CORVINUS UNIVERSITY OF BUDAPEST

TOWARDS SUSTAINABLE FOOD CONSUMPTION?

The Ecological Footprint of Food Consumption in Hungary

PH.D. THESIS

Zsófia Vetőné Mózner

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Introduction

Western lifestyles and patterns of consumption have been heavily criticised as being materialistic, permissive and based on the use of non-renewable resources; furthermore, their environmental impacts are considerable and significant (Wackernagel and Rees, 1996; Vitousek et al., 1997a; Chambers et al., 2000; Takács-Sánta, 2004; Jackson, 2006). Continuous growth of the global economy is not possible in a world with resource-constraints (Daly and Cobb, 1989).

According to traditional economic theory, consumption contributes to growth in well-being. However, the opposite effect is being experienced nowadays. Economic growth does not increase well-being and happiness (at least more recently) but it does increase social inequality. According to the empirical findings of Easterlin who used an international comparison, levels of happiness do not change to a great extent within different countries when GDP per capita changes (Easterlin, 1974). To a certain level, material accumulation can increase well-being and happiness, but developed countries have gone past this level (Argyle, 1987; Max-Neef, 1992; Durning, 1992) and while the environmental impact of consumption grows, the happiness and well-being of humans is not increasing accordingly.

Jackson (2006) states that reducing the growth of total consumption would require little sacrifice. Kerekes (2011) points to the fact that economic growth does not necessarily lead to happiness in our present economic circumstances; both alternative ways of thinking and cooperating are needed.

According to Stern (1997), consumption is not only a social or economic activity; it is a transaction between humans and the environment. The motivation behind acts of consumption may be economic and social, but its impacts are biophysical. This fact has to be taken into account in the case of food consumption as well. In my dissertation I analyse the environmental impact of the food consumption of Hungarians.

Food consumption is a special area of consumption: it is important for both the individual and the economy; it provides nutrients for individuals and its economic role is significant (Tansey and Worsley, 1995). As food consumption fulfils our daily biophysical needs, it cannot be dematerialised and substituted for using other products. Food consumption patterns reflect lifestyle choices and values as well (Lehota, 2004; Schlösler et al, 2012). A variety of impacts and a web of connections are associated with food production and consumption and the issue of technological development cannot be treated separately either.

According to Buday-Sántha (2002), an increasing scarcity of food will be a critical issue as the world's population rises. The use of non-renewable natural resources is increasing steadily and non-sustainable land use may present a problem. By 2050, demand for food could grow by 70% (in order to feed 2.3 billion more people) and agricultural production could reach its ecological carrying capacity (Pimentel and Giampetro, 1994; Kendall and Pimentel, 1994; Matson et al., 1997; Bouma et al., 1998; Harris and Kennedy, 1999; Tilman, 1999; Bennett, 2000; Gilland, 2002; Tilman et al., 2002; Keyzer et al., 2005; Lambin and Meyfroidt, 2011).

There is a great difference between food consumption patterns in developed and developing countries. People in developing countries are challenged by their insufficient calorie intake and malnutrition, while developed countries are faced with the negative health and environmental impacts of obesity and other illnesses because of the excessive intake of calories and a sedentary lifestyle (Gerbens-Leenes et al., 2010).

According to Gerbens-Leenes et al. (2010), we are in a transitional phase of food consumption. This transition is relevant to developed and developing countries but in different ways. In developing countries the growing income per capita is generating growing demand for food, meat and protein. In developed countries with a stable level of protein intake, growth in consumption of carbohydrates and fats can be observed (and furthermore, high levels of food and calorie consumption per capita). Sustaining a European lifestyle creates a demand for land-based resources in other continents where agriculture is mainly based on the use of fossil resources (Palmer, 1998).

Food consumption is said to have one of the highest environmental impacts of all areas of consumption (Lorek and Spangenberg, 2001a; Tukker et al., 2006; Jackson and Papathanasopoulou, 2008; Druckman and Jackson, 2010; Thøgersen, 2005; Tukker et al., 2011). The environmental impacts of food consumption primarily concern land use, as producing food requires the use of one of the most important natural resources; energy, and results in greenhouse gas emissions (Lorek and Spangenberg, 2001a).

Goodland (1997) argues in his study that diet has a significant role in the sustainability of food production; he highlights the environmental impacts of meat consumption and calls for its consumption in moderation. It is well-known that the resource demand for producing animal-based food products is higher, which is why growing demand for meat may prove problematic (Durning and Brough, 1991; Ehrlich, Ehrlich and Daily, 1995; Goodland, 1997; Pimentel et al., 1999; Subak, 1999; York and Gossard, 2004). There are great differences in the regional distribution of food consumption. It is primarily the role of developed countries to change the structure of food consumption and diets (Gerbens-Leenes et al., 2010). In order to reduce the environmental impacts of food consumption the structure of food consumption within households should be altered (Carlsson-Kanyama, 1998; Schor, 2005a; Stehfest et al., 2009; Garnett, 2011; Schlösler et al, 2012).

The main topic of the dissertation is to quantify and analyse the ecological footprint of food consumption in Hungary. The research question requires to examine: which food categories are predominant in Hungarian food consumption; which food categories have large environmental impact and ecological footprint. There has not yet been a representative survey undertaken in Hungary which was designed to measure the ecological footprint of food consumption patterns. In my research I analyse which socio-demographic variables influence food consumption, the consumption of which food category should be changed to moderate environmental impacts. In the dissertation I analyse the consumption of food and its ecological footprint according to education and income level. It is especially interesting and essential to analyse the relationship of income level to ecological footprint.

Previous academic studies did not differentiate by occupational activity and social segments in their examination of food consumption and its environmental impacts. In my research I carry out an analysis to examine the food consumption structure an ecological footprint using the variables of gender, age and type of occupation.

One of the aims of this research was to identify and categorise consumers into groups according to the structure of their food consumption. Knowing the characteristics of these groups would help to focus the communication activities of environmental policy which is designed to decrease the environmental impact of consumption.

Food consumption not only has environmental impacts but the quantity and structure of food consumption directly determines the health of individuals. I believe that it is important to take into account health aspects as well when analysing the environmental impacts of food consumption. Healthy and low-impact diets show many similarities with each other (Gussow and Clancy, 1986; Wallén et al., 2004; Duchin, 2005; Stehfest et al., 2009; Macdiarmid et al., 2011).

One of the research question of my dissertation was this: is it possible to move towards a healthier personal consumption structure while reducing environmental impact? Do these two goals (improving environment and health) supplement each other? What would be the environmental impacts of healthier diets? I carry out a scenario analysis in order to exmine to what extent could the ecological footprint of food consumption be decreased, taking into account nutritional recommendations.

In my research I highlight the significance of proving that a food consumption pattern which is favourable both from environmental and health perspective is realizable and that such a finding could have remarkable consequences for public policy as well. This double dividend can be realized: it offers a great opportunity for instigating a harmonised and integrated environmental and health policy in the future. In my dissertation I give an overview of the ecological footprint of food consumption primarily in a descriptive way by analysing this topic from a number of perspectives.

I focus on the ecological footprint of food consumption of Hungarian consumers in my research but there are some other topics which can be connected to my research area although they are not directly a subject of my analysis. In the following section I summarise the frames of my research topic.

When analysing the ecological footprint of food consumption the issues of population growth and the size of the population arise. Not only is ecological footprint *per capita* important when considering total environmental impact, but also the *size* of the population which causes the ecological footprint with its consumption. The size of the ecological footprint per capita is a problem primarily for developed countries, while developing countries have low ecological footprints per capital but rapidly growing populations. In my research I analyse the ecological footprints of Hungarian consumers and the issue of population is not within the scope of the thesis (in Hungary it is not a growing but a decreasing population that may cause a demographic problem in the future; analysis of this factor is outside the goals of the dissertation).

I present definitions of sustainable food consumption in a broad sense in Chapter 2.2. with some definitions certain elements or perspectives arise which are not directly connected to the topic of the empirical research (such as the topics of animal welfare and the social and cultural characteristics of sustainable food consumption). These topics are not dealt with within my empirical research; however they appear in the definitions in order that there is a complete overview of them.

I carry out my analysis on sustainable food consumption with an environmental and health perspective. From the definitions presented in Chapter 2.2., I identify, using the definition of Duchin (2004): that, during the empirical research, according to which sustainable diet should have low environmental impact and it should contribute to preserving human health. Furthermore I agree with Wallén et al. (2004), according to them: a diet with low environmental impact but not adequate from nutritional aspect, cannot be regarded as sustainable

Opinions vary according to nutritional and health recommendations about what can be considered healthy. In the case of this present research I started with and based my analysis on the recommendations of the Hungarian National Institute for Food and Nutrition Science (OÉTI) which are in accordance with international guidelines for consumers of developed countries who live in a temperate climate zone. I do not analyse the recommendations which are presented by alternative dietary schools or those that are connected to special diets. Different topics which are broadly connected to my research topic (such as sustainability limits, food security and food prices) are not directly subjects of my analysis.

Further limitations and comments on the empirical research can be found in Chapter VI (after the presentation of the ecological footprint calculations); furthermore, I take into account the limitations of the research when I evaluate results and draw conclusions.

The dissertation emphasises the importance of taking a consumption-based approach. The structure of the dissertation follows the structure of the research process.

The Introduction gives an overview of the topic and significance of the research and the research questions and aims can be found presented there as well.

In the first chapter of the dissertation I present the history of the consumption-based approach and definitions of sustainable consumption. The research topic of the dissertation is an examination of the ecological footprint of food consumption; the dissertation employs a consumption-based approach regarding both the chosen topic and the methodology applied. Because of this I found it necessary to present an overview of the development of consumption-oriented research and an analysis of the definition of sustainable consumption. The responsibility of consumers and households has not always been a topic of research; it has grown into a determining issue and a continuously developing area of research. Using a consumption-based approach for research can provide useful answers to such questions which would not be revealed and solved by using a production-oriented research approach.

In Chapter II I summarise the environmental impacts of food consumption and I overview the key natural resources which are connected to consumption of food. In this chapter I present a literature review of the definitions of sustainable food consumption. There are many differing approaches in the scientific literature to this. I collect and synthesize them while also analysing the definitions.

In Chapter III methodological approaches are presented which can be found in the scientific literature to quantify and analyse the environmental impacts of food consumption. The methodologies are evaluated according to how appropriate they are for meeting the research aims. In my research I use the ecological footprint methodological approach and indicator to examine the environmental impacts of food consumption. Accordingly, it is necessary to present the methodology and the literature behind this consumption-based indicator in a more detailed way. The development of the ecological footprinting methodology, the calculation process and the strengths and weaknesses of this indicator are reviewed in the same chapter.

In Chapter IV I give an overview of research which has examined the environmental impact of food consumption (studies are categorised according to the methodological approaches presented in Chapter III). In this chapter I review the development of research which has taken into account both environmental and health perspectives. The aim of the literature review is to systematize those national and international pieces of research which have analysed the environmental impact and sustainability of food consumption, especially those that have taken into account both environmental and health perspectives. To become familiar with the findings of this research was essential before the hypotheses were determined and the empirical research commenced. Also in this chapter I introduce the European and Hungarian structure of food consumption and trends based on economic statistical data, which can serve as useful background data to the analysis of the research questions of the dissertation.

In Chapter V I present the research hypotheses, the methodological approach of the research and the databases I have used.

Chapter VI of the dissertation presents my empirical results, where sections are structured according to hypotheses. The Summary section summarises and evaluates the main conclusions and lessons of the research, and I set out suggestions for future research based on the experiences gained during my empirical research efforts.

I. Development, definition and types of sustainable consumption

The aim of this chapter is to present an overview of the scientific literature on consumption-based environmental research and sustainable consumption.

1.1. Development of the scientific literature on sustainable consumption

Early critics of consumption from industrial societies appeared around the middle of the 19th century and included Henry Thoreau (1854), William Morris (1891) and Thornstein Veblen (Jackson, 2006). Veblen (1899) presented a sociological analysis of the consumer class of his time in his book ‘The Theory of the Leisure Class’.

In the 20th Century, Carson’s book, ‘Silent spring’ (1962) called attention to environmental questions for the first time and highlighted the issue of environmental pollution. The environmental problems arising from pollution and resource use have been analysed for a long time from the production side in scientific research and in political measures as well and people have tried to moderate environmental impacts using a production-based and technological perspective. Approaches such as cleaner production (CP) and industrial ecology have become popular since the beginning of the 1960s as a result of a focus on production-oriented solutions and treatment. Cleaner production is a preventive, integrated and continuously developing strategy that ‘demands that all phases of the life cycle of a product or a process should be addressed with the objective of prevention or minimization of short and long-term risks to humans and to the environment’ (Baas et al., 1990, p.19).

According to the principles of cleaner production, ecological efficiency and economic growth *are* reconcilable and cleaner production promotes the meeting of these two goals at the same time. The main idea of industrial ecology is to modell industrial systems based on the principles of natural ecosystems (O'Rourke, 1996, p.89.). It compares the interconnected nature of industrial production to natural ecosystems regarding material and energy flows. It has a focus on changing production processes.

