacao), South America (vegetable oils, fruits) and Turkey (grains, vegetables) add to the foreign Land Footprint of Austria.

Distal land areas for animal feed are limited to South America (soybean meal, grains) and Australia (grass-fed beef). The majority of land areas for feed production are in Austria and the EU.

Apart from the EU, figure 6 shows that larger land hotspots related to Austrian food consumption are located in tropical regions. Land use in these regions requires specific attention with respect to deforestation and the related loss of biodiversity and a potential deterioration of water filtering capacities. Deforestation of tropical forests also is a major contributor to food related carbon emissions and global warming – as will be shown in the next chapter.

3 Indirect emissions from land use change

3.1 Global land use change and related CO_2 emissions in tropical hotspots

Globally, food and other demand for agricultural goods show an increasing trend in line with population and economic growth. In developed regions, such as Austria and the rest of the EU, increasing supplies are largely met by yield growth and other productivity improvements. However, in tropical and sub-tropical regions the agricultural frontier is increasingly pushed towards forested areas in search for more agricultural land to satisfy the growing demand (Henders et al. 2015). Research shows that, over the last fifty years, increasing consumption of animal products has been largely responsible for land conversions (Alexander et al. 2015). Furthermore, as far as the EU is concerned, a growing share of the Land Footprint is imported (Kastner et al, 2012).

The conversion of forest areas into cropland or grassland, indicated as land use change or LUC, comes together with large amounts of carbon releases from (1) the loss of standing stock (trees), (2) the loss of carbon from humus rich soils in (former) forests and/or (3) soil carbon losses that occur with the conversion of grassland into cropland. At the global level, 22% to 40% of the food related emissions are estimated to originate from land use changes (Vermeulen et al. 2012). These LUC emissions are indicated as indirect emissions as they can generally not be directly related to carbon emitting production activities. They emerge from changes in the global land system, a complex system driven by changes in demand and supply of all actors in all societies. To give an example: if Austria shows an increase in demand for soy from Brazil, this does not necessarily trigger deforestation and, hence, will not necessarily result in LUC emissions related to Austrian demand. If another country or buyer reduces its demand, Austria could increase its Land Footprint in Brazil without LUC emissions. However, when the other country – as well as several others and Brazil itself –increases its demand for soy or other commodities, it is likely to result in land conversions from forest to cropland or grassland to cropland in Brazil. The resulting LUC emissions have to be shared amongst– or allocated to –the involved buyers or, to mention the other argument, have to be shared among all land users in e.g. Brazil as the scale of historical land appropriation also contributes to new land conversions and LUC emissions (see section 3.3 for allocation principles used to calculate indirect GHG emissions related to Austrian food consumption).

Figure 8 shows the annual LUC related CO_2 emissions from a territorial perspective, i.e. the LUC emissions that occurred in the different world regions because of expanding agricultural activities in those regions. The territorial LUC emissions originate from the carbon atlas (carbonatlas.org), which contains a database of LUC emissions in 18 world regions/countries from 1961 to 2010, based on calculations by Houghton et al. (2012). Most regions, including Europe, show a stable, rather low (around ‘zero’) level of LUC emissions, indicating that land use patterns are stable. In this case, net carbon emission (from harvest and plant respiration) equals carbon sequestration (plant regrowth). These regions tend to have limited areas of pristine forests as these have been removed to enable agriculture in earlier times. In some regions, like China, the former Soviet Union and, to a lesser extent, the EU (not visible), carbon sequestration (negative emissions) is actually larger than emissions due to forest reforestation (in abandoned areas) and afforestation schemes (forest plantations).

But the point of interest is the amount of emissions in Southeast Asia, Latin America and in Sub Saharan Africa. Together these tropical and sub-tropical regions account for nearly the entire global budget of LUC related CO_2 emissions, estimated at 4.6 Gton CO_2 per year (or 1.3 Gton in carbon). The forest cover in the Southeast Asian region has declined by over 13% between 1990 and 2010, largely because of palm oil expansion. Deforestation, driven by the palm oil industry, is also likely to be responsible for the peaks in LUC emissions (in 1998, 2002 and 2007). The rapid decline in tropical forest cover has severe consequences for biodiversity and important ecosystem services such as carbon sequestration (Turner and Snaddon, 2016). The long-term global trend in LUC emissions shows a modestly declining trend – towards 1.1 Gton Carbon annually since 1995 – which still accounts for 14 to 20% of global greenhouse gas emissions (Pan et al. 2011). The decrease has been particularly noticeable in Brazil and Indonesia, although higher rates have been recorded for 2013 and 2014 and new tropical deforestation hotspots have emerged, e.g. Asian's Mekong Basin (Weisse and Peterson, 2015).

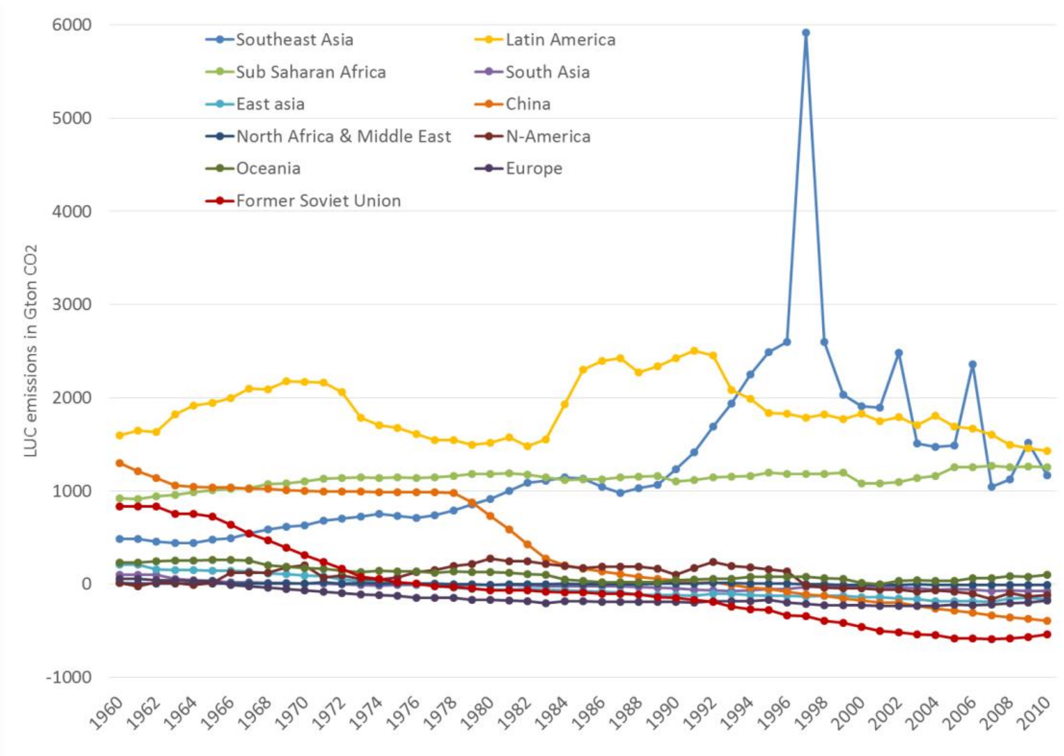

Figure 6: GHG emissions from land use change in world regions 1960-2010 (Global Carbon Atlas 2015 based on Houghton et al. 2012)

3.2 Austria's Land Footprint over time

As shown in the previous section, changing land demand over time, especially in tropical regions, contributes significantly to global anthropogenic GHG emissions. Therefore, we will look at Austria's Land Footprint over time, i.e. the amount of land embodied in the supply of food products for the Austrian population.

