The environmental effects of food consumption for different household categories

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Abstract

This paper investigates food consumption patterns and their environmental impacts in Austria, by focusing on different household categories. For reversing non-sustainable trends in food consumption, it is essential to focus on the consumption by different consumer groups and households, due to differences in socio-economic characteristics and in lifestyle.
Using the Austrian Household Budget Survey 1999/2000, we analyse Austrian household food consumption patterns by focusing on age, income, education, labour force status and family type and on three highly relevant food categories (meat, vegetable and fruit) and calculate their environmental impacts by food category. As indicators for environmental impacts of food consumption, we use greenhouse gas emissions and material input. Due to differences in preferences for specific food categories, we identify factors for influencing the consumption behaviour of those households consuming less sustainably. These factors can be summarised as young age, high income high position and singles.. However this result is only related to preferences and not to quantities consumed. We suggest to address different household categories according to their preferences with “tailor-made” policy measures.

1. Introduction

Unsustainable consumption and production patterns are identified in Agenda 21 as the main causes for global environmental deterioration. Particular attention is paid to the role of households as consumers and the consequences of their choices (UNDSD, 2006). Within the EU-25, approximately one third of total environmental impacts from households can be related to food and drink consumption (Tukker et al., 2006). In fact, the environmental impact of consumed foods and beverages exceeds the impacts of all other investigated consumption domains, even transport (17% of measured impacts) and housing (7% of measured impacts). Moreover, current trends suggest that environmental pressures from food consumption increase (OECD, 2002a; Payer et al., 2000; EEA, 2005).

However, environmental impacts differ considerably across food categories, as verified by several studies. According to Tukker et al. (2006), meat and meat products present the most environmental significant sub-category within food consumption for EU-25, with contributions between 9% and 14% to global warming potential, photochemical oxidation and acidification, and even around 24% to total eutrophication and with high material inputs (biotic, abiotic, water).

Impacts can be differentiated in those occurring along the food chain and those across the food categories. The scale of environmental impacts depends on where and how food is produced, processed, packaged, preserved, distributed, prepared and disposed of. The most significant environmental impacts occur at the beginning of the production chain, in the area of food production (Goodland, 1997; Hofer, 1999; OECD, 2002a), with agricultural production requiring 28% of the food sector's total energy requirement.

Concerning environmental effects across the food categories, meat and meat products are identified as one of the most environmental significant sub-categories, since meat production requires large quantities of natural resources, in particular land, energy and water (Leitzmann, 2003; Gossard and York, 2003; White, 2000; Goodland, 1997; Carlsson-Kanyama and Faist, 2001; OECD, 2001). Within the category of meat, pork and poultry are, from an ecological viewpoint, more sustainable than lamb, beef or veal, which cause the worst damage. The second important group of food products are the aggregate of milk, cheese and all kinds of dairy products, the aggregate of bread and cereal products as well as non alcoholic drinks (Tukker et al., 2006).

The impacts of vegetable and fruit production comprise water pollution caused by pesticides and fertilizer utilisation, agglomeration of organic waste as well as high energy use for greenhouse production and food transport in order to assure year round availability (OECD, 2001). Especially rice, salad and tomatoes turn out to have higher CO_2 emissions than other food groups, due to greenhouse production and long distance transportation (Kramer et al., 1998; Jungbluth, 2000). The smallest environmental impacts emerge from seasonable and fresh vegetable products (especially originating from organic agriculture) with little transport and light packaging (Carlsson-Kanyama, 1998; Jungbluth, 2000; Kramer et al. 1998).

Sustainable[1] food consumption can thus be defined as the preference for meatless or reduced meat diets, organically, regionally and seasonally produced foods, minimally processed, ecologically packed and tastefully prepared foods as well as foods traded fairly (Leitzmann, 2003).

Different socio-economic groups have diverse consumption profiles and lifestyles leading to different environmental impacts. Even within a nation there is wide disparity between consumption patterns (Birch et al., 2004). There are not many studies presenting insights into the relationship between characteristics of consumers, food purchased and environmental impacts (Ferrer-i-Carbonell and van den Bergh, 2004). Such knowledge is however needed for shaping effective (policy) measures favouring sustainable food consumption.

The aim of the present paper is thus to investigate the environmental impacts of household food consumption across socio-economic groups, acknowledging that households' preferences for food differ significantly by household specific characteristics such as age, income, education, family type and labour force status, as discussed briefly in section 2. Building on these results, we discuss the degree of non-sustainability of Austrian food consumption patterns across socio-economic groups, in particular environmental impacts presented by the indicators GHG emissions and material input in Section 3. In Section 4, we suggest policy measures to induce sustainable food consumption patterns based on the results of the environmental analyses according to household categories. The paper is based on work carried out in the research Sufo:trop (www.seri.at/sufotrop) financed by the Austrian Academy of Sciences, running from August 2005 to June 2007.

2. Socio-economic determinants of household food consumption in Austria

In line with the trend of declining household expenditures on nutrition in high income countries (OECD, 2002a), Austrians spend a rather low percentage of their total household budget on foods and beverages (13%). Austrian consumption patterns follow international trends mentioned by OECD (2002a), like the shift to increased consumption of vegetables (with a large share of frozen products), fruits, bottled beverages, cereal products (result of higher consumption of fast food, pizza and pasta), and meat (in particular pork and poultry). A decline can be observed in consumption of potatoes and dairy products, except for

[1]The authors are aware that sustainable food consumption addresses more than environmental impacts in form of CO_2 emissions and material input, which are in particular addressed in this paper.

cheese. Another strong trend is the increasing consumption of easy-to-prepare or pre-prepared meals and the increase of out-of-home consumption.
Using the Austrian Household Budget Survey 1999/2000, we analysed Austrian household food consumption patterns by focusing on five socio-economic characteristics (age, income, education, labour force status and family type) and three highly relevant food categories in more detail: meat, vegetable and fruit. The selection of these food categories is based on the high environmental impacts of meat relative to vegetable and fruit and, on the other hand, the large differences in environmental impacts within these categories (meat varieties, methods of growing, etc.). Apart from expenditures, quantities consumed (in kilogram, litre or units), and socio-economic and demographic characteristics of the households are available in this database. Concerning out-of-home consumption (6% of total household expenditures), the Austrian Household Budget Survey (Statistik Austria, 2004) provides only information on monthly expenditures but not on consumption quantities. Therefore, consumed quantities out-of-home are not considered in our calculations.