In this era a focus on how to more efficiently use resources has started to appear in the production practices of companies. Waste treatment has developed as well and a secondary market for eco-products has appeared. Redesigning products, processes and materials, waste treatment and the implementation of industrial ecology have resulted in pure environmental gains (Graedel and Allenby 1995; Jackson 1996; Geyer and Jackson 2004; Guide and van Wassenhove 2004). These production-based changes, however, have not proven to be enough; in absolute terms the environmental impacts of consumption has not decreased significantly and the total environmental load has increased, despite the development of resource-efficient production processes (Veenhoven, 2004).

Questioning economic growth and witnessing the growing environmental costs of resource use have made it obvious that these production-oriented changes are in themselves not enough to mitigate environmental load (Røpke, 2005). Dealing with the question of consumption and lifestyles was not formerly on the agenda; only a few studies on this topic appeared during this period (Røpke, 2004a).

At the beginning of the 1970s a great step forward was made in that the study of biology and physics started to deal with environmental problems, and that the topic of economic growth and environmental load started being analysed from the perspective of thermodynamics (Georgescu-Rogen, 1971). In the 1970s, research on consumption that analysed consumption demands, symbolic consumption and the consumption of individual and collective goods started appearing. The environmental impacts of consumption were not in the lime-light. In the meantime, critics started questioning the environmental impacts of consumption after examining the paradigm of economic growth and increasing consumption, and after this through examining growing environmental costs and externalities (Daly, 1968; Ayres and Kneese, 1969).

The Limits to Growth, published by the Club of Rome (Meadows et al., 1972), appeared at this time and presented future scenarios about the environmental impacts of consumption patterns. The Meadows model assumed there would be exponential growth in population and industrial capital and therefore the demand for non-renewable resources and pollution would increase. As the supply of global food and non-renewable resources are finite, exponential growth in a finite system would lead to collapse.

Hirsch (1976, cited by Røpke, 2005) was among the first to analyse, as an economist, the social and environmental costs of consumption and point out the limits of consumption which causes environmental externalities and defensive expenditures.

In the 1970s only a few isolated studies appeared. The main topic of research which appeared at the time of the energy crisis was not surprisingly an analysis of energy use and energy-saving behaviour (Mazur and Rosa, 1974; Norgard and Christensen, 1982, cited by Røpke, 2005).

In the 1980s new research appeared, but little research on consumption behaviour (Douglas-Isherwood, 1978; Bourdieu, 1979; Miller, 1987; Campbell, 1987) presented an analysis of the environmental impacts caused by consumption patterns (Joerges, 1982; Uusitalo 1983, cites Røpke, 2005).

After the gradually emerging criticism of the 1970s and 1980s, the report ‘Our Common Future’ published by the Brundtland Committee made a great leap forward in how the growth paradigm and the finite nature of resource use was viewed. This report was the turning point that kicked off the change away from the production-oriented approach to environmental problems. The concept of sustainable development was defined in the report ‘Our Common Future’ and raised attention to the need for global responsibility for environmental issues. The report made economic growth and environmental protection supplementary to each other (WCED, 1987), and made the connection between economic growth and its environmental consequences. No agreement was reached about the relationship of economic growth, well-being and sustainable development (Ekins, 1993). The consumption-based approach started to spread significantly after the Brundtland report was published and appeared in scientific journals and in public policy as well. More and more research was published about economic growth and the limits of consumption (Tinbergen and Hueting, 1991; Meadows et al., 1992). Durning (1992) in his book ‘How much is enough?’ presented criticisms of consumption.

Scientific and public policy results were thus developing in parallel in the 1990s; development in one of these areas helped the other. In 1992 the Agenda 21 action plan was created at the United Nations Conference on Environment and Development in Rio which defined principles which should be behind political measures for sustainable development. One of the messages of the conference was that developed countries should take responsibility, and according take a lead in addressing environmental concerns (Redclift, 1996 cited by Røpke, 2005). Sustainable consumption was defined first in Agenda 21, but consumption and production are mentioned together and the need for technological change is emphasized. The need for lifestyle changes appeared only in later documents.

In the second half of the nineties the issue of consumption and environment became central to environmental policy which helped the development of scientific research as well. [1]

Daly (1991) dealt with basic consumption-related questions in his book 'Steady-state economics'. He examined whether consumption in itself is a goal or a means, and what the relationship between welfare and material and energy consumption is. Daly (1991) presented a solution to the growth paradigm with his steady state economic theory that takes into account ecological and social aspects at the same time. According to Daly, a steady state economy is "an economy with constant stocks of people and artefacts, maintained at some desired, sufficient levels by low rates of maintenance 'throughput' (Daly, 1977, p.17.). Max-Neef (1992) examined the topic of needs and wants and pointed out that satisfying needs is done differently within different cultures, income groups and genders and can change over time as well. Schor (1991) studied the dynamics of consumption and called attention to the work-and-spend cycle. Furthermore, she pointed out the determining role of infrastructural conditions, which alongside individual factors can influence consumption habits.

From the mid 1990s, besides research on sustainable consumption, consumption and lifestyles, other scientific fields developed and influenced research on sustainable consumption. Examples of such fields of study are environmental sociology, the sociology of consumption and environmental psychology (Reisch and Røpke, 2004). Beckmann (1998) and Ölander and Thøgersen (1995) present an overview of research on environmental psychology.

Consumption-based research has influenced production-based research as well. Research into industrial ecology nowadays examines issues with consumption, distribution and size (Hertwich, 2005a; Leeuw, 2005) and agrees with the need for a shift away from a production-based approach. According to Røpke (2005) the following research fields have developed to analyse sustainable consumption: (1) The conceptualization of consumption; (2) The environmental impacts of consumption; (3)

[1] As for the results of environmental policy, the OECD launched a working program on sustainable consumption and production (OECD, 1997) in 1995, UNEP (United Nations Environment Programme) established the Sustainable Consumption Network in 1997 (UNEP, 2001), and in 2005 UNEP and the Wuppertal Institute set up a Collaboration Centre for Sustainable Consumption and Production) (Røpke, 2005). Besides these developments, the launch of the 'Marrakech process' was a significant milestone as well. Fuchs and Lorek (2005), Clark (2007) and Berg (2011) present a comprehensive overview of the public policy development of sustainable consumption.

The driving forces behind growing consumption; (4) Consumption and the quality of life; and, (5) Changing consumption patterns.

1.2. Defining sustainable consumption

Definitions of sustainable consumption have changed compared to the first and original versions (Mont and Plepys, 2008). Definitions can be found both in science and policy-making; the focus of these definitions is sometimes different.

The definition 'sustainable consumption' can be related to Agenda 21 which is one of the most important documents which emerged from the UN Conference on Environment and Development of 1992. The third principle of the conference says that the right to development must be granted while 'meeting the needs of present generations without jeopardizing the needs of future generations' (Agenda 21, 1993). This definition highlights the fact that the present consumption levels of society may endanger some of the future (or even present) generations in terms of satisfaction of needs. Resource depletion cannot be sustained over the long term.

More definitions of sustainable consumption later emerged; these are based on the definition of 1987. According to Costanza et al. (1991, p.8.), sustainable consumption is the "amount of consumption that can be continued indefinitely without degrading capital stocks including natural stocks".

In 1994 the following definition was accepted at the Oslo Symposium organised by the Norwegian government: "The use of goods and services that respond to basic needs and bring a better quality of life, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the lifecycle, so as not to jeopardize the needs of future generations" (Ofstad, 1994). This definition is one of the most-cited definitions of sustainable consumption.

UNEP's definition (1999) is the following: "Sustainable consumption is not about consuming less, it is about consuming differently, consuming efficiently, and having an improved quality of life". Trainer (1996) and Slesser (1997) state that sustainable consumption is about the "management of greed". Princen (1999) analysed definitions of consumption and sustainable consumption and his findings can be summarised as the following: sustainable consumption is when there is no overconsumption, which is the level or quality of consumption that undermines a species' own life-support system and for which individuals and collectivities have choices in their consumption habits (Princen, 1999).

'Consumption Opportunities' is the first document published by the UNEP (2001) that includes references not only to resource efficiency but refers to the need for a change in consumption patterns as well. Besides efficient consumption, the report mentions the concepts of 'different consumption', 'conscious consumption' and 'appropriate consumption'. In order to reach a state of efficient consumption, dematerialisation is needed, while in order to change consumption patterns a strategy of optimalisation is required (UNEP, 2001).

Table 1 shows the characteristics of the different consumption types:

Table 1: Different consumption types and its interpretations

Types of consumption	Strategy	Strategic element	Major agents
Efficient consumption	Dematerialisation	Higher resource-efficiency, increase the efficiency of products and processes	**Industry,** government, consumers
Different consumption	Optimisation	Change the consumption decisions and the infrastructure	**Government,** industry, consumers
Conscious consumption	Optimisation	More conscious consumer choices and products use, better quality of life	**Consumers,** industry, government
Appropriate consumption	Optimisation	Change the level of consumption to realize sustainability and good quality of life	**Society at large** Communities Citizens

Source: Author's own compilation based on UNEP (2001)

It can be seen that the involvement of more and more agents is needed when interpreting the definition in different ways. Sustainable consumption as defined by the UNEP did not become part of environmental policy.

Veenhoven determines the following three components of sustainable consumption:

1. Less consumption refers to a reduction in consumption, to the finiteness of natural resources. This is in accordance with the Club of Rome's call for zero-growth that refers in turn to the fact that the total national products of the world economy cannot grow further (Colombo, 2001).

2. Eco-friendly consumption is a pattern of consumption that does not harm the biosphere. It refers primarily to environmental pollution and the problems associated with CO_2 emissions that are the major focus in this case.

3. Tradition-friendly consumption is a preference for traditional products and traditionally produced goods (e.g. organic and local products).

The Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan of the European Commission defines sustainable consumption as smarter consumption. It supports the improvement of the overall environmental performance of products and aims to help consumers make better choices. This definition emphasizes a small part of sustainable resource use and does not refer to the use and treatment of products and waste; furthermore the overall level of material consumption is not mentioned either.

Table 2 summarises the most important definitions that can be found in environmental policy documents.

Table 2: Definitions of sustainable consumption in environmental policy documents

Source	Definition
Report of the Symposium on Sustainable Consumption, Norwegian Environmental Ministry, Oslo (1994)	„The use of goods and services that respond to basic needs and bring a better quality of life, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the lifecycle, so as not to jeopardize the needs of future generations."
IIED (1998)	„The special focus of sustainable consumption is on the economic activity of choosing using and disposing of goods and services and how this can be changed to bring social and environmental benefit."
UNEP (1999)	„Sustainable consumption is not about consuming less, it is about consuming differently, consuming efficiently, and having an improved quality of life."
Oxford Commission on Sustainable Consumption (2000)	„Sustainable consumption is consumption that supports the ability that supports the ability of current and future generations to meet their material and other needs, without causing irreversible damage to the environment or loss of function in natural systems."
UNEP (2001)	„Sustainable consumption is an umbrella term that brings together a number of key issues, such as meeting needs, enhancing quality of life, improving efficiency, minimizing waste, taking a lifecycle perspective and taking into account the equity dimension; integrating these component parts in the central question of how to provide the same or better services to meet the basic requirements of life and the aspiration for improvement, both current and future generations, while continually reducing environmental damage and the risk to human health."
DTI (2003)	„Sustainable consumption and production is continuous economic and social progress that respects the limits of the earth's eco-systems, and meets the needs and aspirations of everyone for a better quality of life, now and for future generations to come."
National Consumer Council, UK, (NCC, 2003)	"Sustainable consumption is a balancing act. It is about consuming in such a way as to protect the environment, use natural resources wisely and promote quality of life now, while not spoiling the lives of future consumers."

Source: Author's own compilation based on Jackson (2006)

1.3. A critical assessment of the definition of sustainable consumption

The development of environmental policy has influenced greatly the changes in the definition of sustainable consumption (Jackson, 2006). Looking at the variety of definitions we can see that there is no consensus regarding the exact meaning of sustainable consumption and even less so, more efficient or more responsible consumption. Definitions can include reference to changes in consumer lifestyles or only refer to 'efficient consumption' which highlights rather the responsibility of the production side.

The definition from Agenda 21 is fairly general and widely interpreted. At the beginning the aim was to change and call attention to unsustainable consumption patterns; to provoke a shift towards a consumption pattern that is not unsustainable (Jackson, 2006). The first definitions did not provide much of a guideline for real action but they did incorporate important issues that became the basis for later research questions and topics. These include the topics of how to meet basic needs, how to have a good quality of life rather than a desire for more and more products and a high level of material consumption, how to minimise resource use, treat waste and promote intergenerational equality and equity.

Lélé (1991) presented an overview of critiques of the definition and has called it an umbrella term that does not always express the aims which lie behind it.

The focal question in the original definitions of sustainable consumption was simply this: what is the consumption pattern that does not harm future generations? (Valkó, 2003). The definition that was accepted at the world summit on sustainable consumption in Johannesburg in 2002 did not emphasize changes in consumer lifestyles but focused only on more efficient consumption (i.e. consumption of more sustainable products) and omitted reference to the need to reduce overall levels of consumption.

Criticisms of sustainable consumption as 'less consumption' (Veenhoven, 2004) are that the definition is too subjective, it is difficult to implement at a political level and it questions the paradigm of economic growth (Jackson, 2006). Because of these reasons, reference to 'less consumption' does not appear in public policy documents about sustainable consumption, as Princen (1999) has pointed out.