Figure 9 shows that Austria's food related Land Footprint is declining over time, largely as a result of a decrease in grassland use (-27% since 1995) and in other animal feedstuff, mainly oil meals and fodder for ruminants. This favourable environmental trend can be related to both, increases in crop productivity and improvements in feed efficiency, i.e. the rate between animal output/growth and feed consumption. However, a declining Land Footprint over time is not a guarantee that no deforestation or other land conversions, resulting in indirect emissions, was taking place. The use of oil crops and vegetable oils show a steady increase over time and growing imports from tropical fruits, vegetables and nuts also put pressure on land conversions in tropical regions. Finally, it should be noted that, once a land conversion from forest to cropland or grassland has taken place, a reduced Land Footprint by e.g. Austria does not bring back the emitted carbon. In other words, carbon emissions from land use change are more or less irreversible which makes it clear that increases in land use should be prevented rather than reduced, although a reduction prevents land use changes potentially caused by other regions.

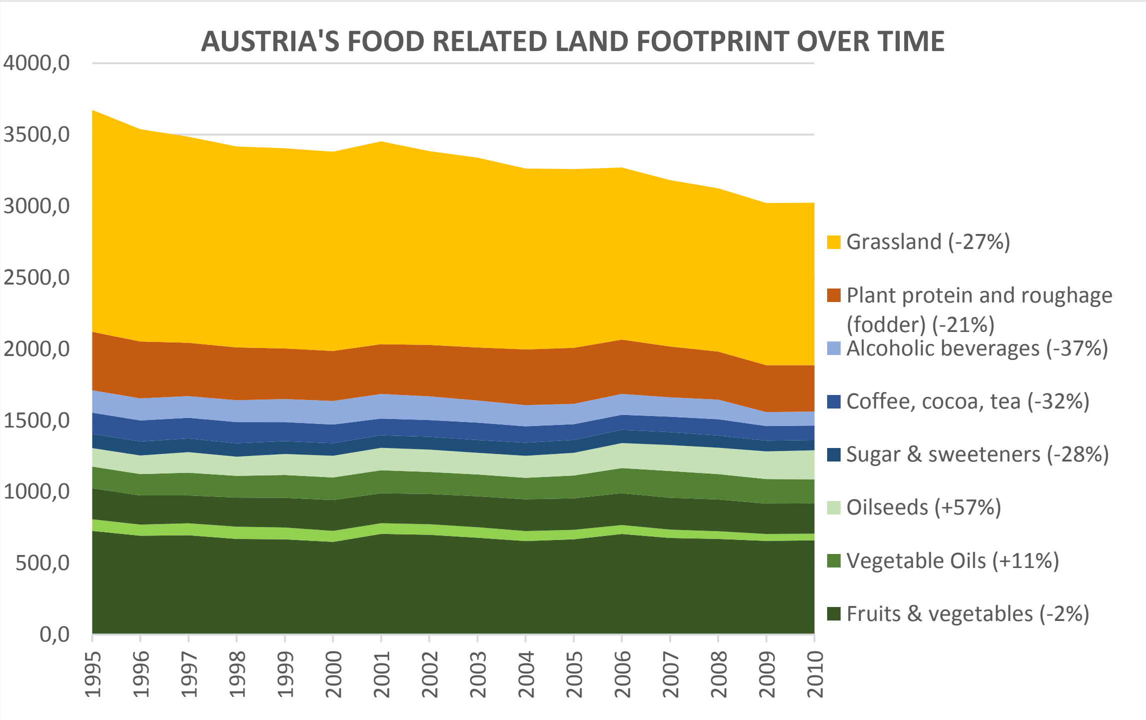

Figure 7: Austria's food related Land Footprint over time, differentiated to land use categories (crops and grassland) (Fischer et al. forthcoming).

3.3 Austria's indirect emissions related to land use change (LUC)

Based on available datasets and calculations of land use change in different world regions, we have two options to calculate Austria's indirect GHG emissions related to food consumption:

1. By relating Austria's land use increase between 2008 and 2009 to the emissions from land use change in the country of origin between 2008 and 2009. This will approximate Austria's current role in LUC related emissions.
2. As the 1st method does not take into account Austria's LUC emissions that have been caused in previous years, we also calculated the average GHG emissions per hectare from LUC in the country of origin between 1995 and 2010, and allocated Austria's relative share in these emissions to Austria's Land Footprint (land use, not land use change) in each country of origin of food products consumed in Austria.

The LUC emissions in the countries of origin have been taken from the carbon atlas (carbonatlas.org). The Land Footprint for Austria in 2010 has been based on IIASA's LANDFLOW calculations by Fischer et al. (forthcoming), and Austria's LUC in the countries of origin between 2008 and 2009 have been based on the embodied land flow matrix of Kastner et al. (2012). Both Fischer et al. (forthcoming) and Kastner et al. (2012) based their calculations on the land database of the Food and Agricultural Organisation (FAO).

The two different calculation approaches – LUC between 2008 and 2009 or land use between 1995 and 2010, result in a bandwidth for Austria's indirect LUC emissions of between 7 and 9 million tonnes of CO_2 (Figure 9), or 24 to 27% of Austria's total food related emissions. It should be noted that the first method, based on the LUC of Austria between 2008 and 2009 also includes Austria's land use change related to non-food biomass demand and is likely to be overestimated since non-food includes increasing volumes of feedstock for bioenergy (oil crops) from tropical regions. Furthermore, as resources embodied in Austrian food consumption are stabilising, indirect emissions related to LUC are likely to be closer to the lower level of the bandwidth.

Nevertheless, an average share of ca. 24-27% indirect emissions in total food related emissions is plausible, also because it is in the middle range between calculations of 15% (Meier and Christen, 2012), 20% (Noleppa, 2012) for Germany and 40% for the UK (Audsley et al. 2009). Adding the indirect emissions to the direct emissions associated with Austria's food consumption (de Schutter et al. 2015), provides a result of 31 million tonnes CO_2 equivalents of average food related GHG emissions in 2009/11, or 25% of Austria's total consumption based carbon footprint (APCC, 2014, based on territorial emissions in 2011 and global product flows in 2004). When compared with recent calculations of Austria's GHG emissions in direct and indirect supply chain activities (with input-output analysis in EORA, as an average over the years 2009-2011), food related emissions would amount to a level of 30% of Austria's carbon footprint (de Schutter et al., forthcoming).