In general, the consumption of vegetables, fruits and meat increase with the age of the household head, since expenditures on out-of-home consumption decrease. Vegetable consumption of the oldest age group, for example, is more than twice that of the youngest age group. Within the category of vegetables, a strong tendency towards higher potato consumption with increasing age can be observed: Vegetable consumption of the 60+ age group is dominated by potatoes (51%) while younger age groups (below 30 years) have a higher share of fruiting and flowering vegetables (29%) and root vegetables (17%). One explanation for that trend is the time consuming preparation needed for potatoes, and the preference for foods which can be quickly prepared. Moreover, older consumers adhere more to traditional eating habits, which are characterized by a high relative intake of potatoes due to low price, nice taste and their satiating character. Within meat consumption, pork consumption responds positively to increasing age, and constitutes a share of 26% in the 60+ group. On the other hand, the youngest age group consumes more than 40% of meat in the form of dried, salted and smoked meat, because of an increase in snack consumption and time restrictions for meal preparation. Relative consumption of poultry, beef and veal is rather stable across age groups. Concerning fruit consumption, older age groups have the highest shares for apples and pears, around 50% of their total fruit consumption, whereas younger groups have a higher share of exotic fruit consumption (around 45%). As argued before, apples and pears play a major role in traditional, deep-rooted eating habits and are thus preferred by older households; younger age groups, on the other hand, prefer more diversity in their diets.

Vegetable consumption responds negatively to increases in household income and educational attainment, due to increases in the share of out-of-home consumption. Moreover, the share of potatoes decreases considerably as income grows, while the shares of fruiting, flowering, leaf vegetables and herbs increase with income. These trends can be explained by both the price and time effect: potatoes are inexpensive and satiating, but require longer preparation time in comparison to fruiting, flowering and leaf vegetables, which can be consumed without cooking as snacks and in salads.
Concerning meat consumption, our analysis confirms the results by Gossard and York (2003), who argue that income has no influence on total consumed quantities of meat. High income households consume a higher share of beef, whereas low income households substitute beef with higher amounts of pork. In addition, the category of dried, salted and smoked meat rises significantly from the lowest to the highest income quartile, due to time scarcity by high income households. Regarding fruit consumption, the share of apples decreases from low to middle income groups (from 40% to 35%), and then grows moderately again, to 37% for high income groups. Second, the consumption of exotic fruits (banana and citrus fruits) increases slightly with growing income, which again reflects that food choices of high income groups are determined by time scarcity and taste.
Similar trends can be observed for higher educated households, due to a positive correlation between education and income.

Differences in consumed quantities of food categories by selected labour force status groups (farming households, workers and employees in low, middle or high positions) demonstrate that the group of employees in middle and high positions have the lowest consumption figures for vegetables, fruits and meat. In contrast, high vegetable consumption occurs in farming households, whereas employed households in low and middle position fall in between. Moreover, potato consumption is particularly high within farming households, as well as in those lead by workers and employees in low positions (between 46% and 48%). Other types of employee households substitute potatoes by fruiting, and flowering vegetables (between 23% and 29%) and root vegetables (between 12% and 18%). By focusing on various meat categories, at least two trends can be identified. First, pork consumption shows high relative figures in farming (31%), but has notably less importance in employee households irrespective of position (15% to 26%). Second, the lower consumption of pork by employee households is compensated for by a higher intake of dried, salted or smoked meat (32% to 43%). As before, the consumption of beef, veal and poultry seems to be mostly independent of labour force status. Regarding fruit consumption, farming households are the maximum consumers of both apples and pears, but they attach less importance to exotic fruits, like bananas or citrus fruits (16%). Again, traditional eating habits can be responsible for this preference. In employee households, irrespective of position, relative consumption of exotic fruits nearly exceeds apple consumption, 34% to 38% for apples versus 30% to 36% for exotic fruits.

With respect to differences in consumed quantities of food categories by family type (single households, couples without children, families, single parents with children), we find that family households consume less meat, vegetable and fruit (per capita in equivalence scale) than single or couple households without children.

By focusing the analysis within the categories of vegetables, meat and fruits, it can be stated that the family type has only a weak influence on food preferences.

3. The environmental impact of food consumption by socio-economic group

The previous section showed that younger, higher income and educated households, families and single parents, as well as employees in middle and high positions, show lower consumption quantities of meat, vegetables and fruits, but prefer within these categories food types with higher environmental pressure. We are now interested what this result implies for environmental impacts across these groups. Thus, we calculate the CO_2 equivalent emissions and the “ecological rucksacks” expressed in material inputs (MI) of meat, vegetable and fruit consumption due to preferences across socio-economic groups and compare them to the emissions of an average household.

We will discuss the following socio-economic groups in more detail: household with heads of age 29 and younger with those with age 60 years and older; households in the first income quartile with those in the fourth quartile; households with secondary school attainment with those with university; farm households, employees in low, medium and top positions, and finally single households, couples, family households and single parents with children.