1.4. Interpretations of consumption in the definition of sustainable consumption

I think it is important to analyse what is meant by ‘consumption’ in the definitions of sustainable consumption as this term can carry different meanings in the literature.

The following three cases have been identified (Lorek, 2009):

1. Consumption = resource consumption that takes into account the whole lifecycle of the product. This definition is based on the fact that the economy is a subsystem of the biosphere (Daly, 1991; OECD, 1997) and in this sense resource use causes environmental problems because of the depletion of resources and waste (Schmidt-Bleek, 1993). In this context sustainable consumption means the moderate, limited use of non-renewable resources, their more efficient use or their substitution with renewable resources. Sustainable consumption means the consumption of industries, governments and households (United Nations, 1992).

2. Consumption = economic (final) consumption (both private and public consumption). In a macro-economic context, consumption can be the aggregate of private and public consumption (European Commission, 2008b). Final consumption takes place within the economic system and it is distinguished from production (Røpke, 1999).

3. Consumption = private consumption (consumption patterns, possession of material goods), thus means sustainable household consumption (Thøgersen and Ölander 2003; Lucas, Brooks et al., 2008).

According to the arguments of Lorek (2009), sustainable consumption should be thought of as resource consumption, otherwise the consumption areas which become the focus of research and environmental policy are of marginal significance and are not those that have significant environmental impact. Agenda 21 was created with reference to the first definition – resource consumption – as it calls for the common responsibility of governments, industries, households and individuals (United Nations, 1992, cited by Lorek, 2009).

1.5. Strong and weak sustainability

Besides the various definitions of sustainable consumption, definitions of strong and weak sustainability exist. Definitions vary because of the different interpretations of the relationship between natural and human capital.

Pearce et al. (1989) and Pearce and Turner (1990) have analysed the relationship between natural and human capital in a detailed way. With strong sustainability, human capital and natural capital (natural resources) are complementary to each other, while with weak sustainability they can substitute for each other (this line of thought is based on the neoclassical economic approach). According to strong sustainability, the growth of the economic subsystem is limited, and as natural capital is not (or is only to a small extent) substitutable by man-made capital – the amount of natural capital available is an absolute sustainability limit. In the terms of weak sustainability, man-made and natural capital can substitute each other; there is no limiting factor (Daly, 1991) and if the combined value of man-made and natural capital does not decrease, or if natural capital is substituted for by man-made capital of the same value then it can be regarded as sustainable (Málovics-Bajmóczy, 2009). Weak sustainability does not limit economic growth; proponents can be characterised as having technological optimism (Prónay-Málovics, 2008). Neoclassical supporters of the concept of weak sustainability have not found a good solution yet to the challenge of how to create more capital without using more resources. Daly (1991) thus calls for a strong sustainability approach.

The interpretations of strong and weak sustainability are not unambiguous from several perspectives when compared to the original definition. The original interpretation has changed over time and authors have interpreted it in different ways (for example, Goodland and Daly, 1996; Turner, 1988; Gutés, 1996; Kerekes, 2006; Fleischer, 2006). Málovics and Bajmóczy (2009) examine the definitions of strong and weak sustainability in a detailed way.

Sustainable consumption should not be interpreted in the same way in developed and developing countries; different strategies are needed in each case. For developing countries growth in the relatively low level of income per person could perhaps be reconciled with sustainability if it were done by using environmentally-friendly technology. However, there is a need for radical changes in production and consumption in developed countries as even lower growth rates in already high levels of income per person significantly increase the absolute level of consumption, as has been highlighted by Ekins (1993). Furthermore, economic growth in developed countries would not solve the poverty problem of developing countries (Goodland and Daly, 1992), but it is developed countries that should reduce their levels of consumption so that consumption in developing countries can grow (Hertwich, 2005b).

Environmental impact can be quantified by the equation used by Ehrlich and Holdren (1971). The Ehrlich equation (Ekins, 2004) expresses the impact on the biosphere where environmental impact (I) is the product of three variables: population (P), economic performance or consumption per person (C) and environmental impact per economic performance (environmental intensity of consumption) (T). The equation shows the technological challenges inherent in promoting both economic growth and sustainability, when $I = P*C*T$.

The level of environmental impact (I) is unsustainable today; even delegates at the Earth Summit in Rio agreed on this. The notion of the need for a reduction in consumption per person (C) does not appear in most environmental policy documents (Princen, 1999; Brown and Cameron, 2000; Røpke, 2005).

In terms of weak sustainability a reduction in environmental impact (I) can be realized by increasing technological efficiency (reducing T). However, in the short run an increase in efficiency can lead to less environmental impact but in the long run the consequences can be catastrophic (Garner, 2000). Weak sustainability can lead to a rebound effect and as a result total resource use can increase (Hertwich, 2005a; Sorrell, 2009). The OECD report of 1997 (OECD, 1997) called attention to the rebound effect although the report did not state the need for strong sustainability.

Many researchers call for strong sustainability: increasing the efficiency of modes of production is not enough in a finite ecological system where the total quantity of consumption is increasing (Jacobs and Røpke, 1999; Reisch and Røpke, 2004; Hertwich, 2005b; Røpke, 2005; de Leeuw, 2005; Schor, 2005b; Jackson, 2006; Mont and Plepsy, 2008; Jackson, 2009; Hanley et al., 2009; Lorek and Fuchs, 2011). There is a need to change consumption patterns and levels in order to come closer to a state of sustainability. The allocation problem defined by Daly (1992) fits the idea of strong sustainability. Daly (1992) called for moves to take into consideration the scale of the throughput and size of the economy, not only the allocation and distribution of economic processes.

1.6. The responsibility of households regarding consumption

According to the principles of strong sustainable development, changing the level and pattern of resource consumption is a necessity. Regarding final consumption, private households are the largest consumers.

Final consumer demand is defined as the direct and (through the consumption of imported and state products) indirect consumption of households. In this sense, households are responsible for the environmental impacts of consumption (Spangenberg, 2004). The effect of the spread of the consumption perspective and approach is that consumers can no more be seen just as 'victims' of environmental pollution and environmental impacts but can be regarded as the causes of such problems as well (Lorek, 2009). This means that they have a responsibility for their use of natural resources (Thøgersen, 2005).

Three components define household consumption (Røpke, 2001): 1) the level of consumption; 2) the structure of consumption; and 3) the environmental intensity of the products and services consumed (taking into account both direct and indirect effects). When evaluating natural resource use from a final consumption perspective, the consumption areas with the three highest environmental impacts are a) food consumption; b) transportation; and, c) household maintenance and energy use (Lorek and Spangenberg, 2001a; Eurostat, 2009). According to research by Tukker et al. (2006) and Tukker and Jansen (2006), food consumption, transportation and household maintenance/housing (which includes energy use) create 70% of the total environmental impacts of households (according to life cycle analysis).

Lorek and Spangenberg (2001a) point out that private households have significant effects on exactly these three consumption areas which have the highest environmental impact – which is why the role of households is outstandingly significant. Spangenberg and Lorek (2002) presented a framework for analysing the responsibility of households. The resource demand of households is incorporated into the most notable environmental indicators such as material flow analysis and ecological footprint calculations.

When analysing the consumption of households, the so-called 'lock-in effect' has to be taken into account. This effect constrains people into working within boundaries presented by the current infrastructure. Consumption choices are restricted by the social-technical system (Røpke, 1999) which people come into contact with when they undertake routine activities (such as using electronic systems, the sewage system, the postal system, the educational system, road networks, etc.). Each area of consumption has its own supply system which comprises the following elements: production, distribution, retail trade, consumption and its material culture (Fine and Leopold, 1995). So, consumption partly consists of being *served* by supply systems but consumers *serve* the supply system as well.

The reason for currently unsustainable consumption patterns may be that customers are locked into an unsustainable consumption structure – yet they can affect this structure as well. Research confirms that lock-in effects and the path-dependency of technological infrastructure makes more difficult the changing of behaviour and leads consumers to participate in such environmentally harmful behaviours such as car use (for example, in the case of an inadequate public transport system) (Schor, 1995; Schor, 1998; Sanne, 2002). Besides analysing consumption patterns and norms and values, the infrastructural frame should be analysed as well (Sanne, 2002; Shove, 2003).

Sustainable consumption is nothing other than "good" consumer behaviour in "bad" consumer structures (Spangenberg, 2004) and the task of policy-supporting sustainable consumption is to create opportunities in the present social-economic structures and patterns to open the way for the new paradigm (sustainable consumption).

In this chapter the appearance of the topic of responsibility for consumption and the consumption-oriented approach in academic research is reviewed and possible interpretations of sustainable consumption are presented. We may settle the idea that a consumption approach is crucial to environmental-economic research as well, as according to the concept of strong sustainable development 'welfare wins' and consumption patterns with their impacts require revaluation. Changes in consumer lifestyles should receive more attention in the future. To achieve these changes, those consumption areas which have the greatest environmental impact should be identified; furthermore, understanding the factors which influence consumption demand and structure are needed as well.

In my thesis I examine the environmental impacts of food consumption, so in the next chapter an analysis of its environmental impact and a definition of its sustainability are presented.

II. The environmental impacts of food consumption and its sustainability

2.1. The environmental impacts of food consumption

According to Myers and Kent (2003) the increasing consumption of food leads to increasing environmental impacts and has potentially negative impacts on the maintenance of food security. As the world's population rises, the environmental load of the consumption of food is expected to increase both in absolute and relative terms (Tilman, 1999; McMichael et al., 2007). The increasing scarcity of food is confirmed by the fact that cultivated land area per person decreased from 0.43 hectares to 0.26 between 1926 and 1998. This trend is expected to continue in the future: a 1.5% decrease in land available per capita can be expected per year until 2030 unless there is significant political intervention (FAO, 2009).

After analysing the environmental impacts of food consumption from a lifecycle perspective it can be stated that agricultural production is responsible for a major part of environmental impact and the food processing industry is responsible for a smaller part (Lorek and Spangenberg, 2001a; ETC/SCP, 2009). Nowadays, agriculture can be held to be a polluting sector as it impacts the state of the environment in a negative way during the carrying out of agricultural activities. This impact is reflected/reacts on itself as well, as a great part of agricultural yield depends on the state of natural resources and their conditions (Ángyán and Menyhért, 1999). Holló et al. (2009) call attention to the increasingly serious environmental impacts caused by industrialised agriculture. The following changes have taken place within agriculture during the last few decades: growing productivity; growing diversity of products produced; lessening of seasonal dependency. In spite of the fact that agriculture seemingly plays seemingly a minor (and decreasing) role in countries' economies, its economic significance should not be underestimated and nor should its impacts on our environment, social welfare and health.

In the following sections I summarise the environmental impacts of agriculture on global level.

30% of all arable land has been affected by erosion and land degradation during the last 40 years, and this proportion is expected to rise in the future (Montgomery, 2007; Wilkinson and Mcelroy, 2007). Agricultural production can be held responsible for 80% of forest degradation (Pimentel and Giampetro, 1994; Kendall and Pimentel, 1994); this is the sector which uses the most natural resources.

Agriculture is responsible for the greatest water use; this sector may even use 90% of the total water in developing countries. Changing food consumption structures (especially increases in the amount of meat consumed) require more and more water (Schaffnit-Chatterjee, 2009). The water demands of intensive agriculture are significant. 500-2000 litres of water are needed for the production of one kg of cereal and as many as 150000- 200000 litres could be needed to produce one kilogram of beef, which is mainly due to the water demands of fodder crops (Pimentel and Pimentel, 2003; Wood et al., 2006; WWF, 2006).

Growth in the amount of greenhouse gases emitted is notable: 10-20% of total CO_2 emissions stemmed from agricultural production in 2005 (Smith et al., 2009). Besides CO_2 emissions, agricultural production is responsible for 47% of methane and 58% of nitrous oxide emissions (Smith et al. 2007; Smith et al., 2009). The main source of nitrogen dioxide emissions is nitrogen from fertilizer use (Pálvölgyi, 2000; Steinfeld et al., 2006).

Agricultural land use may be a severe problem in the future according to estimations from the World Bank (World Bank, 2009). Cereal production should grow by 50% and meat production should be increased by 85% between 2000 and 2030 in order to provide a food supply for the rising population. Livestock production can claim the highest environmental impact of all agricultural activities. Direct impacts are due to grazing and indirect impacts to fodder production (Bruinsma, 2003). Cattle production has the largest environmental impact from all livestock production both in terms of land use and its contribution to climate change (Pimentel and Pimentel, 2003). 6 kg of vegetable-based protein is needed to produce 1 kg of animal protein, which means that the utilization of protein is less efficient with animal products (Pimentel and Pimentel, 2003; Kocsis, 2010b).

The use of artificial agrochemicals and pesticides is harmful to the environment (Bhalli et al., 2009) and high agricultural yields cannot be sustained in the long run (Fox et al., 2007). The presence of nitrogen in the soil, water and atmosphere has severe environmental impacts in the long run, while fertilizer use leads to eutrophication (Smil, 1999; Galloway and Cowling, 2002; Aiking, 2011) and ecosystem services are degraded (Vitousek et al., 1997b).

Not only has there been an increase in the quantity of water use but water pollution is significant due to the use of pesticides and fertilizer, especially during the production of fruits and vegetables and this affects the aquatic ecosystems in a negative way (Arthington et al., 2006; Poff et al., 2007).