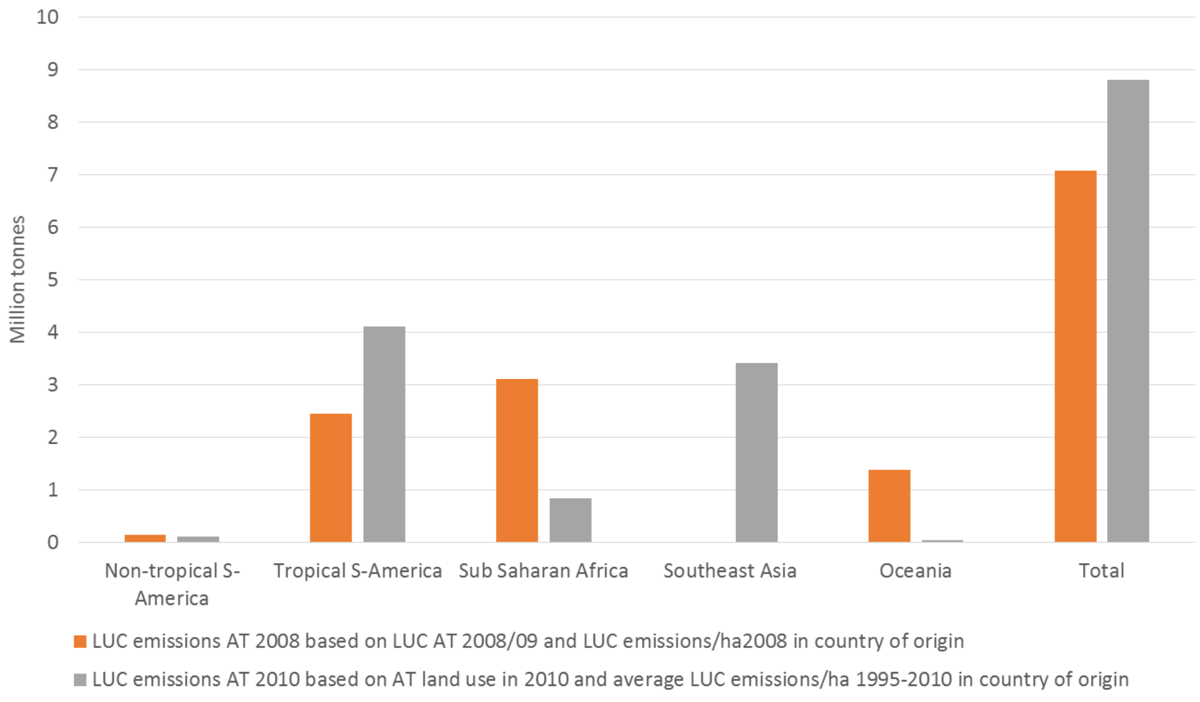

Figure 8: Calculations of Austria's food related emissions from LUC in the region of original production of food, feed or grassland product (in million tonnes CO2 equivalent)

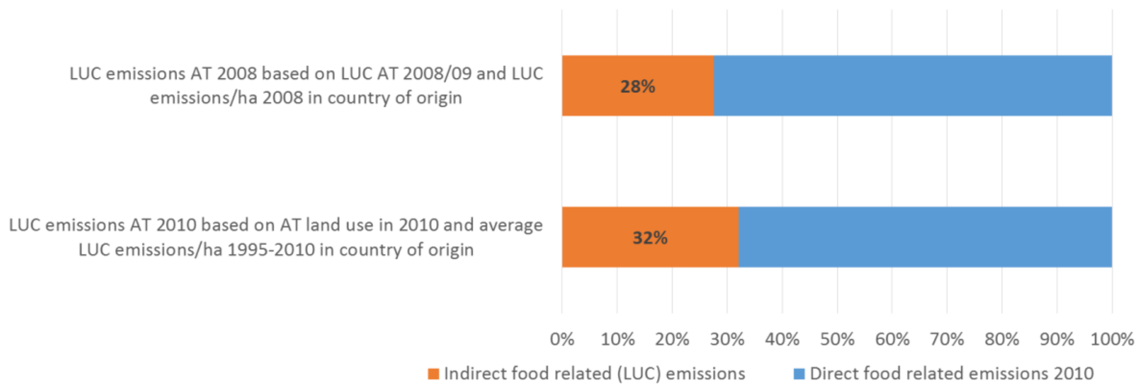

Figure 9: Relative share of indirect and direct emissions in Austria's total food related GHG emissions

4 Land use in a healthy diet in comparison to the current diet in Austria

4.1 Proposed changes towards a healthy diet for the Austrians

As has been shown in the WWF 2015 report on climate and food in Austria (de Schutter et al. 2015), Austrians are Europe's largest consumers of meat and animal fats, contributing not only to climate change but also to the increasing rate of overweight and obese children and adults in the country. Based on recommendations of the Ministry for Health (Elmadfa et al. 2012), a healthy diet should be targeting reduced meat and dairy intake levels, partly compensated by higher plant-based protein levels from grains, pulses and nuts. Vegetable oils and sugar intake levels should be reduced as well (own calculations based on Elmadfa et al. 2012 and Optimix, FKE 2015). More detailed information on the levels of food recommendations in the healthy diet can be found in the previous WWF study on food related GHG emissions in Austria (de Schutter et al. 2015). Figure 11 shows the proposed changes per food category (in kg. and in %) from the current to a healthy diet.

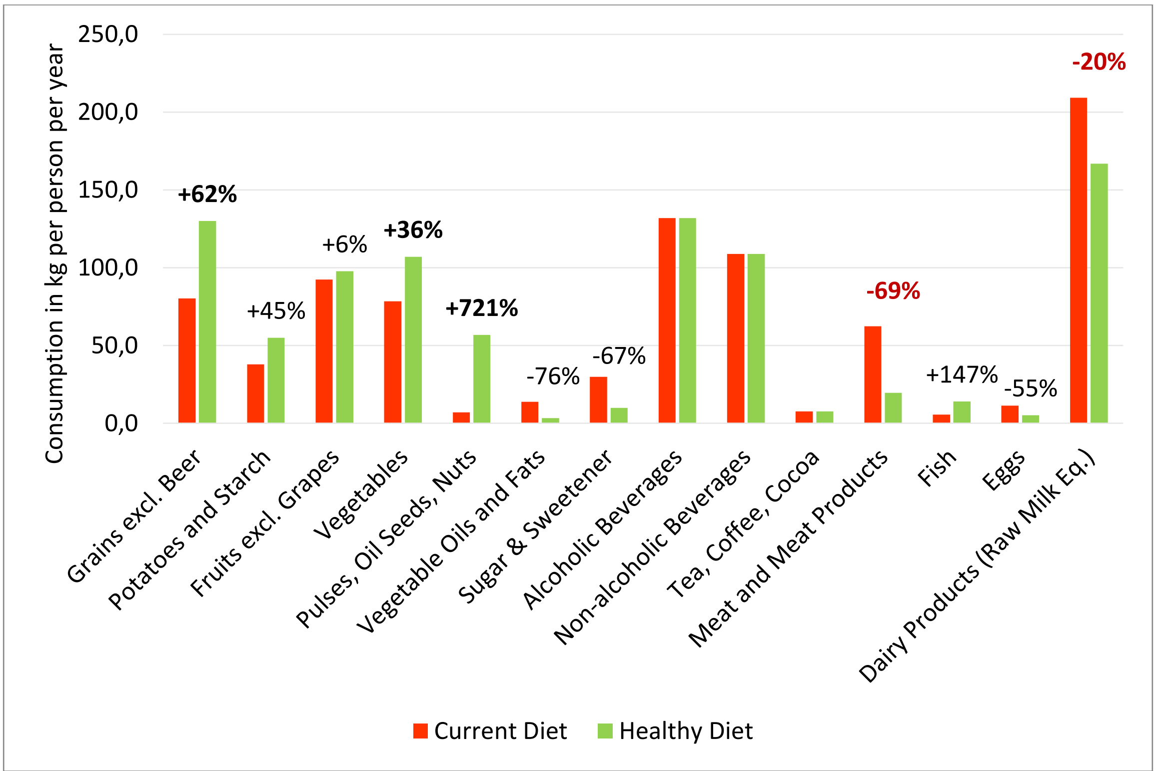

Figure 10: Comparison of food intake in the current diet and in a healthy diet scenario per Austrian (in Kg per capita per year) (Actual food consumption data from FAOSTAT (2015) and Statistik Austria (2014). Intake levels in a healthy diet are own calculations based on reduced levels of animal products (own calculations in: de Schutter et al. 2015)

4.2 Saved land area in a healthy diet

Based on the average land requirements per kilogram final product (from available LCA studies, see Annex 1), calculations have been made for the per capita land use in the current and the healthy diet. Figure 12 shows that the difference in land use is considerable, with a 28% reduction from 0.36 hectare to a level of 0.26 hectare per capita, in case of a shift towards healthy diet patterns.

In the proposed scenario, land use related to Austrian food consumption can potentially decrease from the current 3.05 million hectare to 2.21 million hectare in a healthy diet. As can be seen in figure 13, the majority share of saved land use stems from the reduction in meat consumption from the current 800 gram per week to a recommended level of 377 gram per week (54 grams per day) (de Schutter et al. 2015).