3.1 A methodology for calculating environmental impacts by socio-economic groups

CO_2 equivalents

In assessing the environmental sustainability of household food consumption by different socio-economic groups, we refer to emissions of CO_2 equivalents (CO_2e) generated through production and processing of specific food categories. CO_2 effects were calculated from specific emissions in CO_2 equivalents (units in gram per kg food) per food category (for meat, vegetables and fruits), based on Taylor (2000). Since the consumption database does not distinguish organic production from conventional one, we refer to emission coefficients for conventional production. For meat, LCA estimates were available for beef, pork, dried, salted and smoked meat, and poultry. Due to non-availability of data, other meat categories could not be considered in the analysis. Regarding vegetables, specific emissions are available for potatoes, fruiting and flowering vegetables (as a proxy for fruiting and flowering vegetables we generate a mean emission coefficient from tomatoes, leek, peas and green beans), a selection of root vegetables (mean value is taken for root vegetables), salad and spinach (1/2 each is assumed to contribute to leaf vegetables), selection of brassicas (mean value is taken for brassicas). Concerning tomatoes, we assume that 1/3 is grown on field and 2/3 in glasshouse. For fruit, we have data on apples, oranges (for citrus fruits), cherries, grapes and plums (for stone fruit) and strawberries (for soft fruits). As a proxy, we take the apple coefficient for pears as well. Table 1 summarizes the coefficients used and illustrates the large differences across food categories.

Table 1: CO_2e emissions from meat, vegetable, and fruit consumption (per kg) (adapted from Taylor, 2000)

		CO_2 in kg / kg	**relative to lowest subcategory**
meat	beef	10.69	3.7
	pork	3.12	1.1
	poultry	2.92	1.0
	dried, salted, smoked meat	10.09	3.5
vegetables	leaf vegetables, herbs	0.14	2.5
	brassicas	0.10	1.8
	fruiting, flowering vegetables	0.36	6.5
	root vegetables	0.12	2.2
	potatoes	0.05	1.0
fruit	citrus fruit	0.18	3.2
	banana	0.18	3.2
	apple	0.06	1.0
	pear	0.06	1.0
	stone fruits	0.14	2.5
	soft fruit	0.15	2.6

In order to gain CO_2 equivalent emissions for meat, vegetable and fruit consumption by different socio-economic groups, we multiply these specific emissions by the consumed quantities (in equivalence scale to correct for differences in household size) in the respective food category. Since the total quantities consumed at home differ a lot across households (see Figure 1), we normalize the quantities consumed per food category to the levels of the average household. Thus, we take the total quantity consumed by an average Austrian household and the preference held by the socio-economic group (i.e., the shares per food subcategory). We refer to this effect as "preference effect", because it shows how different tastes and preferences, for a given total consumption quantity of e.g. meat, results in higher or lower emissions. The preference effect thus targets at differences in taste, expressed by demand shares, within the food categories (namely, preferences for specific types of meat or vegetable).

The preference effect is calculated in two steps. First, the deviation in emissions caused by consumption by a specific socio-economic group (*x*) to emissions by the average Austrian household is calculated for food sub-category *i* (meat, fruit, or vegetable) as follows:

$$PE_i^x = \frac{e_i\left(\left(s_i^x \sum_j \bar{q}_j\right) - \bar{q}_i\right)}{\sum_j e_j \bar{q}_j},$$

where e_i is the emission coefficient of food sub-category *i*, s_i^x the share of demand by socio-economic group *x* for food sub-category *i*, and $\sum_i s_i^x = 1$. Furthermore, $\bar{q}_j$ denotes the average quantity consumed of food sub-category *j* (mean of all households).[2] The total preference effect (sum of meat, fruit and vegetable) by socio-economic group is gained by summing over all sub-categories *i.*

Material inputs

Ecological rucksacks and material inputs measure the amount of resources needed for the production of certain goods (Schmidt-Bleek 1997). MI values have been published by the German Wuppertal Institute for Climate, Environment and Energy. As the values express material inputs in kg per kg of food category the amounts of consumed foods have been multiplied with the corresponding MI values. Table 2 gives an overview of the MI values used.

Table 2: MI values for meat, vegetable, and fruit consumption (per kg)

		MI in kg / kg	**relative to lowest subcategory**
meat	beef	17,70	3,9
	pork	5,10	1,1
	poultry	4,58	1,0
	dried, salted, smoked meat	32,76	7,1
vegetables	leaf vegetables, herbs	1,06	2,6
	brassicas	1,06	2,6
	fruiting, flowering vegetables	3,23	7,9

[2] For instance, the preference effect by group *x* for pork is positive if the quantity, demanded after adjusting for total meat consumption (normalized to the level of the average Austrian household such that $\sum_j q_j^x = \sum_j \bar{q}_j$), exceeds the quantity demanded of pork by the average household. As a consequence, the resulting level of emissions would exceed the average level and the preference effect for pork was positive.

	root vegetables	0,41	1,0
	potatoes	1,45	3,6
fruit	citrus fruit	1,82	7,3
	banana	0,54	2,2
	apple	0,25	1,0
	pear	0,25	1,0
	stone fruits	0,89	3,6
	soft fruit	0,57	2,3

Source: Schütz (personal communication), Banana: Giljum (1999) and Schütz (personal communication)

The MI values contain the following material inputs for the production of the food categories:

Meat:

- Biotic raw materials: Indirect flows as biotic materials were derived from German agricultural standard tables as biomass not harvested (straw, leaves, harvest residuals) for feed.
- Abiotic raw materials: These coefficients contain the following abiotic materials in agricultural production of plant feed in Germany 1995: nitrogen fertilizers, phosphate fertilizers, potassic fertilizers, calcium fertilizers, pesticides, fossil fuels, lubricants, and electricity (resp. its equivalent in abiotic material requirements). Further they include energy carrier use in the producing nutrition industries: coal, light fuel oil, medium and heavy fuel oil, gas, and electricity (resp. its equivalent in abiotic material requirements).