The use of agricultural chemicals in intensive production leads to decreases in levels of biodiversity (Kremen et al., 2002; Butler et al., 2007; Lang, 2010; Szabó, 2010). Agricultural land use endangers natural habitats (Green et al., 2005) and furthermore, the impact on ecosystem services could lead to severe problems in the future. Local environmental impacts can be made worse by trade and international trade.

We have seen that agricultural production impacts the state of the environment in diverse ways and that increasing demand may lead to significant problems in the future. I think that in order to solve the problem of the increasing environmental load of agriculture, it will not be enough to make changes on the production side that involve making agricultural practices more sustainable. Changes will be needed on the demand side as well regarding the quantity and structure of food consumption, according to the terms of strong sustainability. Lorek and Spangenberg (2001b) summarise the environmental impacts of the consumption of food, as shown in Table 3.

Table 3: Correlating resources resource use to environmental problems

Environmental problem	Cause	Source	Key resource correlated
Acidification	SO_2, NO_X	fossil fuels	energy
Biodiversity loss	habitat degradation	agriculture	land use
	fragmentation	agriculture, settlements, roads	land use
Erosion	Use intensity	agriculture	land use
Eutrophication	P	agriculture	land use
	N	agriculture, fossil fuels	land use and energy
Global warming	CO_2	airborne, fossil fuels	energy
	CH_4	ranching	land use
	N_2O	agriculture	land use
Waste generation	throughput	consumption volume	material flows

Source: Lorek and Spangenberg (2001b)

The environmental issues and their drivers presented in this section can be connected basically to the use of the following two natural resources: land use and energy use. In order to measure the environmental impacts of consumption of food an indicator is needed that quantifies the use of these resources in a consumption-based way. Having presented details about the natural resources that are of key importance regarding food consumption, I next present and analyse definitions of sustainable food consumption.

2.2. Definitions of sustainable food consumption

When examining the sustainability of food consumption the question arises whether the sustainable consumption of food is actually possible, or whether it is more reasonable to speak about decreasing the environmental impacts of food consumption. In the academic literature that analyses the environmental impacts of food consumption the term 'sustainable food consumption' appears in many references as being a state and/or goal to be reached by applying the idea of sustainable consumption to food consumption. Yet Kiss (2011) argues that using the term sustainable food consumption is incorrect as food consumption is not even sustainable in poorer developing countries: consumption levels exceed the available biocapacity and thus it is more reasonable to speak about the environmental impacts of food consumption. Due to these types of issues I feel it necessary to review the definitions of sustainable food consumption.

Erdmann et al. (1999) defined the conditions that should be fulfilled in order to call consumption of food sustainable. He categorised the most important factors into four dimensions (economic, environmental, health and social) that should be considered together when analysing the sustainability of food. However, no guidance is given by Erdmann et al. (1999) about how these dimensions and the components of these dimensions should be weighted when we attempt to put into practice sustainable food consumption habits. Table 4 shows the goals of sustainable food consumption.

Table 4: The goals of sustainable food consumption

Economic dimension	Social dimension	Health dimension	Ecological dimension
Global food security	Job security	Human health	Conservation of natural resources
Guaranteeing economic competitiveness of private firms and enterprises	International justice	Changing of consumption patterns	Maintaining of ecological resilience
Stable and efficient markets	Reinforcement of consumer interests	Eating should be enjoyable	Improvement of biodiversity

Source: Erdmann et al. (1999)

Koerber and Kretschmer (2001) agree with the four dimension classification made by Erdmann et al. According to these authors sustainable food consumption could be realized by optimizing nutritional regimes. They list the following requirements for sustainable nutrition: the diet should consist primarily of lacto-vegetarian, regional and seasonal food products which are less processed and in environmental-friendly packaging, while maintaining the cultural diversity of food consumption and maximising the consumption of organic food products.

Alfredsson (2002) uses the term ‘green consumption’ or ‘green diet’ for products and consumption patterns with low energy intensity and low CO_2 emissions.

Leitzmann (2003) lists seven criteria for sustainable food consumption: these are a preference for a mainly plant-based diet based on organically, regionally and seasonally produced food which is minimally processed, ecologically packed and tastefully prepared, as well as fairly traded. We can see that Leitzmann (2003) sets strict conditions for defining sustainable food products. Vermeir and Verbeke (2004) describe as ‘sustainable’ or ‘ethical’ those products that have been grown using organic methods, which are distributed fairly (fair trade) and which are animal-friendly.

Duchin (2005) claims that a sustainable diet should have a low environmental impact and should contribute to preserving human health. According to Hayn, Empacher and Halbes (2005) a sustainable diet not only has positive health and environmental impacts but takes into account the relevance of healthy food consumption habits in everyday life.

Pack et al. (2005) claims that sustainable food consumption is a preference for:

- foods that have a higher resource efficiency (e.g. open-ground vegetables instead of greenhouse production),
- regional instead of imported foods,
- meatless or reduced meat diets,
- lower amounts of bottled beverages and
- organically produced foods instead of conventionally produced foods.

Besides these factors they mention that food processing and packaging can have notable environmental impacts; for example, pre-packaged and frozen products cause larger environmental impacts than fresh and less-packaged products. Wallén et al. (2004) calls for low energy inputs per food item consumed but also calls for a diet that provides the amount of nutrients that is required. A diet with low environmental impact which is not adequate from a nutritional perspective cannot be regarded as sustainable because in the long run it may lead to malnutrition and to illnesses.

Hoffmann (2005) examines the term from an environmental perspective. Sustainable nutrition means a preference for foods of plant origin (fruits and vegetables) and a reduction in the consumption of highly processed foods.

According to the British Sustainable Development Commission (2005) the following criteria should be met for food consumption to be considered sustainable:

- is safe, healthy and nutritious, for consumers in shops, restaurants, schools, hospitals etc;
- can meet the needs of the less well off people;
- provides a viable livelihood for farmers, processors and retailers, whose employees enjoy a
- safe and hygienic working environment whether nationally or abroad;
- respects biophysical and environmental limits in its production and processing, while reducing energy consumption and improving the wider environment;
- respects the highest standards of animal health and welfare, compatible with the production of
- affordable food for all sectors of society;
- supports rural economies and the diversity of rural culture, in particular through an emphasis on local products that keep food miles to a minimum.

Tischner and Kjaernes (2007) state that the aim should be not only a reduction in the amount of food consumed but a definition of the consumption of which food groups should be reduced, where they were produced and processed, who prepared them (and where), who consumed them and how the food waste was handled or reused. The following examples can be given of sustainable food consumption: buying organic, local and seasonal food, buying fair trade products, maintaining a healthy and balanced diet; furthermore, the reuse and selective collection of water bottles and soft drinks and food packaging and the treatment of organic waste (Belz and Pobish, 2005). Lefin's definition (2009) of sustainable food consumption is the following: the access to and consumption of food products required for an active, healthy life, taking into account economic, social and environmental sustainability.

Sustainable food consumption decreases health costs in the long run. Despite favourable environmental and health effects a shift towards consumption of lower-impact and more healthy food products is not ongoing (Eurostat, 2009). Consumers generally do not consider the environmental impacts of their consumption of food. The reason for this may be that they underestimate the scale of the problem and underestimate the value of natural resources; furthermore they have expectations of a comfortable lifestyle and associate the solving of environmental problems with high costs (NationalGeographic, Globescan and Greendex, 2008).

2.3. The synthesized interpretation of sustainable food consumption

Sustainable food consumption has been evolving as a research topic since the beginning of the 2000's. The term 'sustainable food consumption' does not have a standard definition which is accepted by everyone. The interpretation of the definition changes according to the approach of the research field or environmental policy. It is common in all definitions that the role of individual action is important when deciding between consumption alternatives; besides this, social (health/welfare) and environmental impacts appear commonly as well. Table 5 presents a summary of the definitions presented in this chapter according to the main aspects they highlight, and according to the focus of the research question utilised, which concerns the promotion of sustainable food consumption.

Table 5: Categorisation of definitions of food consumption

Authors	Environmental dimension	Health dimension	Social dimension	Economic dimension
Kroerber and Kretschmer (2001)	+	+	+	+
Alfredsson (2002)	+			
Leitzmann (2003)	+		+	
Vermeir and Verbeke (2004)	+		+	
Duchin (2004)	+	+		
Wallén et al. (2004)	+	+		
Belz and Pobish (2005)	+	+		
Hayn, Empacher and Halbes (2005)	+	+	+	
Pack et al. (2005)	+	+		
Hoffmann (2005)	+			
British Sustainable Development Commission (2005)	+	+	+	+
Tischner and Kjaernes (2007)	+			
Lefin (2009)	+	+	+	+

Source: Author's own compilation (2012)

It can be seen that most of the definitions of sustainable food consumption do not only cover environmental factors but incorporate at least one more aspect. Environmental aspects are primary, followed by the dimension of health. Not only environmental impact but also impact on human health is an important feature of most of the definitions. Food consumption has a direct impact on the health of consumers so this factor cannot be analysed separately. Looking at the definitions it can be seen that social or economic aspects do not take priority in themselves. Present food consumption patterns are not sustainable because not only carrying capacity is being reached but human health is threatened as well.

I think the diversity of the definitions shows that sustainable food consumption cannot and should be analysed by focusing on a single dimension. A multidimensional interpretation of the term and a complex approach to problem-solving are necessary. Making consumption sustainable means that there should exist alternatives to consumption which are sustainable in terms of both their environmental and social effects.

I think it is important to note that the question of doing sports and excercises might arise when we analyse food consumption. Doing sports increases calorie demand and thus the ecological footprint of food consumption might increase, though it contributes to healthy and balanced lifestyle. The lack of excersises and sports can lead to health problems in the long run and it can increase costs in the health system.

As for the analysis of the consumption of healthy food, I follow the approach and definitions used in international environmental and sustainability analyses. From the definitions, I apply the definition of Wallén et al. (2004) in my research. It is important to note that that defining what healthy food consumption is much more detailed and complex from the dietetics point of view, although I do not deal with these complex issues in this dissertation. The environmental advantages of moving towards consuming healthier food is primarily analysed in the thesis later on.

Table 6 shows the possible combinations of sustainability and health in food consumption. In the case of *A*, food consumption can be regarded healthy and its environmental impact is low. This ideal state appears in the definitions of sustainable food consumption. When the environmental impact of food consumption is relatively low, but it is not appropriate for the individual’s health, then food consumption pattern is sustainable but it isn’t healthy as in case *B* (in case of a low-impact but not varied diet).

Table 6: Possible combinations of sustainable and healthy food consumption

	Healthy	Not healthy
Sustainable	A	B
Not sustainable	C	D

Source: Author’s own compilation (2013)

If food consumption is healthy, but fruits and vegetables are imported from far-away countries, then the environmental impact can grow and case *C* can happen. Food consumption is neither healthy nor sustainable when diets include predominantly high-impact food and the diet is far from nutritional recommendations (case *D*).

2.4. Overconsumption and misconsumption

The issue of overconsumption and 'misconsumption' (consumption of inappropriate items) is closely connected to the topic of consumption of food as well, as there are remarkable differences in consumption of food and food consumption structures at the global level. According to estimates from the WHO, half of the world eats in an unhealthy way. People starve because of poverty in developing countries or their consumption of food is not diverse; while in developed countries consumption of too many calories causes problems (Gerbens-Leenes et al., 2010). Consumer society in developed countries generates new demands and individual happiness is dependent on consumption. According to a definition from classical economics, consumption is the activity undertaken to satisfy needs or to satisfy an unsatisfactory condition. 'Want' is a specific desire to satisfy needs. Needs satisfaction can depend upon different cultural wants and thus cases of misconsumption can arise. The goods consumed do not serve to satisfy basic needs, but in fact hinder the satisfaction of needs. Distorted cultural wants influence consumption. Social and psychological needs increasingly influence consumption habits (Belk, 1996; Campbell, 1996; Prónay-Málovics, 2008). Food consumption may basically satisfy physiological needs but in developed countries this is not the only driver of consumption.

According to Princen (1999) and Kocsis (2001), we can define overconsumption and misconsumption. Overconsumption happens when the quantity or type of consumption endangers the living system of a species and other choices are available. Overconsumption is an aggregate concept. Habitats are overloaded because of the effects of consumption and are not be able to renew some resources or dispose of wastes. There are two types of overconsumption: overconsumption in terms of *quantity* (when an individual consumes more than is needed which may result, for example, in obesity or a deterioration in health); and overconsumption in terms of *quality:* we often do not buy durable products but rather cheaper products of worse quality – the result is the generation of more and more waste. It can also happen that consumers prefer well-known brand-label products rather than products which are cheaper and more directly useful.

The overconsumption of some leads directly or indirectly to the underconsumption of others (Princen, 1999). Overconsumption of food leads to negative environmental, social and health impacts. Misconsumption can be interpreted on an individual level when an individual endangers its own well-being, independently of whether on an aggregate level overconsumption happens (Kocsis, 2001). In the case of misconsumption the individual suffers a net loss, or their consumption is suboptimal in terms of resource use. This can appear as excess consumption of food, the buying of unnecessary products or a state of always being unsatisfied. Misconsumption appeared as luxury consumption for a select few people until the 20th century, but today it is a mass social phenomenon due to mass production.