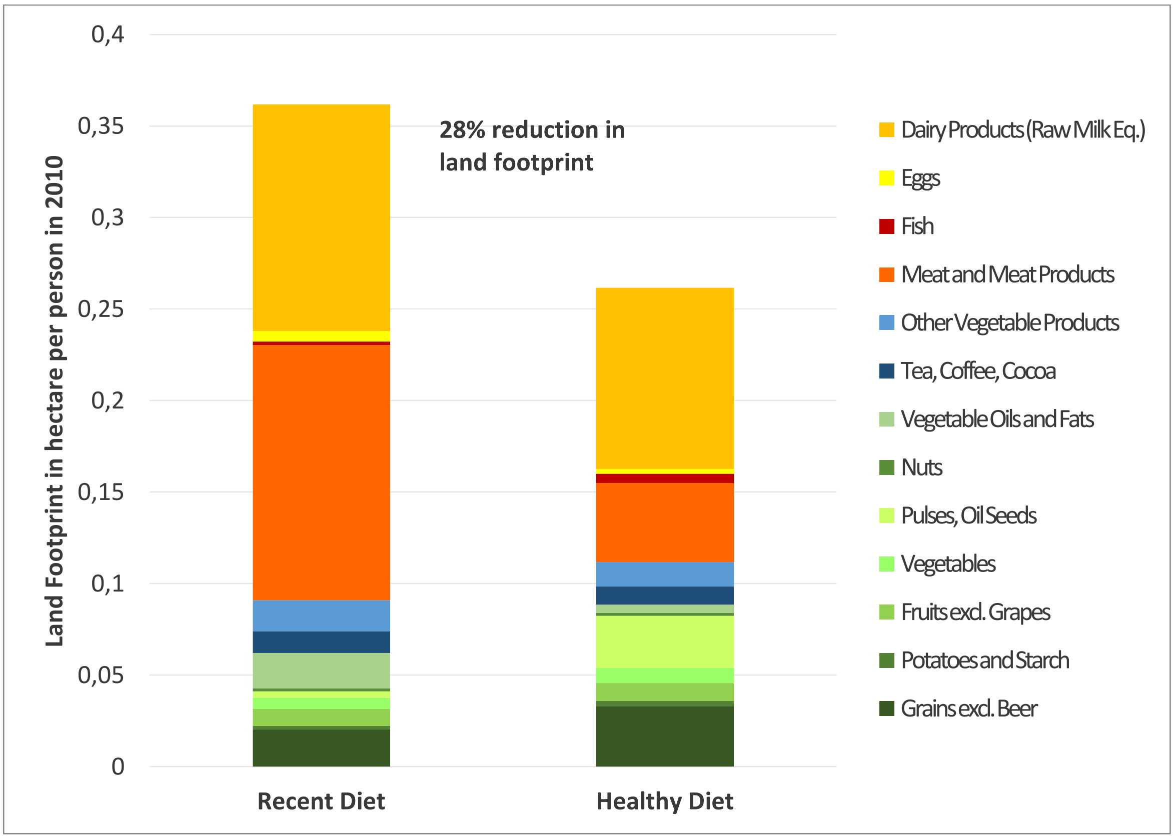

Figure 11: Per capita Land Footprint in the current and a healthy diet with reduced levels of animal based products, sugar and vegetable oils (own calculations based on DACH (Elmadfa, 2012) and Optimix (FKE, 2015) recommendations in kg/head/day.

*Contains sugar and sweeteners and alcoholic beverages (soft drinks are not included). For beverages, no official recommendations have been provided in the healthy diet and are therefore kept at the same level as in the current diet.

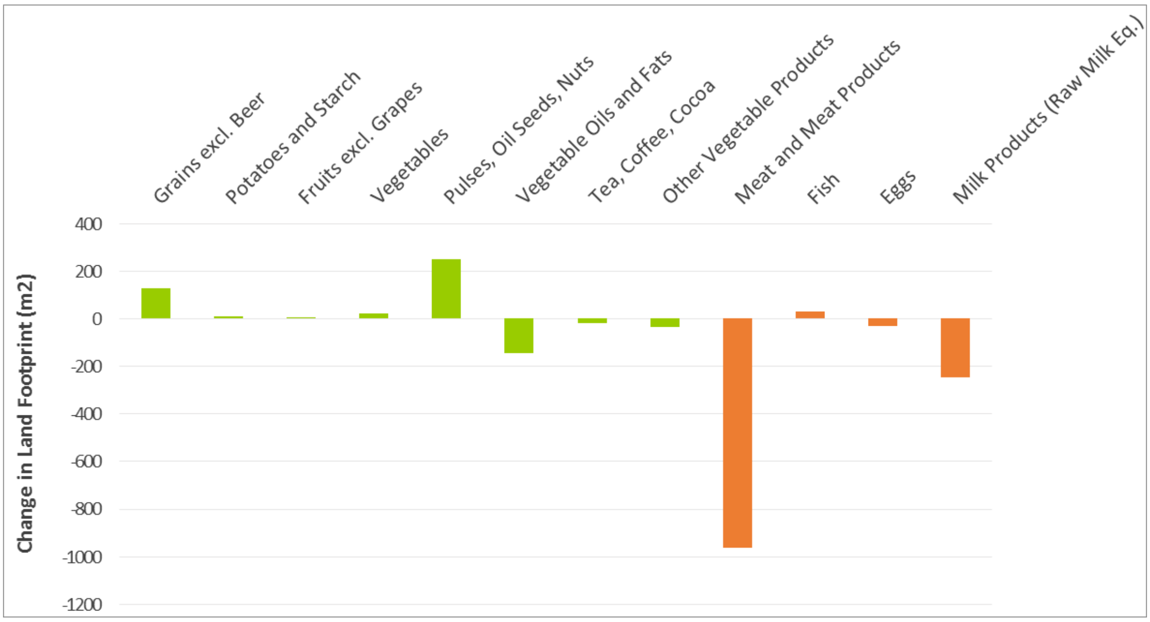

Figure 12: Absolute changes in land use per food category after changing from the current to the proposed healthy diet

A reduction of the Austrian food Land Footprint of 28% would also have a positive effect on food related GHG emissions. As has already been shown in the WWF 2015 Report (de Schutter et al. 2015), direct GHG emissions will be reduced with 22%. Indirect emissions, calculated at a level of 7 to 9 million tonnes annually (see section 3.3), will be reduced as well. A reduction in beef consumption will save the largest amounts of agricultural area, but in the case of Austria this currently embodies a large share of domestic grassland which may not have a considerable impact on the amount of cropland used in tropical regions (the largest hotspots of indirect emissions related to Austrian food consumption). A reduction in dairy, pork or poultry products will free up cropland suitable for food crops that may therefore be preferable in the context of indirect emissions related to land use change. Furthermore, as consumption of grains and pulses is projected to increase in a transition towards a healthy diet, LUC emissions related to increased demand for e.g. soy or quinoa from (sub-)tropical regions should be prevented.

When we would assume indirect emissions to become negligible as land requirements reduce under a sustainable consumption scenario based on a healthy diet, food related GHG emissions could theoretically come down to a level of 19 million tonnes CO_2 equivalents (the level of direct emissions only). However, at this point it is not possible to calculate reductions in indirect emissions due to their strong dependency on specific changes in the diet and on land use changes in the countries of origin. As we discussed before, land use changes are subject to various drivers and depend on the Austrian demand as well as the demand for food and non-food biomass from other countries.

Joint efforts of consumers, producers and policy makers in Austria to shift our largely animal based diets to more plant based ingredients would reduce LUC emissions related to food consumption, which helps preventing undesirable climate change at the global level and contributes to an improved health status of children and adults in countries with Western Lifestyles (BIO IS et al. 2014).