Fruits and vegetables:

- Biotic raw materials: Indirect flows as biotic materials were derived from German agricultural standard tables as biomass not harvested (straw, leaves, harvest residuals).
- Abiotic raw materials: These coefficients include the following abiotic materials in agricultural production in Germany 1995: nitrogen fertilizers, phosphate fertilizers, potassic fertilizers, calcium fertilizers, pesticides, fossil fuels, lubricants, and electricity (resp. its equivalent in abiotic material requirements).
- Citrus fruit and banana: These categories also contain MI for transport. This methodological inconsistency has been accepted to recognise the environmental effect through transport for these two categories which are transported over long distances.

3.2 The CO_2 emissions due to the preference effect by age, income and education

Table 3 reports the results for meat, vegetable and fruit consumption across socio-economic groups. A positive effect stands for higher emissions than the average household, and a negative effect for lower ones. The column "Δ row %" gives the change in emissions per food subcategory (i.e. meat, vegetable, fruit) while the column "Δ total %" refers to the change in emissions relative to the aggregate of meat, vegetable and fruit. Since meat consumption causes much higher emissions than fruit or vegetable consumption, the total effect is generally dominated by meat consumption. Note that the socio-economic groups are only mutually distinct within a socio-economic variable (like age, income, etc.) but not across variables.

The general trends are as follows. First, the highest CO_2e effects from meat, vegetable, and fruit consumption in total, as measured by the preference effect, can be observed for top employee households (+11% compared to average household), and for high income households (+6%), while the lowest environmental effects emerge for low income households (-4.4%) farm households and low educated households (-4% each). Moreover, the effects within the subcategories usually point in the same direction as the total effect: for instance, low income households have a negative preference effect for meat, vegetable and fruit separately and in total. Moreover, if the effects for the subcategories point in opposite directions, the sign of the total effect is dominated by the effect of meat consumption. This case is illustrated for people in low and middle positions who have positive effects for fruit or vegetable, respectively, but negative effects for meat and in total. Thus, while these households have preferences which lead to lower emissions than the average preferences, they prefer fruit (or vegetable) types which are less environmental friendly than the average household. For instance, high position people prefer more exotic fruits instead of apples, and middle positions people consume more leaf and fruiting and flowering vegetables instead of potatoes.

Let us now discuss the results in more detail. Starting with the effect of age, older people consume more vegetables and fruits in proportion to meat (Figure 1). Younger ones, on the other hand, have a higher (relative) preference for dried, smoked and salted meat, minced meat, fruiting and flowering vegetables. In addition, older households choose their diet in line with traditional eating habits (potatoes, apples, pork) whereas younger ones compose their diet more diversely (exotic fruits). With respect to the CO_2e effects of food consumption, older age groups are more environmental sustainable than younger ones (2.1% less CO_2e emissions compared to the average household), based on older people's preference for apples, instead of exotic fruits, and potatoes instead of fruiting and flowering vegetables.

Table 3: Change in CO_2e emissions from meat, vegetable, and fruit consumption of selected socio-economic groups relative to average Austrian household

	change in CO_2 emissions relative to average Austrian household (preference effect)			
	Δ row %	Δ total %	Δ row %	Δ total %
age*	< 30 years		> 60 years	
total (Δ%)	+1.9%	+1.9%	-2.1%	-2.1%
meat (Δ%)	+1.2%	+1.1%	-1.7%	-1.6%
vegetable (Δ%)	+14.2%	+0.5%	-8.5%	-0.3%
fruit (Δ%)	+10.6%	+0.3%	-8.2%	-0.2%
income	low (quartile 1)		high (quartile 4)	
total (Δ%)	-4.4%	-4.4%	+6.0%	+6.0%
meat (Δ%)	-4.4%	-4.2%	+6.0%	+5.7%
vegetable (Δ%)	-2.9%	-0.1%	+10.6%	+0.3%
fruit (Δ%)	-3.3%	-0.1%	+0.7%	+0.0%
educational attainment*	low (secondary school)		high (university)	
total (Δ%)	-4.0%	-4.0%	+4.9%	+4.9%
meat (Δ%)	-3.7%	-3.5%	+4.3%	+4.0%
vegetable (Δ%)	-9.6%	-0.3%	+25.6%	+0.8%
fruit (Δ%)	-7.7%	-0.2%	+2.2%	+0.1%

*) of household head

The effect of income on sustainability is as follows. As discussed above, total emissions of high income households increase by 6%, due to a positive preference effect (more beef, more fruiting and flowering vegetables). Low income households contribute to emissions by 4.4% less than the average household, which can be regarded as a strong negative preference effect. While the consumed quantities of vegetables decline from the first to the fourth quartile, preferences for fruiting and flowering vegetables (in particular tomatoes) on account of potatoes cause emissions of CO_2 equivalents to rise. However, this increase of 10.6% in emissions from vegetable consumption translates into an increase of +0.3% in total only. A similar trend can be observed for emissions from fruit and meat consumption.

3.3 The CO_2 emissions due to the preference effect by labour force status and family type

The effect of labour force status can be best understood by investigating four groups which are quite different in their food choices: farm households, workers and employees in low, middle and high positions. From a sustainability perspective, farm households and, to a lesser extent, households of low and middle position workers contribute considerably less to emissions, because of traditional eating habits. On the other hand, workers in high positions contribute far more to emissions from meat, vegetable and fruit consumption, due to a preference for more environmentally harmful meat, fruit and vegetable categories relative to the average Austrian household.