In the case of food consumption, misconsumption could be consumption that is far from nutritional recommendations (e.g. a diet with a high share of animal products, added sugars, fats and salt). The consumption of these items together with a sedentary lifestyle can lead not only to higher environmental impacts but to illnesses as well and can influence quality of life in a negative way in the long run (Lefin, 2009).

Overconsumption causes the depletion of natural resources and biocapacity. Misconsumption can be seen as a social problem (Kocsis, 2001). The relationship of overconsumption to misconsumption is illustrated in Table 7 of Kocsis (2001, p.43.).

Table 7: Possible combinations of overconsumption and misconsumption

	Overconsumption	No overconsumption
Misconsumption	A	B
No misconsumption	C	D

Source: Kocsis (2002, p.43.)

Field D represents the optimal and desirable situation; there is neither overconsumption nor misconsumption. From an environmental point of view, field A and C are important. Overconsumption happens along with misconsumption in developed countries. In field A, the consumption of local products can be a good alternative from an individual and a social perspective (Prónay and Málovics, 2008).

Kocsis (2001) summarises in his research ideas about material consumption and desires for possession.

2.5. Socio-economic factors which influence the consumption of food

Different opportunities and alternatives exist to reduce the environmental impacts of consumers in different regions and cultures as food consumption can be influenced by different factors in diverse countries and cultures.

Consumption of food is directly determined by biological, psychological, sociological, anthropological, demographical, economic and political factors (Lehota, 2004). Social status has a determining role in an individual's socialization, in their experiences and in the framing of their psychological features (Gossard and York, 2003). The elements of social structure thus determine the frame and environment within which psychological factors are embedded. The social and economic factors that can influence food consumption are reviewed in this section.

Different social and demographical features and values as well as lifestyles can influence food consumption. Much research has confirmed that food consumption patterns can be determined by socio-demographic factors (Hulshof et al., 1991; Smith and Baghurst, 1992; Roos et al., 1996; Johansson et al., 1999; Irala-Estevez et al. 2000; Dowler, 2001; Roos et al., 2001). According to this research there are significant differences in consumption, basically based on gender, age and occupational activity. Hayn et al. (2005) listed seven socio-economic factors that can have an impact on food consumption: age, social status (which is determined by income and type of occupation), education, gender, place of residence, ethnic identification and the lifestyle of the individual. The statements made by Hayn et al. (2005) are based exclusively on German academic literature and German empirical research. According to Hayn et al. (2005) age is one of the most important determining factors concerning the environmental impact of food consumption. Age can influence food consumption patterns both at a product level and regarding the structure and timing of eating.

Concerning the differences in consumption of food between genders, many studies have confirmed that significant differences exist regarding the consumption structure of men and women (Payer at al., 2000; OECD, 2001b; Hayn et al., 2005). Gossard and York (2003) analysed the meat consumption of households and its environmental impacts. Their results show that men eat more meat (especially more beef) than women. Dietz, Kalof and Frisch (1996) compared consumption of meat and vegetarian diets. Age, body weight, education, gender, ethnic identification, region and type of work were proven to be significant factors in their analysis.

Income as an economic and social factor is a determinant of food consumption. Research confirms that households are price sensitive regarding food purchases and consumption (Trichopoulu et al., 2002; Hayn et al., 2005). In some cultures a lower income is associated with less consumption of fruit and higher consumption of potatoes and cereals (Trichopoulu et al., 2002). Lehota (2004) highlighted the fact that income is one of the most important determinants of consumption of food within the social-economic macro-environment. Income has an impact on the level and structure of consumption and on the variety of foodstuffs consumed. Income plays an important role in the consumption of healthy food but at the same time it is questionable whether people take advantage of this opportunity (namely, whether having a higher income creates a shift towards healthier food consumption).

Expenditure spent on food compared to total expenditure may be a good indicator of the level and structure of food consumption. A high proportion of expenditure on food indicates a lower socio-economic status and lower income (James et al., 1997).

Education is another determinant of food consumption (Liberatos et al., 1988) as it not only reflects the number of years spent in school and achievements attained, but it is connected to the type of work one does, income and to availability of information about healthy nutrition (Johansson et al., 1999).

Trichopoulou et al. (2002) compared changes in the food consumption patterns of seven European countries through ten years using national statistical data. According to the results the level of education determines the understanding and acquirement of pieces of information about health and the environment. The higher the level of education, the healthier one eats. Researchers thus state that education is the most important factor determining food consumption. Besides education, the size of the household is an influencing factor.

Results from Irala-Estevez et al. (2000) showed positive correlation between the level of education and fruit and vegetable consumption for the countries analysed (Belgium, Denmark, Estonia, Finland, Germany, Lithuania, Norway, Spain, Sweden and the United Kingdom). Roos et al. (2001) could not confirm this result. Their results showed that in Western, Central and Northern Europe a higher level of education leads to consumption of greater amounts of vegetables and fruit, but the opposite is true for Southern and Eastern Europe. Their research indicated that fruit and vegetable consumption decreases with a higher level of education in regions where the consumption of these food products is already more popular and more closely connected to traditional diets.

Besides the factors mentioned above, institutional factors may play an important role as well (Tanner and Kast, 2003; Hofmeister et al., 2011). Neulinger and Simon (2011) mentioned that consumption of food and the state of an individual's health can also be determined by marital status and the lifecycle of the family. Schaefer (2006) examined changes in food consumption patterns regarding life events and the variables of education, income and place of residence. Education and place of residence were proven to be significant factors but income was not, as it had no influence on the making of more sustainable and healthier choices when life events occurred.

Hofmeister et al. (2011) stated that the consumption patterns of Hungarian households are determined by various factors: income, demographic changes (whether more women are working, if there are more single households or more retired people) and changes in lifestyles.

Being aware of the factors and determinants presented in this section is important when assessing the environmental impacts of food consumption. I turn to this in later chapters.

III. Methodologies for examining the environmental impacts of food consumption and the ecological footprint

The aim of this section is to give an overview of the methodologies that can be used to quantify and analyse the environmental impacts of food consumption.

The use of so-called biophysical methodological approaches has become popular for measuring the environmental impacts of food consumption. The central idea of the biophysical view is that the economy is based on natural material and energy flows; energy is transformed, degraded and then returns back to nature.

Throughput is the cause of environmental degradation from a thermodynamic and ecological perspective, according to papers by Boulding (1993), Daly (1993) and Georgescu-Roegen (1993). According to these authors the problem is that human consumption demands and uses more of the regenerative capacity of natural resources than the natural regenerative capacity of the ecosystem. Biophysical methodologies examine the energy, material and land use of the economy and consumption. The development of the field of ecological economics has opened up a new area for calculating in 'naturals' (Røpke, 2005); its increasing role is emphasized in many studies (Rothman, 1998; Martinez- Alier et al., 2001; Spangenberg and Lorek, 2002; Giljum and Eisenmenger, 2004). Biophysical methodologies that focus on the sustainable use of natural resources have been popularised not only at the national but also at a regional level (Daly, 1990; Ekins et al., 2003).

Table 8 shows the methodologies that are appropriate for measuring the environmental impacts of food consumption. They are summarised according to whether they could be used in product or system level analysis. The '+' symbols in the table show that the methodology is applied often at that level while the '(+)' symbols mean that the methodology has been used only a few times on that level. It can be seen that the majority of the methodologies listed are used for product level analysis; their use at a system level is not wide-spread and they are not always appropriate for the research aims. The most important natural resources that are used to create food for consumption are land use, energy use and material use (Spangenberg and Lorek, 2002). This is why measuring these types of resources is necessary for an input-oriented analysis.

For input-oriented research we can distinguish between CO_2 and GHG accounting and lifecycle analysis. The ecological footprint is an aggregate type of biophysical indicator, which means that it measures several impacts at the same time. The use of this methodology is widespread.

The aim of this section is now to introduce research methodologies that are biophysical, consumption-based and which are appropriate both from a theoretical and an empirical perspective for examining the environmental impacts of food consumption.

Table 8: Research methodologies that are appropriate for examining the environmental impacts of food consumption

Methodology	Product level	System level
Material flow analysis	+	+
Energy requirement analysis	+	(+)
Accounting of land requirements	+	+
Foodmile	+	(+)
Foodprint and foodshed analysis	+	+
CO_2 and GHG accounting	+	+
Lifecycle analysis	+	(+)
Ecological footprints	(+)	+

Source: Author's own compilation based on Pack et al. (2006a)

3.1. Methodologies for examining the environmental impacts of food consumption

In the following section I present the characteristics of the methodologies that analyse the environmental load of food consumption.

A. Material flow analysis (MFA)

The work of Ayres and Kneese (1969) about 'industrial metabolism' influenced the development of this methodological approach which is based on the theory of industrial ecology. Material flow analysis quantifies material flows in weight, mostly expressed in tons. It measures the total material requirements for a product's (or an economic sector's) production, which is the sum of the direct material requirements (from which the product is prepared) and the natural resources that were used during production (which are not included in the final product but were used during manufacturing) (Schmidt-Bleek, 1994; Hinterberger et al., 1997). Material flow analysis measures both direct and indirect material flows. Matthews et al. (2000) summarises the characteristics of the methodology.

Material flow analysis can be appropriate both for product level and system level analysis, its methodology is consumption-based, so it takes into account the impacts of trade as well, according to which countries can be net importers or net exporters depending on their use of materials (Schmidt-Bleek, 1994; Hinterberger et al., 1997; Fischer-Kowalski, 1998; Haberl et al., 2004). MFA methodology is based on strong sustainability (Hinterberger et al., 1997).

The disadvantage of MFA is that it measures environmental impact exclusively based on the weight of raw materials and not on the ecological impact of the material, so it cannot differentiate be used to differentiate between materials regarding their usefulness and the harm caused to the environment (Hinterberger et al., 1997). With the exception of material flows this methodology does not give information on the environmental impact itself. So the aggregated results and their interpretation can be misleading.

An advantage of the methodology is that it is internationally-acknowledged at measuring total resource use. MFA has lead to the construction of a good database for other indicators (such as the ecological footprint). The methodology can be used at the micro level as well where the MIPS (material input per service unit) indicator is mostly used (the material input demand per service unit (Schmidt-Bleek, 1994)). The methodology is frequently used as an appropriate indicator of the state of the environment (Bringezu et al., 2004; Weisz et al., 2005; Giljum et al., 2008), and it's output has become part of international statistical sets as well (OECD, 2007a-b; OECD, 2008). An advantage of the methodology is that it is easy to understand and to communicate; it can thus raise the awareness of consumers. For food consumption the material flow is equivalent to the quantity of food consumed. The methodology is less frequently used on its own for analysing food consumption. It is used to supplement other methodologies (Faist, Kytzia and Baccini, 2001; Risku-Norja and Maenpaa, 2007) as the weight of food products itself does not provide direct information or allow for direct conclusions to be drawn about environmental impacts and resources used.

B. Energy analysis

The subject of energy analysis is usually the direct and indirect energy that used in the whole lifecycle of a product or economic sector and is measured in Joules (J) (IFIIAS, 1974).

Like with material flow analysis, total primary energy input that includes direct and indirect energy demand (Haberl, 2001) can be quantified. The roots of energy analysis go back to the 1970s when it was not typical in economic analysis to take into account indirect energy needs, but research revealed that there was a need to quantify both direct and indirect energy demand. In the 1970's, analysis that examined the energy needs of food production appeared (Leach, 1976; Steinhart and Steinhart, 1974), as well as research which examined the energy content of packaging (Bousted, 1974) and other research that analysed other consumption areas (Cook, 1971; Odum, 1971; Rappaport, 1971; Herendeen, 1972; Chapman, 1975). Energy analysis methodology significantly developed later and today it is one of the most frequently-used and accepted methodological approaches. Energy analysis can be done using a consumption-based approach where the energy content of both imported and exported products are calculated. The results of energy analysis are easy to understand and different product groups are well-comparable, though the method cannot give a complete picture of environmental impact (Hertwich, 2005a).

When calculating the energy content of food consumption, especially the energy demands of livestock, it is particularly important to take into account the energy requirements for consumed fodder (Haberl et al., 2001).

C. Land use analysis

Land use analysis methodology measures the size of the actual land area that is used for food production and uses units of hectares. Schütz (2003), Bringezu et al. (2003) and Steger (2004) give good summaries of the methodology of land use analysis. Cropland and grazing land etc. appear in aggregated form in most cases during the analytical procedures. The methodology quantifies the land requirements of different food products. Knowing real land requirements can help when the land requirements for consumption are compared with data about the land that is actually available. Results derived from using the method are easy to understand.

D. CO_2 and GHG accounting

CO_2 accounting measures the CO_2 or GHG emissions expressed in CO_2 equivalents of food consumption which are due to the consumption of a product group or to a food consumption structure. The quantity of CO_2 can be expressed in terms of weight, in tons or kilograms. CO_2 accounting is appropriate for both product and system-level analysis. CO_2 accounting measures the impact on climate change while at a product level it can be combined with lifecycle analysis. At a system level it is used as a separate indicator.

E. The use of food miles

The resource use of consumption of food is determined by the transportation of food products, which is an increasingly important factor as the share of imported products is increasing and impacting GHG emissions accordingly. Food miles are the distance that the product travels (is transported) from the producer to the final consumer. Blanke and Burdick (2005) reviewed methodological issues with food miles. There is general agreement that, in spite of some methodological shortcomings, this indicator has a great role to play in communicating with consumers (Smith et al., 2005). Research that uses the food mile indicator to measure the environmental impacts of food consumption quantifies exclusively the impacts of transportation. The methodology is appropriate for examining food networks as well (see research by Princen, 1997; Duffy et al., 2005; Pretty et al., 2005; Smith et al., 2005; and Sirieix, 2008).