5 Conclusions

5.1 The large impact of animal products on Austria's global Land Footprint

A growing number of studies confirm the relation between human diets and environmental impacts (Erb et al. 2016; Röös 2015; Westhoek et al. 2014; Wirsenius et al. 2010). This relationship is most profoundly shown in diets where the protein supply is largely based on animal products. This is the case in Austria, where a large Land Footprint, extending the borders of the country, is required for nutrition. Due to the inefficient energy conversion from plant based to livestock products, large quantities of animal feed – and embodied land areas – are required to supply consumers with diets rich in animal protein. As Austrians are the largest meat consumers in the EU, as well as significant dairy consumers, food products of animal origin account for 74% of the Land Footprint related to food consumption in Austria.

A closer look at the geographical distribution of Austria's Land Footprint shows that circa 40% of the Land Footprint is located outside Austria. Thereof, the majority share is caused by the consumption of animal products (62%), mainly in terms of land areas required for feed imports and to a lesser extent of imports of animal products from neighbouring EU countries. With respect to Austria's food related Land Footprint outside the EU, the majority share of land is embodied as cropland for plant based food products such as coffee, fruits and vegetable oil (see also figure 6 in section 2.2).

5.2 The large impact of Austrian consumption on climate change

In the WWF 2015 study on climate and Austrian food consumption (de Schutter et al. 2015), it has been shown that Austrian food consumption causes an estimated 2,586 to 2,851 kgCO_2-equivalents per capita per year in the form of direct emissions in the supply chain from primary production to food intake at the consumer level. This amounts to an estimated 20% of the country's total consumption based carbon emissions in the last decade (APCC, 2014). In this study, it has been calculated that indirect GHG emissions, from land use changes associated with Austrian food consumption over time amounted to 7-9 million tonnes, depending on the calculation methodology. Including the indirect emissions related to land use changes, Austria's total food related emissions amount to 29-33 million tonnes CO_2 equivalents, leading to an estimated share of 25 to 30% of Austria's total Carbon Footprint in the last decade (1995-2011). It can thus be concluded that, together with mobility, food consumption accounts for the largest share in Austria's global carbon footprint (Hertwich and Peters, 2009), making it a priority 'sector' for policy efforts to change food consumption patterns towards more sustainable diets.

5.3 Shifting towards a healthy diet will significantly reduce Austria's Land- and Carbon Footprint

Shifting the current animal based diet towards a healthy diet based on higher levels of plant based protein and energy is projected to reduce Austria's food related Land Footprint with 28%. In terms of GHG emissions, the Carbon Footprint may decrease to the level of direct emissions in a healthy diet, i.e. a reduction of 39% towards a level of 19 million tonnes CO_2 equivalents. In this case, indirect emissions caused by land use changes are assumed zero, requiring not only a reduction of animal protein levels, but also careful consumption of plant based products from tropical regions. Furthermore, the resulting 'freed' land areas enable less developed regions to increase their land use for the supply and consumption of healthy and sufficient levels of nutritional products. As calculated by Erb et al. (2016), shifting diets towards lower meat levels in developed regions are likely to prevent further deforestation and, consequently, will support a reduction in emissions from land use change in tropical regions.

5.4 Other environmental impacts related to Austria's animal protein rich diet

The high levels of direct and indirect emissions caused by the Austrian food consumption clearly demonstrate the great contribution of food consumption, as an important economic activity, to climate change. The impact of Austria's large Land Footprint, however, goes further than the climate impact. A large Land Footprint is also associated with high levels of water use, nutrient pollution and biodiversity loss; processes, which put major threats to the functioning of local and global ecosystems. For example, Thaler et al. (2013) show that Austrian livestock production is responsible for 87% of the food production induced water footprint, for 71% of the nitrogen input and for 58% of the phosphorous input. As soil nutrients tend to wash out with rainfall, animal husbandry is responsible for 46% of the nitrogen and 28.5% of the total phosphor emissions into surface water in Austria.

Furthermore, food consumption is the most important (indirect) driver of biodiversity loss at the global level (MEA, 2005). Austria's global Footprint links food consumption with distal production areas and, implicitly, to biodiversity losses – both related to agricultural practices and to land use changes (in particular deforestation). High meat consumption levels and increasing demand for vegetable oil from tropical regions are strong underlying drivers of historic and current biodiversity loss. More research is recommended to link Austria's Land Footprint more explicitly to biodiversity loss. Apart from that, Austria has an important function in the conservation of land areas for the protection of endangered species. Austria hosts a significant proportion of the species that are threatened at the European level and has the important responsibility for protecting these species within its territory (IUCN, 2013). In both cases, driving biodiversity loss and protecting endangered species, food consumption plays a key role and policies to support a shift towards a more sustainable consumption pattern are urgent.

This study, as well as other studies (e.g. Röös et al. 2015; Erb et al. 2016) show that a shift towards a healthy diet based on recommendations for nutritious foods and lower levels of animal products, has the potential to significantly reduce local and global environmental pressures associated with Austria's global food related Land Footprint.

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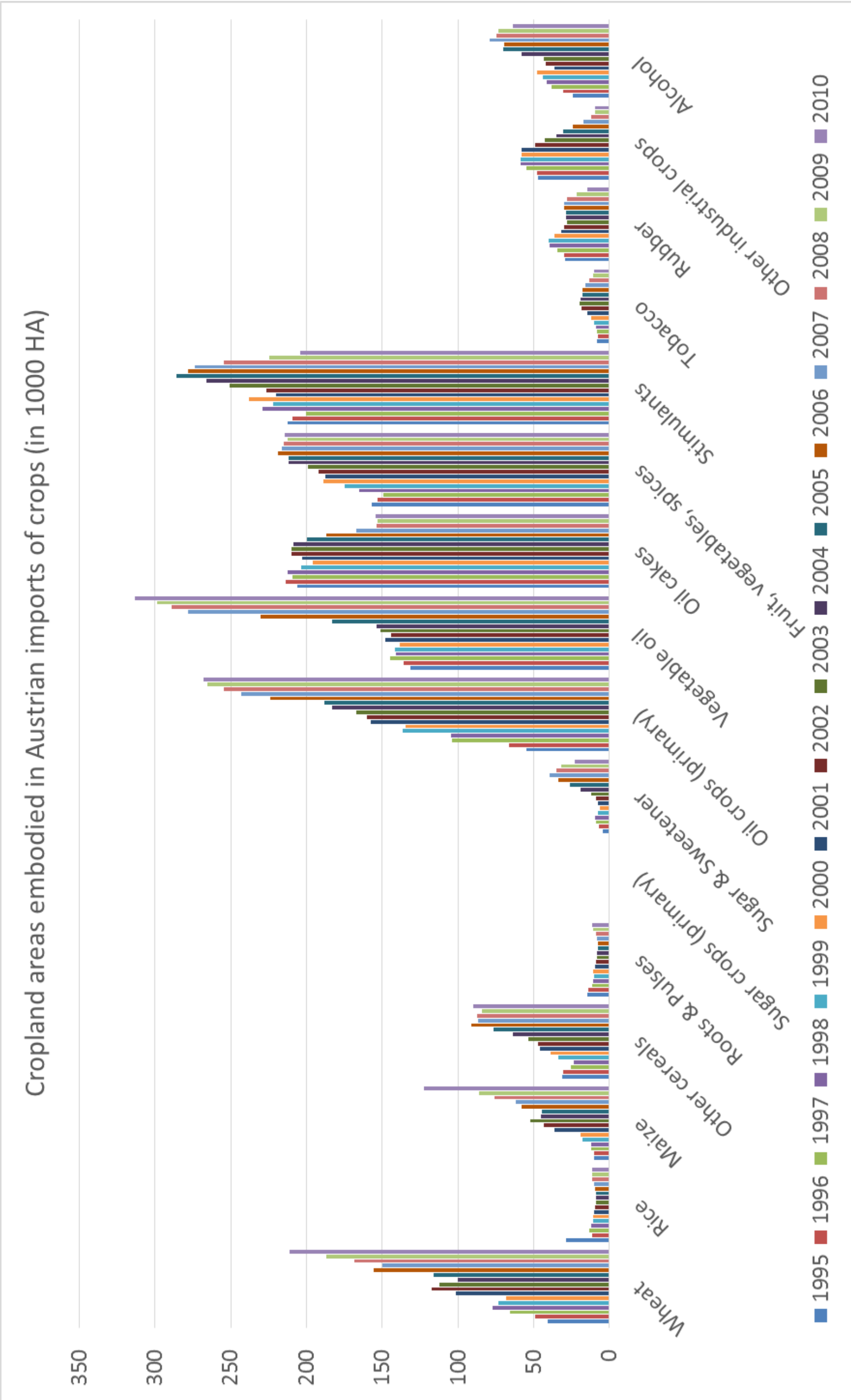
ANNEX 1: Land Footprint calculations per food category