Finally, we investigate the impact of family types on CO_2e emissions. Couples, families and single parents show lower CO_2e emissions than the average household, while single households have emissions above average (total preference effect +2.8%). This is caused in particular by a higher preference for dried, salted and smoked meat as well as for beef. Interestingly, the positive preference effect of meat consumption by single households is not reverted by the negative preference effect from fruit and vegetable consumption, again due to the much higher specific emissions of meat compared to fruit and vegetable. On the other hand, family households and single parents have higher emissions from vegetable and fruit consumption than the average household, but again this effect is dominated by a negative preference effect from meat consumption (which is due to a very low share of beef consumptions).

Table 3 (cont.): Change in CO_2e emissions from meat, vegetable, and fruit consumption of selected socio-economic groups relative to average Austrian household

	change in CO_2 emissions relative to average Austrian household (preference effect)			
	Δ row %	Δ total %	Δ row %	Δ total %
labor force status*	farmers		employees low positions	
total (Δ%)	-4.1%	-4.1%	-1.6%	-1.6%
meat (Δ%)	-3.5%	-3.3%	-1.6%	-1.5%
vegetable (Δ%)	-8.6%	-0.3%	-4.8%	-0.2%
fruit (Δ%)	-20.9%	-0.5%	+0.6%	+0.0%
labor force status	employees middle positions		employees high positions	
total (Δ%)	-1.4%	-1.4%	+10.8%	+10.8%
meat (Δ%)	-1.5%	-1.4%	+10.9%	+10.3%
vegetable (Δ%)	+2.1%	+0.1%	+13.3%	+0.4%
fruit (Δ%)	-0.7%	-0.0%	+4.7%	+0.1%
family type	single		couples	
total (Δ%)	+2.8%	+2.8%	-1.3%	-1.3%
meat (Δ%)	+3.1%	+3.0%	-1.4%	-1.3%
vegetable (Δ%)	-2.3%	-0.1%	+1.1%	+0.0%
fruit (Δ%)	-2.7%	-0.1%	-1.9%	-0.0%
family type	single parents		family	
total (Δ%)	-3.7%	-3.7%	-0.1%	-0.1%
meat (Δ%)	-4.6%	-4.3%	-0.3%	-0.3%
vegetable (Δ%)	+11.9%	+0.4%	+1.5%	+0.1%
fruit (Δ%)	+8.8%	+0.2%	+5.6%	+0.1%

**) of household head*

3.4 The material inputs due to the preference effect by household category

Table 4 summarizes the results of the calculation of the material inputs associated to food consumption for different household categories. A positive effect stands for higher material inputs than the average household, and a negative effect for lower ones. As in table 2, the column "Δ row %" gives the change in inputs per food subcategory (i.e. meat, vegetable, fruit) while the column "Δ total %" refers to the change in inputs relative to the aggregate of meat, vegetable and fruit. Since meat consumption requires much higher material inputs than fruit or vegetable consumption, the total effect is generally dominated by meat consumption.

Table 4: Change in material inputs from meat, vegetable and fruit consumption of selected socio-economic groups relative to an average Austrian household

	change in MI relative to average Austrian household (preference effect)			
	Δ row %	Δ total %	Δ row %	Δ total %
income	**low (quartile 1)**		**high (quartile 4)**	
total (Δ%)	**-4,7%**	**-4,7%**	**+5,3%**	**+5,3%**
meat (Δ%)	-7,0%	-4,3%	+6,7%	+4,1%
vegetable (Δ%)	-0,0%	-0,0%	+3,1%	+0,7%
fruit (Δ%)	-2,4%	-0,3%	+3,2%	+0,5%
education of household head	**low (primary school)**		**high (university)**	
total (Δ%)	**-6,2%**	**-6,2%**	**+5,3%**	**+5,3%**
meat (Δ%)	-6,5%	-4,0%	+4,6%	+2,8%
vegetable (Δ%)	-3,1%	-0,7%	+9,2%	+2,2%
fruit (Δ%)	-10,3%	-1,5%	+2,1%	+0,3%
age of household head	**< 30 years**		**> 60 years**	
total (Δ%)	**+8,2%**	**+8,2%**	**-4,2%**	**-4,2%**
meat (Δ%)	+9,1%	+5,6%	-3,7%	-2,3%
vegetable (Δ%)	+4,8%	+1,1%	-3,3%	-0,8%
fruit (Δ%)	+10,3%	+1,5%	-8,2%	-1,2%
employment of household head	**farmers**		**unskilled workers**	
total (Δ%)	**-7,9%**	**-7,9%**	**-2,2%**	**-2,2%**
meat (Δ%)	-4,9%	-3,0%	-3,3%	-2,1%
vegetable (Δ%)	-5,1%	-1,2%	-0,6%	-0,1%
fruit (Δ%)	-25,4%	-3,7%	-0,2%	-0,0%
employment of household head	**skilled workers**		**top employees**	
total (Δ%)	**-0,6%**	**-0,6%**	**+11,5%**	**+11,5%**
meat (Δ%)	-0,4%	-0,2%	+15,8%	+9,8%
vegetable (Δ%)	-1,0%	-0,2%	+3,8%	+0,9%
fruit (Δ%)	-1,0%	-0,1%	+5,5%	+0,8%
family type	**single**		**couples**	
total (Δ%)	**+2,1%**	**+2,1%**	**-1,3%**	**-1,3%**
meat (Δ%)	+4,3%	+2,7%	-2,4%	-1,5%
vegetable (Δ%)	-1,1%	-0,3%	+0,6%	+0,1%
fruit (Δ%)	-2,2%	-0,3%	+0,2%	+0,0%
family type	**single parents**		**family**	
total (Δ%)	**+2,6%**	**+2,6%**	**+0,8%**	**+0,8%**
meat (Δ%)	-1,5%	-0,9%	+0,7%	+0,4%
vegetable (Δ%)	+7,9%	+1,9%	+0,1%	+0,0%
fruit (Δ%)	+11,7%	+1,7%	+2,3%	+0,3%

Material input for the different socioeconomic groups show the following changes compared to the average household:

- **Income:** Low income households show lower material inputs than the average household, high income household show higher material inputs.
- **Education:** Households with low education cause lower material inputs than the average household; households with high education higher ones.
- **Age:** Younger households show lower material inputs than an average household whereas older households show lower material inputs (with only a small change in MI compared to average).
- **Employment:** Unskilled workers show higher material inputs through their food consumption than an average household, top employees higher ones.
- **Family type:** Single and single parent households show higher material inputs than the average household, couple households a lower one.