F. Lifecycle analysis

Lifecycle analysis measures environmental impacts (material and energy use, CO_2 and GHG emissions, waste) and contributions to environmental problems (acidification, eutrophication, climate change, health effects etc.) by taking into account the whole lifecycle of a product. The following elements can be regarded as whole lifecycle: extraction of raw materials, energy use, production and manufacturing, use of the product, reuse or recycling of the product, transportation, final waste disposal and waste treatment (UNEP, 2003).

Lifecycle analysis was done for some products in the 1960s, but the methodology started becoming more popular since the second part of the 1990's (Murray, 2010). The methodology behind lifecycle analysis is robust and widely accepted and it is defined in international standards (ISO 14040; ISO 14044). In the following paragraphs I summarise LCA methodology based on research by Murray (2010).

The impact of a given product or sectoral level is analysed in the assessment; a system-level analysis is not the aim of the methodology. The assessment is done in the following phases: (1) Goal definition and scope, establishing system boundaries; (2) Inventory analysis, data collection and modelling the lifecycle of the product; (3) Impact Assessment in the lifecycle stages; and (4) Interpretation of results.

The advantage of lifecycle analysis is that it takes into account environmental impacts in the most detailed way and it makes possible a comparison of results at a product or process level. The methodology has high-level data requirements and it is sensitive to the quality of data (very detailed and reliable data are needed in order to produce precise results).

The disadvantage of the methodology is the problem with system boundaries. This refers to the fact that a limit has to be defined beyond which environmental impacts are not taken into account in the analysis. Poorly-defined system boundaries can result in a high level of uncertainty (perhaps 50%) regarding the reliability of the results (Lenzen, 2008).

The representativeness of the analysed product at a product group level can be questionable as well. Comparability of the results can be difficult because equivalents are used in the calculation of the environmental impacts and because primary data comes from various sources. The methodology is excellent for product-level analysis as it can give an overview of a sector's performance, but it is less appropriate for use in system level analysis. Combining it with other methodologies (such as the input-output analysis[2]) can prove to be advantageous when carrying out analysis higher than the product-level.

[2] The model for input-output analysis is a statistical table that shows the relationships of the economic sectors of a country. The input–output analysis methodology was developed by Leontief (1936) in the form of an industry-by-industry matrix. Leontief developed this model in order to evaluate sectoral interdependencies and environmental impacts. Leontief's research (1936; 1970) can serve as a starting point for the methodology. The input-output approach is able to track the transformation of goods through an economy; it is able to show the impact of final use as well as the impact of the use of raw materials.

Results of research that has used lifecycle analysis nicely supplements research that uses other methodologies to measure the environmental impact of consumption of food (Kramer et al., 1999; Carlsson-Kanyama, 1998; Kramer et al., 1999; Carlsson-Kanyama and Faist, 2000; Bruinsma, 2003; Carlsson- Kanayama et al., 2003; Wood et al., 2006).

G. Ecological footprint

The ecological footprint is an indicator based on natural capital and it is one of the most widely used methodological approaches of biophysical resource-accounting. Developed by Wackernagel and Rees (1996), the ecological footprint is an indicator of environmental load and measures human demand on nature by assessing how much biologically productive land and sea area is necessary to maintain a given population with a given consumption pattern. The measurement units are global hectares. The ecological footprint method has introduced a new feature to the measurement of environmental impacts by quantifying the impacts of food consumption and food supply systems (Røpke, 2005). When the research aims behind the use of the ecological footprinting methodology are accurate and clear and system boundaries are well-defined ecological footprint is appropriate for macro-level analysis as well. The approach of the ecological footprint is anthropogenic; it takes into account the biocapacity which is useful to humans. The methodology does not evaluate the utility of land types based on their CO_2 accumulation potential but takes into account their potential utility from a human perspective (Haberl et al, 2004).

The ecological footprint is one of the few consumption-based environmental indicators which show how far humanity is from a sustainable state; it is an objective, non-biased, aggregate, one-dimensional indicator of sustainability. The ecological footprint is presented in a more detailed way in the next sub-chapters.

When applying the ecological footprint methodology for measuring the environmental impacts of food consumption, the so-called *foodprint* term should be mentioned. This directly shows the land which is required for food production to satisfy national or regional consumer demand. The term was introduced by Johansson (2005) who used life-cycle analysis in its determination. Besides direct land use, semi-direct land use has been taken into account as well (e.g. the use of fallow land) (Johansson,

2005) which is required to support an ecosystem; furthermore, indirect resource use and degraded land has been included into the calculation methodology.

The term *foodshed* (Kloppenburg, 1996) can also be mentioned when examining the methodologies available for measuring the impact of food consumption. *Foodshed* refers to the land which surrounds the habitat of the population which is required for the needs of a population. This land is part of a bio- or eco-region which has natural boundaries (Omernik, 2004) and comprises local agricultural land where food is produced. The methodology behind the foodshed concept is less developed and less well-known compared to the ecological footprint, which is by now a well-elaborated, standardized and acknowledged methodology.

3.2. A critical appraisal of the methodologies available for measuring the environmental impact of food consumption

This chapter has so far presented the different methodologies that exist to quantify the environmental impact of food consumption. Biophysical methodologies are based on the embeddedness of the economy into nature. The larger the economy is, the greater impact it has on the biosphere, which makes it necessary to express the size of the economy and the extent of consumption using a natural, biophysical unit (Røpke, 2005). In the academic literature we can find both system-oriented and product-oriented approaches.

The aim of my research is system-oriented, not product-oriented, which is why I think that the life cycle assessment methodology is not appropriate for accomplishing my research aims. Through considering solely food miles, only the environmental impacts of transportation can be quantified.

Land use is also one of the most commonly-applied methodologies, as the use of land for resources in food consumption is significant. Calculating CO_2 emissions can be important as well, especially knowing that the emissions from agricultural production are a sizable portion of total emissions and that they are a factor in the creation of environmental policy as well.

The ecological footprint is a specific consumption-based methodology; it connects the ecosystem with human consumption from an anthropogenic perspective and it is suitable for macro level analysis as well: I therefore intend to use this indicator in my research.

Besides the methodologies presented in this chapter, scenario-analysis is often used in research which is designed to measure the impact of food consumption. Scenarios are pre-defined fixed dietary choices which are used to flag up the changes in environmental impact which can occur when diets change. The starting point of the analysis is the assumption that energy intake is constant and diets are balanced. The scenarios can be applied to diets which are regarded as 'ideal' (i.e. they are balanced diets which fulfil nutritional requirements), or diets which fulfil environmental criteria (e.g. produce low CO_2 emissions).

When examining the environmental impacts and sustainability of consumption, I think that the thought of Pulselli et al. (2008) is worth considering. Pulselli et al. state that sustainability itself cannot be measured as it is not a physical phenomenon; sustainability is an ideal state, an ideal. If we investigate this issue from another perspective we could consider a state of unsustainability and actually 'measure its distance' from an ideal sustainable state. There is a prominent role for the application of adequate methodology and the use of relevant indicators when measuring the environmental impacts of consumption and appropriate models should be used in order to formulate effective recommendations.

The next chapter provides a detailed review of ecological footprint methodology.

3.3. Defining the ecological footprint and its antecedents

The definition of the Ecological Footprint is the following: 'the Ecological Footprint is a resource accounting tool that measures how much biologically productive land and sea is used by a given population or activity, and compares this to how much land and sea is available, using prevailing technology and resource management schemes' (Wackernagel et al., 1996). The difference between the ecological footprint and available biocapacity gives the so-called 'ecological deficit' which is an important indicator for showing to what extent a population exceeds sustainable limits. Populations with unsustainable consumption patterns have larger footprints than their available biocapacity. The ecological footprint is appropriate for measuring energy and resource flows and converting them to the unit of the bioproductive area which is needed to sustain these flows. Biologically productive land includes forests, croplands and fishing grounds, but deserts, open seas and oceans and glaciers are excluded from the calculation. The ecological footprint also takes into account that productive land and sea areas have a capacity to absorb waste products.

The ecological footprint measures human impact on nature (Wackernagel and Rees, 1996). As a result, physical areas are expressed in so-called global hectares. These measurement units are hectares with world-average productivity and the biocapacity of all biologically productive areas on the planet. The advantage of using global hectares is that it makes it easier to compare regions and nations. This methodological approach is suitable for revealing the differences between consumption patterns using a consumption approach. The advantage of using 'land use' units is that it these units are more familiar, acceptable and closer to life to decision-makers than units of energy, CO_2 emissions or biodiversity (Herendeen, 2000).

There already existed a few methodologies which were developed with similar aims before the development of the ecological footprint. The Swedish Borgström developed the 'ghost acreage indicator' (1972) which measured biocapacity in hectares and the ability of a biologically productive area to sustain renewable resources and assimilate waste. Ghost acreage refers to the land which is required to sustain the consumption of people but on which people do not live. Borgström (1974) highlights in his study that to sustain the consumption of Europe 50% more land would be needed and Japan would require five times more land than its actual territory. Research findings from Borgström also indicated that humanity is overshooting the available biocapacity of the Earth and we need more than one 'Earth'. Catton (1980) named this additional land which would be required 'phantom planets'. This expression refers to the fact that humanity is using parts of its ecosystem which are not at our disposal as they are not able to renew themselves.

It is here important to mention research by Vitousek (1986) about the 'net prime products' of ecosystems which has also played an important role in creating and developing the ecological footprint method. Larsson, Folke and Kautsky (1994) also used calculations similar to the ecological footprint method in their analysis of the sustainability of shrimp farming.

After this research, William Rees developed an indicator called the 'regional capsule' which was the direct antecedent of the ecological footprint. The ecological footprint methodology was later developed later by him and his Ph.D. student Wackernagel and they published this indicator in their book ‘Our Ecological Footprint’ in 1996.

The novelty of the Ecological Footprint is that it helps give an answer to a research question which is constructed using the opposite logic to the questions framed in earlier research. This is, namely, how much of the regenerative biological capacity of the planet is demanded by a given human activity? To answer this question, available and applied technology and resource management practices are taken into account. If a country is not aware of its biocapacity and how much it actually uses, it cannot be sustained efficiently in an era of climate change and increasing resource-scarcity (Wackernagel, 2010).

3.4. The methodology behind ecological footprint calculations

Ecological footprint calculations are based on six assumptions, according to Ewing et al. (2010, p.3., adapted from Wackernagel et al. 2002).

- The majority of the resources people consume and the wastes they generate can be quantified and tracked.
- An important subset of these resource and waste flows can be measured in terms of the biologically productive area necessary to maintain flows. Resource and waste flows that cannot be measured are excluded from the assessment, leading to a systematic underestimate of humanity’s true Ecological Footprint.
- By weighting each area in proportion to its bioproductivity, different types of areas can be converted into the common unit of global hectares, hectares with world average bioproductivity.
- Because a single global hectare represents a single use, and each global hectare in any given year represents the same amount of bioproductivity, they can be added up to obtain an aggregate indicator of Ecological Footprint or biocapacity.
- Human demand, expressed as the Ecological Footprint, can be directly compared to nature’s supply, biocapacity, when both are expressed in global hectares.
- Area demanded can exceed area supplied if demand on an ecosystem exceeds that ecosystems regenerative capacity.

Components of the ecological footprint:

- Cropland: land required for the production of agricultural products
- Grazing land: land required for grazing livestock
- Fishing grounds: land used for fishing
- Forest
- Built-up land: land used and covered by infrastructure (for the use of industry, transportation and population)
- Carbon uptake land: area of annual forestry required to sequester the CO_2 emissions

Table 9 shows the sources for databases which are used.

Table 9: Input data to the ecological footprint and biocapacity calculations

Dataset	Source
Agricultural produdtcs, livestock products, fishing	Food and Agriculture Organization of the United Nations (FAOSTAT) http://faostat.fao.org/default.aspx
Forest	Food and Agriculture Organization of the United Nations (FAOSTAT) FAOSTAT ForeSTAT http://faostat.fao.org/default.aspx
Energy use, CO_2 emissions	Three database are used: 1. CO_2-emissions data from International Energy Agency (IEA) database 2. Energy content of imported products: from scientific publications 3. Carbon sequestration: IPCC (2006)
Built-up land	CORINE Land Cover data, EEA database http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667
International trade	UN Statistics Division: UN UN Commodity Trade Statistics Database COMTRADE http://comtrade.un.org/

Source: Ewing et al. (2010)

Besides these databases, further data are used in calculations from publications in academic journals (Ewing, 2010). In the following section I review the methodology of the ecological footprint calculations based on Ewing et al. (2010).

The ecological footprint is a consumption-based indicator. It allocates the resource use of production, transportation, distribution and consumption to the place of consumption, to final consumers.