Population 2010-2012 (1000	8433			Quelle (sehe unten):															
	Verbrauchsdaten			1 (AT)	2 (NL)	3 (UK)	4 (France)	5 (Sweden)	6 (NL)	7 (NL)	8a (meta _min)	8b (meta _max)	9 (NL)	10 (DE)	AT (selected from 1 or average 2-10)	Land use (x0,1 ha)	Land use (HA)	*of which cropland*	*of which grassland*
Product	Brutto Verbrauch (FAO)	Brutto Verbrauch in Kg (Statistik	Brutto Verbrauch AT (tonnes)	LF/kg product (m2/kg food)															
Grain products	**121,1**	**121,4**	**1023682**	**1,83**	**1,4**									**1,8**	**1,7**	**1716373**	**171637**	*171637*	
Wheat flower	81,0	79,8	672953	2	1,6										1,8	1211316	121132		
Rice	3,7	4,4	37105													0	0		
Rye flower	12,7	13,4	113002													0	0		
Maize products	12,3	20,8	175406													0	0		
Barley products	0,2	0,5	3879													0	0		
Oat products	1,8	1,4	11469													0	0		
Other	9,4	1,2	9867													0	0		
Starchy roots	**58,3**	**57,1**	**481524**	**0,3**											**0,3**	**157892**	**15789**	*15789*	
Cassava			0													0	0		
potatoes	58,3	48,4	408157		0,2									0,3	0,3	102039	10204		
Sweet potatoes			0													0	0		
Frozen processed		8,7	73367													0	0		
Fruits average	**146,0**	**107,5**	**1117091**		**0,5**									**0,9**	**0,8**	**904844**	**90484**	*90484*	
apples	53,1	40,3	339850													0	0		
apricots		2,5	21364													0	0		
avocados		0,3	2530													0	0		
bananas		11,7	98947													0	0		
blueberries		0,3	2530													0	0		
cantaloupe			0													0	0		
cherries		1,3	10963													0	0		
citrus fruits	26,1	14,1	118905													0	0		
cranberries		0,1	843													0	0		
dates	0,1	0,1	843													0	0		
grapes	7,9	3,3	28110													0	0		
honeydew			0													0	0		
kiwi		1,0	8433													0	0		
mangoes		0,4	3373													0	0		
melons		3,8	32045													0	0		
papaya			0													0	0		
peaches		4,6	38792													0	0		
pears		10,8	91076													0	0		
pineapples	2,2	2,3	19396													0	0		
plums		3,2	27267													0	0		
raspberries		2,7	22488													0	0		
strawberries		4,1	34856													0	0		
watermelon		0,5	4217													0	0		
Processed fruits		***24,9***	***210263***													**0**	**0**		
canned fruit		3,3	27829													0	0		
frozen fruit		1,0	8433													0	0		
dried fruit		1,4	12087													0	0		
fruit juices		19,2	161914													0	0		
Vegetables average	**109,3**	**104,6**	**931847**		**0,3**									**0,5**	**0,6**	**559108**	**55911**	*55911*	
artichokes		0,2	1687													0	0		
asparagous		0,6	5060													0	0		
paprika		5,1	43008													0	0		
broccoli		3,7	31202													0	0		
brussels sprouts		0,5	4217													0	0		
cabbage		6,9	58188													0	0		
carrots		8,7	73367													0	0		
cauliflower		1,1	9276													0	0		
celery		1,2	10120													0	0		
collards (chinese cabbage)		4,0	33732													0	0		
sweet corn		1,0	8433													0	0		
cucumbers		4,7	39635													0	0		
eggplant & courgette		4,5	37949													0	0		
andivie		1,5	12650													0	0		
garlic		0,2	1687													0	0		
Green beans		0,3	2530													0	0		
Green peas		1,0	8433													0	0		
head lettuce		3,3	27829													0	0		
romaine lettuce		5,4	45538													0	0		
mushrooms		2,1	17709													0	0		
mustard greens			0													0	0		
onions	16,9	9,6	80957													0	0		
pumpkin		2,0	16866													0	0		
radishes		0,4	3373													0	0		
snap beans		0,2	1687													0	0		
spinach		1,0	8433													0	0		
squash		0,2	1687													0	0		
tomatoes	19,4	27,7	233594													0	0		
Other vegetables (incl. garden vegetable		7,5	63248													0	0		
Processed vegetables		***5,9***	***49755***													**0**	**0**		
canned vegetables		1,9	16023													0	0		
frozen, processed & dehydrated		4,0	33732													0	0		