3.5 Comparison of CO_2e emissions and material inputs

Environmental effects for CO_2e and MI correspond for most socio-economic groups, thus the effects go into the same direction (increase or decrease compared to an average household). This is the case for the following criteria: Income, education, age, employment, single households.

The different size of the effects in material inputs and CO_2e can be explained by the different ratio of environmental effects of different food categories.

For two socio-economic groups effects in CO_2e and MI show into opposite directions. For **single parent households** and **family households** CO_2e emissions are below but material inputs are above those for average households. This effect is stronger for single parent households for which CO_2e emission decrease by 3.7% but material inputs increase by 2.6%. Again, this effect can be explained by the different relationship between the ratios of CO_2e and MI for different food categories.

Table 5 shows the difference between environmental effects for CO_2 emissions and material inputs.

Table 5: Environmental effects for CO_2 emissions and material inputs in comparison

	preference effect (Δ total %)			
	CO_2	MI	CO_2	MI
income	**low (quartile 1)**		**high (quartile 4)**	
total (Δ%)	**-4,4%**	**-4,7%**	**+6,0%**	**+5,3%**
meat (Δ%)	-4,2%	-4,3%	+5,7%	+4,1%
vegetable (Δ%)	-0,1%	-0,0%	+0,3%	+0,7%
fruit (Δ%)	-0,1%	-0,3%	+0,0%	+0,5%
education of household head	**low (primary school)**		**high (university)**	
total (Δ%)	**-4,0%**	**-6,2%**	**+4,9%**	**+5,3%**
meat (Δ%)	-3,5%	-4,0%	+4,0%	+2,8%
vegetable (Δ%)	-0,3%	-0,7%	+0,8%	+2,2%
fruit (Δ%)	-0,2%	-1,5%	+0,0%	+0,3%
age of household head	**< 30 years**		**> 60 years**	
total (Δ%)	**+1,9%**	**+8,2%**	**-2,1%**	**-4,2%**
meat (Δ%)	+1,1%	+5,6%	-1,6%	-2,3%
vegetable (Δ%)	+0,5%	+1,1%	-0,3%	-0,8%
fruit (Δ%)	+0,3%	+1,5%	-0,2%	-1,2%
employment of household head	**farmers**		**unskilled workers**	
total (Δ%)	**-4,1%**	**-7,9%**	**-1,6%**	**-2,2%**
meat (Δ%)	-3,3%	-3,0%	-1,5%	-2,1%
vegetable (Δ%)	-0,3%	-1,2%	-0,2%	-0,1%
fruit (Δ%)	-0,5%	-3,7%	+0,0%	-0,0%
employment of household head	**skilled workers**		**top employees**	
total (Δ%)	**-1,4%**	**-0,6%**	**+10,8%**	**+11,5%**
meat (Δ%)	-1,4%	-0,2%	+10,3%	+9,8%
vegetable (Δ%)	+0,1%	-0,2%	+0,4%	+0,9%
fruit (Δ%)	-0,0%	-0,1%	+0,1%	+0,8%
family type	**single**		**couples**	
total (Δ%)	**+2,8%**	**+2,1%**	**-1,3%**	**-1,3%**
meat (Δ%)	+3,0%	+2,7%	-1,3%	-1,5%
vegetable (Δ%)	-0,1%	-0,3%	+0,0%	+0,1%
fruit (Δ%)	-0,1%	-0,3%	-0,0%	+0,0%
family type	**single parents**		**family**	
total (Δ%)	**-3,7%**	**+2,6%**	**-0,1%**	**+0,8%**
meat (Δ%)	-4,3%	-0,9%	-0,3%	+0,4%
vegetable (Δ%)	+0,4%	+1,9%	+0,1%	+0,0%
fruit (Δ%)	+0,2%	+1,7%	+0,1%	+0,3%

3.6 Discussion

Our results confirm the result by White (2000) that the ecological footprint triggered by meat consumption is higher than by vegetarian consumption. According to Carlsson-Kanyama (1998), however, if the vegetarian diet consists of a high share of exotic foods, it can be more environmental harmful than a meat based one. We find that this latter effect is not able to reverse the sign of the preference effect in CO_2 emissions and material inputs from meat consumption: single parents, couples and families have a positive preference effect for vegetables, a negative one for meat, and a negative total effect (in the case of material inputs the signs are all positive for families).

Across household groups, the deviations in CO_2e emissions and material inputs as measured by the preference effect can be explained by the relative emission intensity of meat as opposed to vegetable and fruit (see Table 1 and 2) and the preferences within these categories. While a stronger preference for imported and glass house grown vegetables increases the environmental effects (see, e.g., the positive preference effect for vegetables by high income households) these can be compensated by lower environmental effects from meat consumption, as the opposing signs for family households, couples and single parents illustrate, who have a high preference for poultry (and a lower one for beef). Thus, preferences make a difference, even if overall consumption quantities are normalized to average household levels.