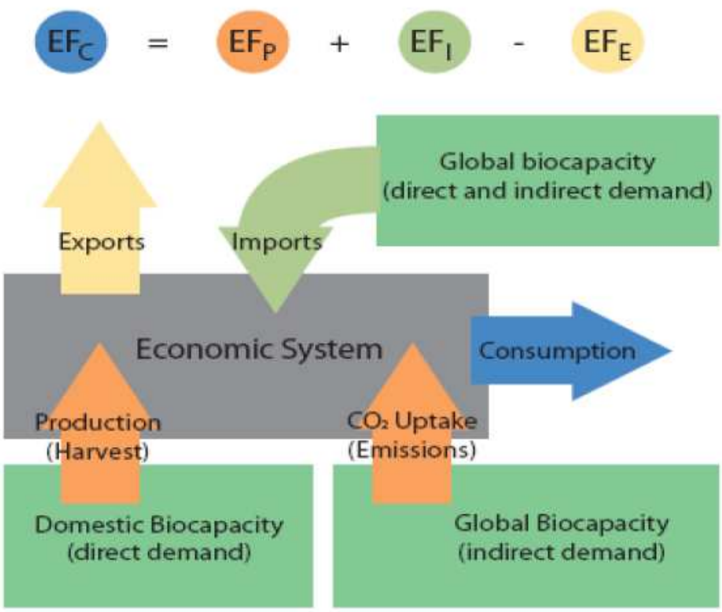
The ecological footprint of consumption can be calculated with the following formula:

$$EF_C = EF_P + EF_I - EF_E$$

…where: EF_P: is the ecological footprint of production, EF_I and EF_E are the ecological footprints of imported and exported products.

According to this consumption-based methodological approach, the environmental impacts of the consumption demands of imported products are allocated to the consumer (while the impacts of exported products are not). Figure 1 shows the logical relation of ecological footprinting methodology to economic flows and available biocapacity.

Figure 1: Schematic of Direct and Indirect Demand for Domestic and Global Biocapacity



Forrás: Ewing et al. (2010, p.6.)

The following yield factor shows the ecological footprint of production. Using this formula the ecological footprint can be calculated for all land types:

$$EF_P = \frac{P}{Y_N} \cdot YF \cdot EQF$$

…where P is the quantity of the primary product harvested or CO_2 emitted measured in tons, Y_N is the national average yield for national production (or its carbon uptake capacity) and

YF is the yield factor (the ratio of local and world average productivity for usable products within a given land use type). This is calculated as the ratio of national average to world average yields so its value is different for each country and it can change each year. It has no unit of measurement.

The equivalence factor converts a land type (cropland, grazing land, forest etc.) to an area of land with world average biological productivity. It can be calculated as the ratio between the biological productivity of specific land use types and that of the world average land. Its unit of measurement is global hectare/world average hectare. The methodology assumes that the land with the highest productivity is used for agricultural production, less productive land is used for forestry and land with even less productivity is used for grazing. This assumption is based on the assessment of land types from an anthropogenic perspective.

Ecological footprint and biocapacity has been calculated in National Footprint Accounts for more than 200 countries in the world. According to the ecological footprint per capita in 2010, 1.51 Earths would be needed to sustain the global consumption of resources and services. This demand has increased 2.5 times since 1961. The aim of the ecological footprint calculation is to quantify the demand of final consumption on biocapacity, but the calculations are based on the production and CO_2 emissions of primary products. Besides primary products, the ecological footprint of derived, secondary products can be calculated as well. The ecological footprint of secondary products can be calculated from the ecological footprint of primary products using the so-called extraction rate which shows the ratio of the derived product to primary product required.

Calculation of the yield factors

The yield factor is the ratio of the national average yield to the world average yield. The yield factor for a given land use type is the following:

$$YF_L = \frac{\sum_{i \in U} A_{W,i}}{\sum_{i \in U} A_{N,i}}$$

Where U is the set of all usable primary products that a given land use type yields. $A_{W,i}$ is the land required for world average products, $A_{N,i}$ is the land required for the national average products. $A_{W,i}$ and $A_{N,i}$ can be calculated with the following formulas:

$$A_{N,i} = \frac{P_i}{Y_N} \quad \text{and} \quad A_{W,i} = \frac{P_i}{Y_W}$$

…where P_i: is the total national annual growth of product *i* and Y_N and Y_W are national and world yields. $A_{N,i}$ is always the area that produces *i* within a given country, while $A_{W,i}$ gives the equivalent area of world-average land yielding *i*. (Galli et al., 2007). The primary products of all land types belong to just one secondary product, with the exception of cropland. For this type of land the yield factor can be calculated using the following equation:

$$YF_L = \frac{Y_N}{Y_W}$$

The yield factor of cropland can be determined from the yield of crops using an FAO database. The yield factor of forest is the ratio of the net annual increment of national forest stock and the net annual increment of world forest stock. The yield factor of land for carbon uptake is the same as the yield factor for forests. The yield factor of built-up land is the same as that of cropland, assuming that built-up land is built on or near productive agricultural land. The yield factor of inland waters equals one, due to lack of data regarding the productivity of freshwater ecosystems.

Table 10: Sample yield factors for selected countries

Yield	Cropland	Forest	Grazingland	Fishing grounds
World average	**1. 0**	**1. 0**	**1. 0**	**1. 0**
Algeria	0.3	0.4	0.7	0.9
Germany	2.2	4.1	2.2	3
Hungary	1.1	2.6	1.9	0
Japan	1.3	1.4	2.2	0.8
Jordan	1.1	1.5	0.4	0.7
New Zealand	0.7	2	2.5	1
Zambia	0.2	0.2	1.5	0

Source: Ewing et al. (2010). p.6.

Calculation of the equivalence factors

In order to measure the different land types in one standard measurement unit, quantification of the equivalence factors is required. This converts the various land types to the world-average productivity (Wackernagel and Rees, 1996; Monfreda et al., 2004). Equivalence factors differ by land use types and year by year as well.

The main assumption behind the calculations is the weighting of land use types according to their contribution to producing resources that are useful to humans. This assumption confirms that the ecological footprint takes an anthropogenic approach. It is assumed when classifying the different land types that land with the highest productivity is land dedicated to agriculture, irrespective of actual land use.

Calculation of the equivalence factors is based on the Global Agro-Ecological Zones (GAEZ) model combined with real land use data from the database of FAO ResourceSTAT Statistical Database. The GAEZ model classifies land (globally) into five categories according to its agricultural productivity. Each land type is then allocated a quantitative suitability index.

The equivalence factor is the ratio of the suitability index for a given land use type (world-average value) to the average suitability index for all land use types. The equivalence factor for built-up land is equal to that of cropland, and the equivalence factor for carbon uptake land is equal to that of forests (Ewing et al., 2010).

The global hectares, calculated using the equivalence factors, show how much land (of world average productivity) would be needed to satisfy the demand for products (Monfreda et al., 2004; Galli et al., 2007).

Table 11: Examples for equivalence factors

Area type	Equivalence factor (global hectares per hectare)
Cropland	2.51
Forest	1.26
Grazingland	0.46
Marine and inland water	0.37
Built-up land	2.51

Source: Ewing et al. (2010). p.8.

Calculation of biocapacity

Biocapacity refers to the land which is available in the biosphere for human needs. It is the biologically productive area that provides ecosystem services for human use.

It can be calculated using the following formula:

$$BC = A \cdot YF \cdot EQF$$

…where A is the area of land that is available of a given land use type, YF is the yield factor and EQF is the equivalence factor.

Biocapacity is the theoretical maximum of natural regenerative capacity. However, available biocapacity is not necessarily being used in a sustainable way.

The anthropogenic approach appears in the methodology for calculating biocapacity as well, as biocapacity refers to the useable and utile land available for human needs and unproductive areas and water surfaces are not included in its calculation.

The difference between the ecological footprint and biocapacity gives the ecological balance. The ability to calculate this balance is one of the advantages of the methodology as not only can environmental impact be quantified using the ecological footprint, but it can then be compared to sustainability limits (ecological balance = biocapacity – ecological footprint).

In the case of a negative ecological balance the given land has exceeded its biocapacity (regenerative capacity of natural stock) so the situation is one of ecological deficit. The population consumes more than is being produced. Consumption of imported products or the overuse of local resources leading to depletion of resources can lead to ecological deficit (overshoot).

The ecological footprint is an indicator of the environmental impact of consumption itself, not of overconsumption, as it can properly reveal the environmental load of underconsumption. This is why the methodology for ecological footprinting can be applied to quantify the environmental impact of various consumption areas.

The concept of the ecological footprint supports more equal use of the Earth's natural resources. One of the aims of sustainable development is to balance use of resources with an adequate quality of life for all (Wackernagel and Rees, 1996). The ecological footprint is an indicator of the present environmental state and the state of sustainability; it provides a common measure of all humanity's demands on the planet. Thus the ecological footprint not only highlights real unsustainable consumption patterns but it can show where change is needed and what kind of (consumption-related) measures are necessary (Wackernagel and Rees, 1996; Costanza, 2000).

Two approaches to ecological footprinting

Regarding the ecological footprinting method, two different approaches to its calculation exist today.

1. The ecological footprint developed by Wackernagel and Rees (1996) calculates the ecological footprint based on aggregate data. This is so-called 'compound' footprinting using a top-down approach. The advantage of this approach is that it measures indirect impacts properly, national data are easily modified by local data in regional calculations and the results of the detailed methodology are comparable. However, it shows less precisely the local characteristics of smaller regions.

2. The other methodology uses a bottom-up approach according to Simmons (2000), where the ecological footprint is calculated based on individual data. This makes possible the calculation of the ecological footprint not only for countries but for smaller regions, cities or even for companies. More local and regional data are needed

for this methodology, modification of assumptions can result in great differences in the results (Simmons, 2000), the methodology is not standardised.

3.5. Critical issues about the ecological footprint of food consumption

Before applying the ecological footprint indicator in my research, I felt it important to become aware of the weaknesses and shortcomings of the methodology. These are described in the following section.

For Rees (2006) the footprinting methodology presumes that we use agricultural land in a sustainable way, so when calculating biocapacity the yield factor does not include sustainable yields, but actual yields. Biocapacity does not reflect the land use required for sustainable production, but shows the actual area used for production. The reason for this methodological assumption is that there is no reliable data about sustainable yields. This methodological decision leads to confirmation that available biocapacity is overestimated in ecological footprint calculations as sustainable yields would be expected to be lower in many cases than current ones: furthermore the methodology does not make a difference between intensive and extensive types of agricultural practices. I analyse the issue of intensive and extensive agricultural production methods in footprint methodology in Mózner et al. (2012) where suggestions for methodological improvement are also given.

Lenzen et al. (2003) suggests the use of so-called disturbance factors (a multiplier between 0 and 1). By multiplying actual land use with this factor we arrive at an estimation of the amount of land which is cultivated sustainably, according to a definition provided by Lenzen et al. (2003). Fiala (2008b) also points out the fact that the ecological footprint cannot differentiate between intensive and extensive agricultural land use. It is important to note that a piece of land may have multiple functions, but in ecological footprinting only one function is assigned to a piece of land (Kitzes et al., 2007) in order to avoid double-counting (Venetoulis and Talberth, 2007).

The measurement unit of the ecological footprint is global hectares and hectares of world average productivity. The use of global hectares refers to the ‘calculated land’ approach. If the land area is expressed using actual national yields then we arrive at real land use – this approach is termed the ‘measured land’ approach (Bicknell et al., 1998; Lenzen and Murray, 2001).

Using hypothetical global hectares could lead to dangerous outcomes as many could interpret them as being real hectares; furthermore, even when measuring with real hectares the methodology still does not indicate actual land use, which may be relevant on the national and a regional level. Researchers increasingly suggest that ecological footprint should be calculated in real hectares (Wiedmann and Lenzen, 2007). Kissinger et al. (2012) recommend using both real and hypothetical land use in ecological footprinting calculations, pointing out the advantages and disadvantages of the two approaches.

Table 12: A summary of studies that analyse methodological questions regarding the ecological footprint of food consumption

Methodological issue	Relevant scientific literature
Calculating the biocapacity of the agriculture	Lenzen and Murray (2003) Lenzen et al. (2006) Rees (2006) Kitzes et al. (2007) Giljum et al. (2007) Fiala (2008b)
The use of local, real hectares or global hectares	Wackernagel et al. (2004b) Van Vuuren and Bouwman (2005) Kitzes et al. (2007) Giljum et al. (2007) Wiedmann and Lenzen (2007) Hoekstra and Chapagain (2007) Kissinger et al. (2011)

Source: Author's own compilation based on Best et al. (2008)

3.6. General methodological questions

Land required for 'fossil fuel use' (i.e. land required for carbon uptake) comprises almost 50% of the total ecological footprint. Ayres (2000) questions this result, as according to the indictor it is possible that there is not as much land available on Earth as is sufficient to support sustainable energy use. He advises using CO_2-emissions as a separate indictor.

Calculating waste flows is incorporated into the ecological footprint with the exception of toxic waste and biologically non-degradable wastes, which are not entirely incorporated. Nor are water flows calculated within the ecological footprint indicator. Hoekstra (Luck et al, 2001; Lenzen, 2003; Hoekstra and Chapagain, 2007) have developed a separate indicator (the water footprint) which is independent of the ecological footprint.

The ecological footprint cannot show the impact of human production on biodiversity so it cannot be used as a biodiversity indicator for a specified area. According to van Kooten and Bulte (2000), the ecological footprint is a complex indicator; it can be used to synthesize data about resource-use, income and population. When analysing results it should be taken into account that, because of the aggregate data used, an improvement in one land use type can be offset by deterioration in another type of land. According to Moffat (2000), economic, social and environmental sustainability should not be measured solely using one indicator.