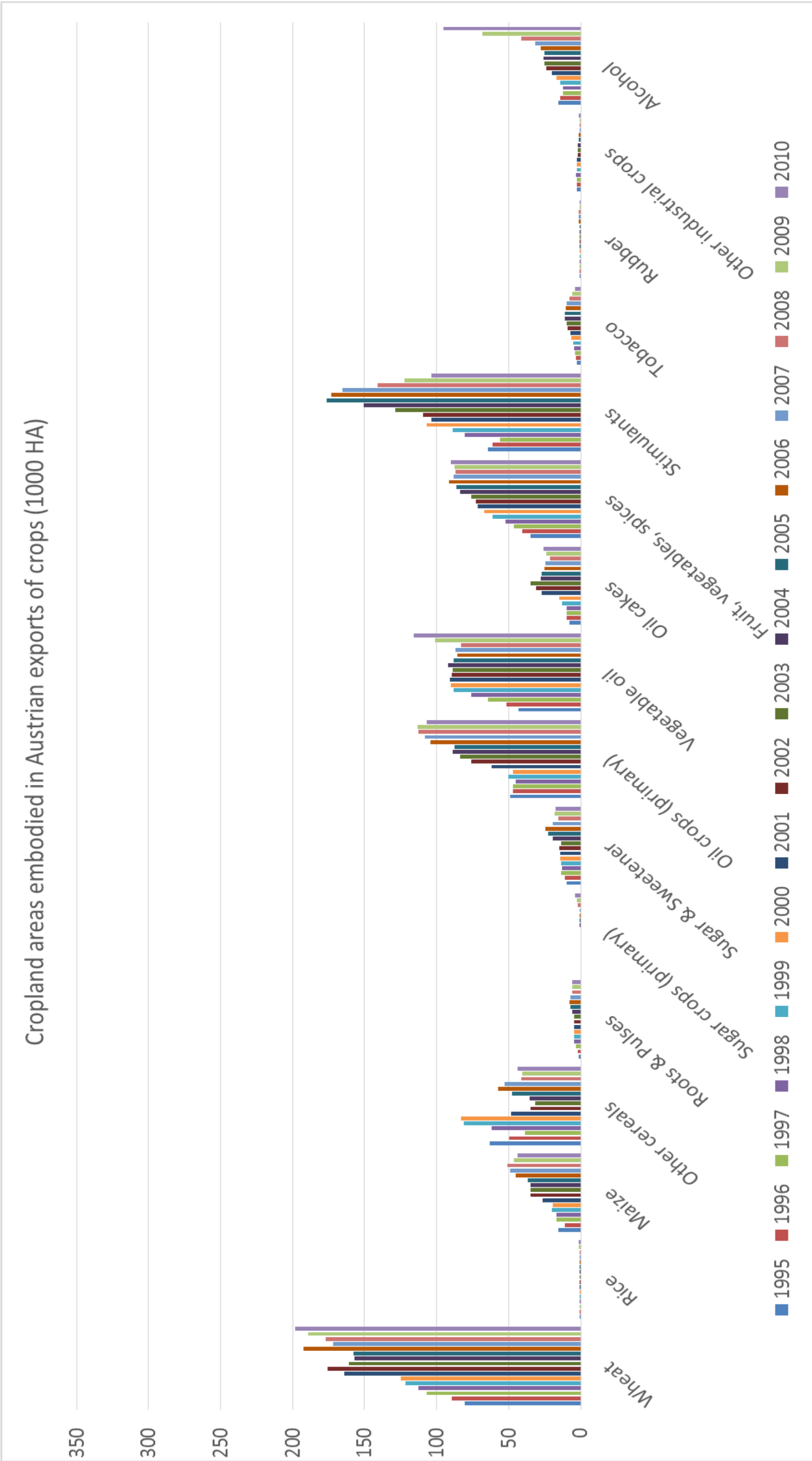
Product	Verbrauchsdaten Brutto Verbrauch (FAO)	Brutto Verbrauch in Kg (Statistik Austria)	Brutto Verbrauch AT (tonnes)	1 (AT) LF/kg product (m2/kg food)	2 (NL)	3 (UK)	4 (France)	5 (Sweden)	6 (NL)	7 (NL)	8a (meta _min)	8b (meta _max)	9 (NL)	10 (DE)	AT (selected from 1 or average 2-10)	Land use (x0,1 ha)	Land use (HA)	*of which cropland*	*of which grassland*
Legumes (Pulses)	**0,9**	**1,0**	**8433**								**3**	**8**		**2,1**	**4,4**	**36824**	**3682**	*3682*	
Beans	0,2	0,3	2530										1		1,0	2530	253		
Peas	0,5	0,5	4217										1		1,0	4217	422		
Other	0,2	0,2	1687													0	0		
Nuts	**8,0**	**5,8**	**48911**											**2,9**	**2,9**	**141843**	**14184**	*14184*	
peanuts	1,0	0,8	6746													0	0		
total tree nuts	7,0	5,0	42165													0	0		
Vegetable oils	**23,5**	**23,5**	**198176**	**8,2**	**20,7**										**8,2**	**1625039**	**162504**	*162504*	
margarine		3,3	27829		21,5											0	0		
salad and cooking oils		7,3	61561													0	0		
other added fats & oils		4,0	33732		10,3											0	0		
Oilcrops	**5,3**	**5,3**	**44695**	**5,7**										**4,1**	**5,7**	**254761**	**25476**	*25476*	
Soya beans	1,7	1,8	15179													0	0		
Rapeseed		0,6	5060													0	0		
Other		2,9	24456		10,3											0	0		
Added sugar and sweetene	**47,7**	**43,4**	**365992**	**1,3**										**1,2**	**0,9**	**320975**	**32098**	*32098*	
Sugar (raw eq.)	41,1	37,2	313708		1,2										1,2	376449	37645		
Sweeteners (incl. kakaomass	5,4	5,0	42165													0	0		
Honey	1,1	1,2	10120													0	0		
Alcoholic beverages		**135,0**	**1138455**	**0,9**											0,9	**972000**	**97200**	*97200*	
Beer		105,0	885465		0,5										0,5	442733	44273		
Wine	30,8	30,0	252990		1,5										1,5	379485	37949		
Spirits			0													149783	14978		
Non alcoholic drinks		**163,2**	**1376266**												**0,0**	**0**	**0**	*0*	
soda		72,0	607176													0	0		
spring water		91,2	769090													0	0		
tap water			0													0	0		
Kaffee, Kakao, Schokolade		**9,5**	**80062**	**12,6**											**12,6**	**1005000**	**100500**	*100500*	
coffee		7,2	60718		15,8										9,8	593272	59327		
tea		0,2	1635		35,2										35,2	57542	5754		
Kakao		2,1	17709												20,0	354186	35419		
Meat products	**116,3**	**106,0**	**893898**												13,1	**11748000**	**1174800**	*662100*	*512700*
Beef (beef cattle and dairy h	17,3	18,0	151794	40,00	20,9	20,4		42,88			7	420			46,0	6977000	697700	*204700*	*493000*
Beef & veal (dairy)						12,2					15	29		25,4	20,4		0		
Pork	86,7	55,7	469718		8,9	5,46	5,4-9,9				8	15	7,5	8,9	7,1	3327151	332715	*332715*	
Lamb	1,1	1,1	9276								20	33		19,9	21,2	197000	19700		*19700*
Poultry	*19,2*	*20,8*	*175406*	*4,2*				*5,5*			*5*	*8*		*6,2*	5,8	1013849	101385	*101385*	
Other meat		1,2	10120		16								10	19,9	0,0	0	0		
Offals		2,2	18553														0		
Fats and other products	11,2	7,0	59031		12,1						4	7	19		3,9	233000	23300	*23300*	
Eggs	**13,7**	**14,2**	**119749**	**4,0**	**3,5**	**7,2**				**5,2**	**4**	**7**	**4**	**3,8**	**4,0**	**479952**	**47995**	*47995*	
Fish & Seafood	**13,3**	**7,5**	**63248**								**2**	**6**		**0,2**	**2,7**	**172877**	**17288**	*17288*	
fresh & frozen fish	10,3		86860													0	0		
fresh & frozen shell fish	2,1		17709													0	0		
canned fish and shellfish	0,5		4217													0	0		
cured fish	0,5		4217													0	0		
Dairy products (in raw milk eq.)		**238,44**	**2010765**	**5,2**	**1,2**	**1,18**		**1,54**	**1,28**						5,2	**10442000**	**1044200**	*419200*	*625000*
Buttermilk													2		2,0	0	0		
Fluid milk		53,4	450322	1,2	0,9								2		1,4	615440	61544		
Yoghurt		25	210825	1,4									2	2,4	2,9	611393	61139		
Cheese		18,9	159384	9,9	10,2						6	17	10	9,9	34,3	5462737	546274		
condensed milk		1,3	10963											5	5,0	54815	5481		
dry milk products		0,5	4217											5	9,6	40338	4034		
cream & sour cream	7,7	7,8	65777	6										5	7,5	494427	49443		
cream cheese		1,1	9276	8,65										9,9	9,3	86038	8604		
butter		5	42165											20,7	20,7	872816	87282		
																	0		
Total		**1047,5**	**8833202**														**3053749**	*1916049*	*1137700*