A natural next step would be to look into absolute differences in consumption levels as well. If highly educated levels show the lowest consumption levels of meat (as indicated by Figure 1), but within meat they prefer less sustainable categories – what is the overall effect of both preference and absolute consumption quantities on CO_2 emissions and material inputs? Unfortunately, we cannot answer this question directly, since total quantities consumed are highly dependent on the level of out-of-home consumption and Household Budget Surveys do not provide consumption quantity data for out-of-home consumption. If we had this kind of data to adjust total consumption quantities, we were able to distinguish a preference effect and a quantity effect when decomposing the differences in food consumption across socio-economic groups.

Thus, as a first indication we can look into the relative shares of different food categories (meat, vegetable, and fruit) by socio-economic groups. To start from, Figure 1 summarizes the total quantities consumed for selected socio-economic groups. In order to be able to analyse these differences, Table 6 shows the vegetable to meat ratio and fruit to meat ratio, which indicate the amount of consumed vegetables and fruits (in kilograms) in proportion to one kilogram of meat.

Figure 1: Consumption quantities for selected socio-economic groups (equivalence scale)

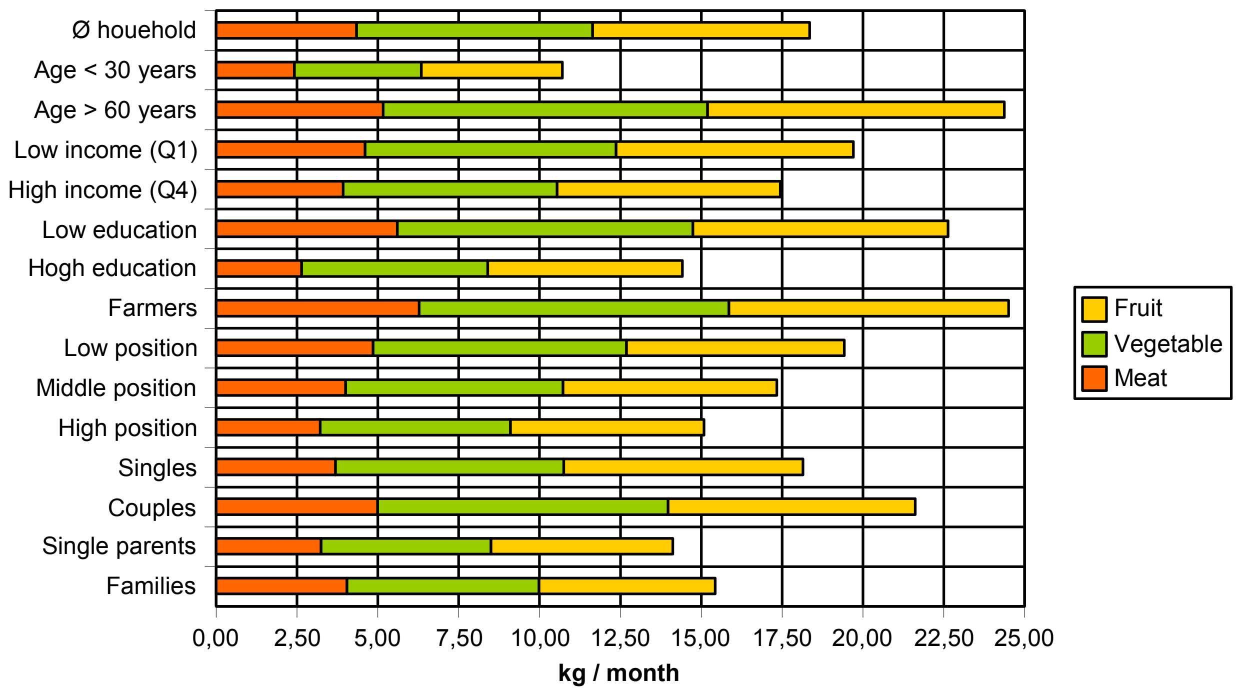

Table 6: Mean ratios between vegetable, fruit and meat consumption by socio-economic groups (STAT, 2004; own calculation)

	vegetable to meat ratio	fruit to meat ratio	vegetable to meat ratio	fruit to meat ratio
income	low (quartile 1)		high (quartile 4)	
	1.48	1.46	1.48	1.62
education*	low (primary school)		high (university)	
	1.46	1.31	1.92	2.10
age*	< 30 years		> 60 years	
	1.40	1.63	1.72	1.62
labour force status*	farmers		employees low position	
	1.40	1.30	1.44	1.29
labour force status*	employees middle position		employees high position	
	1.46	1.50	1.63	1.74
family type	single		couples	
	1.68	1.82	1.61	1.43
family type	single parents		family with children	
	1.40	1.64	1.29	1.26

*) of household head

In fact, the vegetable to meat and fruit to meat ratio of the oldest age group is higher compared with middle or younger aged households. In other words, the age group of those 60 and older proportionately consumes more vegetables and fruits per kg of meat and thus consumes more sustainable than the young households.

With rising income, the vegetable to meat ratio and fruit to meat ratio do not change significantly. On the other hand, with higher educational levels we find the vegetable to meat and fruit to meat ratios increase. On the basis of the Duncan test about mean equivalence, the group means of the vegetable-to-meat ratios differ significantly (error statistic $p < 0.05$) across educational groups, and the same applies to the fruit to meat ratio. These results clearly meliorate the assessment of the previous section where the preference effect was strongly negative for high income and highly educated households.

Regarding labour force status, no general trends can be observed, except that the vegetable to meat ratio as well as the fruit to meat ratio is highest for employees in high positions. Across family types, single households have higher shares of vegetable and fruit consumption as opposed to family households and single parents with children.