	Country (ar	YR of publicat	Authors	Title
1	Austria	2.016 €	Fischer et al. (Forthcoming)	
2	Netherlands	2002	P.W. Gerbens-Leenes and S. Nonhebel	Consumption patterns and their effects on land required for
3	UK	2006	Williams, A, Audsley, E and D Sandars	Determining the environmental burdens and resource use in th eproduction of agricultural and horticultural commodities. Defra project report ISO205
4	France	2005	Basset-Mens and an der Werf	Scenario-based environmental assessment of farming systems: the case of pig production in France
5	Sweden	2012	Flysjö, Cederberg, Hendersson, Ledgard	The interaction between milk and beef production and emissions from land use change - critical considerations in LCA and carbon fotprint studies of milk
6	Netherlands	2009	Thomassen, Dolman, van Calker, De Boer	Relating life cycle assessment indicators to gross value added for Dutch dairy farms
7	Netherlands	2006	Mollenhorst, Berentsen, De Boer	On-farm quantification of sustainability indicators: an application to egg production systems
8a	Multiple (m	2012	Nijdam, Rood, Westhoek (meta study_min	The price of protein: Review of land use and carbon footprints from LCAs of animal food products and their substitutes
8b	Multiple (m	2012	id.	id.
9	Netherlands	2013	Temme, van der Voet, Thissen, Verkaik, D	Replacement of meat and dairy by plant-derived foods: estimated effects on land use, iron and SFA intakes in young Dutch adult females
10	Germany	2012	Meier and Christen	Environmental Impacts of Dietary Recommendations and Dietary Styles: Germany As an Example

ANNEX II: Embodied cropland areas in Austrian imports and exports of crops (excluding feed crops)



Source: IIASA LANDFLOW calculations (Fischer et al. 2016)



Source: IIASA LANDFLOW calculations (Fischer et al. 2016)

ANNEX III: Austria's Land Footprint according to country of origin, 2010 (Land flow calculations by G. Fischer and S. Tramberend (IIASA, 2015), own grassland calculations based on FAOSTAT 2015)

Austria's Land Footprint per product according to country of origin in 1,000 HA, 2010

	Austria	Europe	West Asia	Russia	North America	Central America	South America	North Africa	Sub Saharan Africa	South Asia	Southeast Asia	Central & East Asia	Australia & Oceania
Wheat	79,4	50,1	0,3	4	0,8	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,1
Rice	0,0	3,4	0,0	0	0,5	0,0	0,5	0,0	0,0	1,0	3,3	0,0	0,0
Maize	7,8	4,8	0,0	0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Other cereals	24,1	7,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2
Roots & pulses	13,3	2,2	0,2	0,4	0,2	0,0	0,1	0,0	0,2	0,0	0,2	0,3	0,0
Sugar & Sweetener	20,8	8,6	0,1	0	0,0	0,3	1,7	0,0	0,5	0,0	0,1	0,0	0,0
Oil crops (primary)	6,5	5,1	0,7	0,8	1,4	0,2	3,7	0,0	1,1	3,9	1,1	0,8	0,0
Vegetable oil	51,8	87,4	0,3	4,3	1,3	0,0	1,9	1,7	1,8	2,3	10,1	0,2	0,2
Fruit, vegetables, spices	37,5	62,8	24,7	0,2	4,3	2,2	9,0	2,1	4,7	4,1	4,6	4,5	0,4
Stimulants (Cocoa, Coffee, Tea)	0,0	0,0	0,0	0	1,9	9,7	29,5	0,0	34,5	4,7	19,7	0,5	0,0
Alcohol	75,2	20,4	0,1	0,2	0,4	0,0	0,3	0,0	0,2	0,0	0,0	0,0	0,4
Total Land Footprint of Food crops inlcuding Beverages	316,4	251,8	26,4	10,0	10,8	12,4	46,7	3,8	43,0	16,0	39,1	6,5	1,3
Total Land Footprint of Feed crops	634,8	483,8	0,5	0,6	1,9	0,0	5,2	0,4	0,2	0,0	0,6	0,1	1,2
Total Land Footprint of Grassland	871,0	252,3	0,0	0,0	0,3	0,0	9,6	0,0	2,7	0,0	0,0	0,0	1,8
Total Land Footprint in 1,000 HA	**1822,2**	**987,9**	**26,9**	**10,6**	**13,0**	**12,4**	**61,5**	**4,2**	**45,9**	**16,0**	**39,7**	**6,6**	**4,3**
% of total Area	**59,7**	**32,4**	**0,9**	**0,2**	**0,4**	**0,4**	**2,0**	**0,1**	**1,5**	**0,5**	**1,3**	**0,2**	**0,1**

Region & countries																		
Europe	Belgium-Luxembourg	Denmark	Finland	France	Greece	Ireland	Italy	Netherlands	Portugal	Spain	Sweden	United Kingdom	Bulgaria	Cyprus	Estonia			
	Poland	Czech Republic	Slovakia	Slovenia	Romania	Andorra	Belarus	Faeroe Is	Bosnia and Herzegovina	Greenland	Iceland	Liechtenstein	Moldova, Republic of	Macedonia	Norway			
	Croatia	Latvia	Lithuania	Malta	Germany	Isle of Man	San Marino	Switzerland	USSR	Ukraine	Yugoslav SFR	Channel Islands	Hungary	Serbia and Montenegro				
West Asia	Bahrain	Iran, Islamic Rep of	Iraq	Israel	Jordan	Kuwait	Lebanon	Qatar	Saudi Arabia	Oman	United Arab Emirates	Yemen	Palestine O.T.	Türkei				
North America	United States of America	Canada	Mexico															
Central America	Antigua	Bahamas	Barbados	Bermuda	Belize	Cayman Is	Costa Rica	Cuba	Dominica	Dominican Republic	El Salvador	Grenada	Guadeloupe	Guatemala	Haiti			
	Puerto Rico	St Kitts Nev	St Lucia	Saint Vincent/Grenadines	Trinidad and Tobago	Turks Caicos	BR Virgin Is	US Virgin Is	Honduras	Jamaica	Martinique	Montserrat	Netherlands Antilles	Nicaragua	Panama			
South America	Bolivia	Aruba	Chile	Colombia	Ecuador	Falkland Is	French Guiana	Guyana	Paraguay	Peru	Suriname	Uruguay	Venezuela	Brasil	Argentina			
North Africa	Libyan Arab Jamahiriya	Morocco	Syrian Arab Republic	Tunisia	Egypt													
Sub Saharan Africa	Angola	Botswana	Burundi	Cameroon	Cape Verde	Central African Republic	Chad	Comoros	Congo, Republic of	Benin	Equatorial Guinea	Ethiopia PDR	Djibouti	Gabon	Gambia	Tanzania, United Rep of	Sudan	Sierra Leone
	Malawi	Mali	Mauritania	Mauritius	Mozambique	Namibia	Niger	Nigeria	Guinea-Bissau	Eritrea	Zimbabwe	Reunion	Rwanda	St Helena	Sao Tome and Principe	Senegal	Seychelles	Somalia
	Ghana	Guinea	Cote d'Ivoire	Kenya	Lesotho	Liberia	Madagascar	Congo, Dem Republic of	Zambia	Mayotte	S-Africa	Togo	Uganda	Burkina Faso	Ethiopia	Swaziland		
South Asia	Bangladesh	Bhutan	Sri Lanka	Maldives	Nepal	Pakistan	India											
Southeast Asia	Brunei Darussalam	Myanmar	Cambodia	Korea, Republic of	Laos	Malaysia	Papua New Guinea	Philippines	Timor-Leste	Singapore	Taiwan, China Province	Thailand	Viet Nam	Indonesia				
Central & East Asia	Armenia	Afghanistan	Azerbaijan, Republic of	Georgia	Kazakhstan	Kyrgyzstan	Korea, Dem People's Rep	Mongolia	Tajikistan	Turkmenistan	Uzbekistan	Japan	China					
Australia & Oceania	Australia	Amer Samoa	Solomon Islands	Cook Is	Fiji Islands	French Polynesia	Kiribati	Guam	Marshall Is	Microneisa	Nauru	New Caledonia	Vanuatu	New Zealand	Niue	Norfolk Is	N Marianas	Pacific Is
	Palau	Tonga	Tuvalu	Wallis Fut Is	Samoa													