Thus, we have to modify the previous section's conclusions for those households who have a strongly positive preference effect (high income, employees in high positions, singles etc.). While they consume less sustainable types of particularly meat, they have higher shares of vegetables and fruits relative to meat. In other words, their overall combination of meat, fruit and vegetables is more sustainable than on average, making their classification as unsustainable consumer groups more ambiguous. The only exception to this observation is the group of young households who has both a positive preference effect and low fruit to meat and vegetable to meat ratios.

4. Concluding policy suggestions

In order to support the environmental sustainability of food consumption, it is necessary to change the current unsustainable food consumption patterns. There are plenty reports and articles talking about different policy options (OECD, 2001; OECD, 2002a, 2002b; Payer et al., 2000) fostering sustainable consumption in general and for food and beverages in particular. We can divide such options in those addressing all consumers (general trends) and those differentiating between them according to their consumption patterns.

In this paper we analysed the determinants of socio-economic characteristics for food consumption behaviour. Concerning environmental effects, high income households, highly educated and those in high positions have the highest CO_2 emissions according to their preferences; high income, young households and those in high positions have the highest material inputs. If their share of vegetables and fruits relative to meat is taken into account, their negative status is decreased, except for the young households. Their environmental effects are nevertheless among the high ones. This result is supported by the preferences of those households for easy-to-prepare-food. Concerning age, young people are less environmentally friendly than older ones; higher educated and top position households eat less meat, but prefer GHG intense categories of meat and of fruits and vegetables. On the other hand, the consumption of organic food is higher the older, better educated and wealthier people are (Hinteregger, 2006). Thus policies, in particular aiming at influencing the behaviour of younger, wealthy people and those in high positions could be a very efficient way of changing the trend. It is however important to address exactly the reason for their environmental impact, for instance preference for fruiting and flowering vegetables or for meat. A study with empirical findings in the Netherlands (Ferrer-i-Carbonell and van den Bergh, 2004) confirm these results (unsustainable consumption is in general positively related to income, education and high-status jobs, as well as to age which is not in line with our findings). We have to be aware that the share of wealthy, well educated and high position households is below 20% and the share of younger households is only 10%; thus measures directed at those groups address high environmental impacts but can only reach a small percentage of the Austrian population. The big group of low and middle position households have – as we have shown – lower environmental impacts, but the sum of their impacts is high due to high number of households in those groups. Therefore it is wise to address those groups as well and encourage them to keep their traditional eating habits AND to consume more organic food (via information campaigns, subsidies, CO_2 taxes etc.) and less meat.

If consumption patterns are to change, the behavioural decisions of consumers, but also producers or retailers have to be changed. Therefore individuals need to have adequate knowledge, a positive attitude to change (willingness) and access to sufficiently attractive alternatives (ability) (OECD, 2002b). Various types of policy instruments can influence those three factors, coarsely grouped into regulatory, economic and social instruments. According to the policy aim and the addressed group of people, different instruments are appropriate. In general a set of instruments including instruments from different groups is most efficient. Economic instruments usually address consumers, regulatory address producers and social address both groups. Examples for economic instruments are charges or taxes (CO_2 tax, material input tax) and subsidies. Social instruments mainly focus on the knowledge and willingness of people through better education, information campaigns, and labelling, or voluntary agreements by producers for actions beyond legal requirements (an Austrian example are different organic food labels belonging to supermarkets). Those social instruments are in particular suitable to address different classes of households and influence their lifestyles. All instruments are influencing individual choices (OECD, 2002b), which are determined by preferences, which again are determined by various factors such as biological needs and social factors (habits, culture, tradition, socio-economic characteristics). Thus, in order to change behavioural decisions it makes sense to influence preferences and if factors behind those preferences are taken into account, the success of policies can be increased. However, one has to be aware that those changes are of a mid-term to long-term character and cannot happen from one day to the other.

Having said that it makes sense to influence the consumption behaviour in general and those of households, consuming less sustainably, the following instruments are appropriate. Public education via campaigns which promote a more environmentally sustainable diet and inform consumers about the environmental impacts of their food consumption patterns could be one effective measure. These campaigns should specifically focus on young people, for example by involving them in different campaigns, as well as on high income households and people in top positions via media those households use (certain newspapers, internet, TV programmes etc.). Information in combination with labelling addresses all household types; however, the form of information can vary depending on who should be addressed (different media, in form of exhibitions, school programs, and internet). One label currently in the development phase in Austria is the FUTURO indicating a sustainability value in form of a prize (Jakubowizc et al., 2004).

Furthermore, consumer behaviour is strongly driven by convenience, time constraints and taste. This is reflected by the CO_2 emissions and material inputs according to labour force status and family type. Employees in high positions usually have higher time constraints, their preference for environmentally harmful food is higher than for farmers or workers/employees in low and middle positions. Single parents have preferences for food with higher CO_2 emissions and material inputs than families or couples, due to time constraints; in the case of CO_2 emissions, they remain however below the average household, whereas singles have higher emissions than the average household due to other time management or preferences for quick-to-prepare food (cooking for oneself is not so “nice”). Therefore, it is desirable to increase the supply of sustainable products fulfilling those criteria, both for in-home and out-of-home consumption (organic convenience food). Here the behaviour of producers and retailers has to be addressed by regulatory instruments (bans), economic instruments (subsidies, taxes) or social instruments (voluntary agreements). With respect to out-of-home consumption, a more sustainable food supply by canteens of public institutions (ministries, schools, universities) could set a good example in achieving sustainability.

Thus, in order to change the currently unsustainable trend in food consumption a lot of policy instruments are available to choose from. Best is a set of instruments, economic, social and regulatory ones, aiming at all consumers on the one hand and on households with socio-economic characteristics determining higher negative sustainability impacts on the other hand.

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