Critical perspectives concerning the ecological footprinting methodology and suggestions for possible methodological improvements can be found in more detail in the following papers: van den Bergh and Verbruggen (1999), Ayres (2000), Costanza (2000), Neumayer (2004), Kitzes et al. (2007), Venetoulis and Talberth (2008), Best et al. (2008), Fiala (2008b) and Kitzes et al. (2009a-b).

3.7. The significance of using the ecological footprint indicator

Despite the several methodological shortcomings and the criticism of the ecological footprint which exists, there are many arguments which support the use of this indicator.

For a long time, evaluation of environmental impacts were production-oriented but these production-oriented environmental solutions (such as a focus on improving eco-efficiency) did not decrease environmental impacts. Development of the ecological footprint was done exactly at the time when the consumption approach started to appear in ecological economics (Wackernagel and Rees, 1996). The core and significant novelty of the ecological footprint is that its methodology and meaning is consumption-centred; it shows the environmental impacts of consumption and it emphasises the responsibility of the consumer. Using the ecological footprint, the impacts of different types of land use can be analysed and the environmental impact of national consumption can be compared. The environmental burden generated by economic sectors can be evaluated from a responsibility-for-consumption perspective.

The indicator can be used for individuals; it can be interpreted easily and it highlights individual consumer responsibility and suggests which areas of consumption consumers should address to decrease the environmental impact of their consumption. Local and global environmental responsibility can easily be connected using the ecological footprint. The results from household ecological footprint analyses can be summarised and aggregated and these results can be analysed at a regional or national level as well.

The ecological footprint is a biophysical indicator; this bring us closer to correctly analysing research questions connected to land and resource use (Borgström et al, 1999; Wackernagel et al., 1999a). The indicator incorporates impacts from international trade as well by taking into account both imported and exported products.

As the indicator compares the environmental impacts of consumption, it defines the ecological balance and defines unsustainable consumption by taking into account the finite nature of natural resources. The ecological footprint therefore suits the strong environmental sustainability approach (Neumayer, 2003).

As for the uses of the ecological footprint, it is not appropriate for measuring social welfare and non-environmental aspects of sustainability (Wackernagel, 2010). It is designed to highlight the minimum conditions for sustainability (i.e. living and consuming within the limits of natural resources). The ecological footprint is appropriate for comparing different lifestyles based on aggregate data (Wackernagel and Rees, 1996). Hammond (2006; 2007) argues that the ecological footprint is an alternative, quantitative indicator which can express the steps required to move towards a higher level of sustainability. Thus the ecological footprint and its related indicators are appropriate for showing by how far we have exceeded biophysical limits – and in which areas (Costanza, 2000).

The indicator shows for a certain date the land use required by consumption; it gives a 'snapshot' of the resource use of a given population (Wackernagel and Rees, 1996). The methodology is not dynamic, though the results can be compared over time and space as well, so changes in a dynamic system are traceable. The methodology is appropriate for expressing trends and slow changes; it can supplement well environmental indicators which measure quick changes in flows and states.

The utility of the indicator has already been tested (i.e. whether it can also be used in environmental policy, during political decision making, the environmental evaluation of production processes and its application in research projects (Herva et al, 2008; Niccolucci et al, 2008; Stoeglehner and Narodoslawsky, 2008)). One of the uses of the ecological footprint is to help decision makers (Wackernagel and Yount, 2000) by measuring and defining sustainable and unsustainable processes and products. Even the European Union has noticed the possibilities inherent in using the ecological footprint and examined whether it is appropriate for measuring the use of natural resources (Best et al., 2008). This research examined the use of the ecological footprint along with other methodological tools and indicators.

The result of the footprinting methodology is an index which makes the interpretation of environmental issues and their communication in policy, education and environmental campaigns easier, so it represents a useful tool for communicating about resource consumption. According to a survey by Szigeti (2012), the ecological footprint is the most well-known environmental indicator in Hungary. Csutora (2011) confirms that the ecological footprint is one of the most accepted and most cited indicators. The methodology has been well developed by the Global Footprint Network. The ecological footprint is an appropriate tool for drawing the attention of different social groups to their environmental load. The ecological footprint helps identify minimum conditions for sustainability; its utility is acknowledged despite its methodological shortcomings (Kitzes et al, 2009a). It can be used to broadly indicate environmental impact and it is a good tool for measuring the ecological cost of political decisions. The methodology is continuously developing; new alternatives and suggestions are evolving, taking into account the critiques which exist (Kitzes et al, 2009a).

Summarising the chapter, ecological footprinting is an appropriate methodological approach for measuring sustainability and the environmental impacts of food consumption. The ecological footprint can be used to call attention to the limits of resource use and it can indicate the use of which resources generates significant environmental load. Having a consumption approach is its great advantage, since on the one hand it is able to quantify the impacts of consumption and on the other it can be used to highlight the role of trade in the distribution of ecological, environmental resource and environmental load.

In summary, Kocsis (2010b, p.5.) states that the ecological footprinting methodology is appropriate and that "*we regard this indicator as an important, approximate value of human load using the system of the living Earth and that of human control over the biosphere*".

IV. Literature review - the environmental impacts of food consumption

The aim of this chapter is to provide a review of research which has focused on measuring the environmental impacts and resource use of food consumption and has applied land use, CO_2-emissions and the ecological footprint as indicators. I present in a separate sub-section a review of research into both environmental and health factors, which are the antecedents of my research.

4.1. Literature review - the land use demands, CO_2 emissions and ecological footprint of food consumption

Gerbens-Leenes and Nonhebel (2002a) calculated land requirements per person using production data from the Netherlands and conducted an international comparison of 14 countries in which they specified the land requirements of the most important food consumption categories and identified major consumption patterns. The authors called attention to the fact that future demands for land might increase, not only due to population growth but because of changing consumption patterns. Between 1950 and 1990 the land required for food production has grown by one third in the Netherlands due to increases in consumption of meat and due also to consumption of coffee, wine and beer which make high demands on land as well. 10% of European land use is devoted to the production and manufacturing of four drinks: beer, wine, coffee and tea.

In another piece of research, Gerbens-Leenes and Nonhebel (2002b) introduced a piece of methodology designed to define the land requirements of more than 100 food categories by which the total land requirement for consumption could be identified. Their results cannot be generalised, though with relevant and suitable data the methodology can be applied to other countries.

Pimentel and Pimentel (2003) examined the differences between the land, energy and water requirements of meat and plant-based diets, assuming that the caloric value of the diets were equal. Due to consumption of food in the USA alone, 50% of the total land, 18% of non-renewable energy sources and 80% of water is used during agricultural production. The authors compared the land, energy and water requirements of a typical modern diet with a high meat diet and a lacto-ovo-vegetarian diet. They found that a meat-based diet required more embodied energy than a plant-based diet so they regard the latter to be more sustainable. The authors state that the structure of

American agricultural production is not sustainable and it is based on excessive reliance on fossil resources. Significant structural changes would be required if the number of people who eat meat-based diets were to be decreased in number.

Cowell and Parkinson (2003) identified the land and energy use required for the United Kingdom's food consumption for 1992. They examined 14 food categories (by inspecting produced, consumed, exported and imported quantities of food) and came to the conclusion that local food production could be become a reality by changing consumer wants. Not all types of food could be produced in the United Kingdom, but their consumption could be replaced by other food types of the same category. The food consumption categories were rated regarding their contribution to self-sufficient agriculture in the UK. The authors note that the production of a food type within a country's borders is not desirable when the joint resource efficiency of production and transportation of an imported product is higher than that of the locally-produced product. In this case, the consumption of the imported product results in less environmental load and it is more reasonable to import it. The novelty in this study was the use of real consumption data in the calculations undertaken.

Schmid and Lohm (2005) analysed the environmental impacts of food consumption in the Swedish town Linköping between 1870-2000. Due to consumption and the supply of imported products the need for land has doubled, but only a quarter of the amount of local resources is needed due to improvements in the efficiency of local production.

Steinfeld et al. (2006) give a summary about the environmental impacts, trends and future prospects of livestock production. Zhu et al. (2006) examined the global meat consumption of low, middle and high income groups and likely impacts on GHG emissions. If the high-income group replaced their consumption of 10 kg of meat with non-meat products, then a significant decrease in methane and dinitrogenoxide emissions could happen, but not necessarily in the regions where the replaced food was consumed. The authors state that changing the lifestyles of high income people is not enough, as the middle income group is growing and along with it their consumption of meat. The need to change the food consumption structure was highlighted by this study.

Gerbens-Leenes and Moll (2006) identified the land, fresh water and energy needs of Dutch food consumption by conducting time-series research for 1950 and 1990. 17 food categories were analysed and grouped into five larger categories (beverages, fats and oils, meat, dairy products and cereals). Their analysis confirmed that there are growing food-consumption related demands for resources.

The land use of Dutch livestock production has been calculated by Elferink and Nonhebel (2007) who distinguished between poultry, pork and cattle production (representing 90% of Dutch meat consumption). Their results showed there could be up to three times the difference in the land requirements of the various animals.

The potential GHG emissions of future meat consumption have been examined by Fiala (2008a). According to their findings, because of expected growing demand, agriculture will have a greater role in decreasing emissions.

According to the research of Risku-Norja (2011), 70% of total emissions result from primary production in Finnish agriculture, taking into account the production of fertilizer and the energy use of agriculture as well. If a shift was made towards a strict vegetarian diet, GHG emissions could be decreased by 50%. A diet without consumption of any products made from ruminant animals could decrease the emissions of agriculture by 33%. This decrease in the emissions of agriculture would mean a 5-8% reduction of total Finnish emissions. Risku-Norja et al. (2009) analysed the environmental impacts of dietary changes. The authors stress that as the alternatives presented in the scenarios are not fully realistic, it would be instrumental to introduce changes to public catering and in the meals provided for schools. Through dietary changes, Finnish GHG emissions could be decreased by 2-6.6%.

Garnett (2009) studied the alternatives for decreasing GHG emissions in the livestock production sector. The indirect impacts of livestock production were identified using land use and CO_2 emissions as indicators for the year 2050. The author framed political recommendations in order to reduce emissions, taking into account the need to increase food security.

Various food consumption scenarios were developed by Stehfest et al. (2009) in order to examine the opportunities to reduce environmental impacts through dietary changes. CO_2 emissions could be globally reduced by 20% between 2010 and 2050 and the costs of climate change could be lowered by 50% if people had healthier diets (i.e. consumed less meat). Stehfest et al. (2009) used GHG, CO_2 emissions and land use as indicators in the scenarios.

Risku-Norja (2011) analysed the GHG emissions of a vegetarian diet and confirmed that through dietary changes negative environmental impacts could be mitigated. Though GHG emissions would decrease if people followed vegetarian diets, this change would not be optimal for biodiversity. Her study highlights that not only relative results but reductions in absolute terms are important.

Huber at al. (2011) examined the CO_2 emissions of German lifestyle groups, stressing that technological development is not enough to mitigate environmental impacts. The lifestyles and daily routines of consumers should be investigated. Their results show that CO_2 emissions from the food consumption of the lifestyle group with a higher income and social status is higher, but the environmentally-conscious ‘eco-elite’ have lower CO_2-emissions due to their lower consumption of meat and fish.

Palmer (1998) used the ecological footprint to define the environmental impacts of US food consumption. According to the author’s results, red meat consumption accounts for 79% of the ecological footprint. American food consumption is not sustainable and red meat consumption should be reduced by 50%.

Wackernagel (1999b) shows the methodology for bottom-up calculation of the ecological footprint, using the example of Italian food consumption.

White (2000) identified and compared the ecological footprint of the American, European and Oceanic diet and he further examined the differences between a meat-based and a vegetarian diet. His research pointed to the higher impact of meat consumption in all the regions which were analysed.

Deutsch and Folke (2005) analysed in their research the ecological footprint of Swedish food consumption between 1962 and 1994. The consumption of locally-produced products has dropped to one half of former times because of the increase in the supply of imported products. It was found that 35% of the environmental impact of food consumption related to land use beyond the country borders and a great proportion of fodder growing for livestock production required foreign land use. The study highlights the dependency of Swedish agriculture on foreign land and the significance of Swedish households’ consumption of food.

Ádám et al. (2010) studied the ecological footprints of Hungarian youngsters according to their food consumption patterns. The ecological footprint was significantly lower for those who consumed less meat and fish. Ádám et al. (2011) also analysed the ecological footprint of Hungarian organic food consumption and stated that those who consume organic food more often can claim to have a lower footprint than those who never consume it. These two studies are based on a smaller, non-representative sample; furthermore, the ecological footprint intensities were not calculated from the academic footprint methodology of the Global Footprint Network (a scoring system was used, which leads to less reliable results).

Chen et al. (2010) conducted an analysis of the environmental impacts of food consumption in rural China between 1980 and 2010 using the ecological footprint. The environmental load of food consumption has increased continuously over the last 30 years, particularly because of increases in meat consumption, which has resulted in a greater demand for fodder. The consumption of seafood has grown as well. The increasing productivity of land has compensated for some of the increases in requirements for land. Results show that, while consumption patterns have changed, the food category with the greatest ecological footprint still remains cereal production and consumption, although this decreased throughout the period examined. Ecological footprints show close correlation with expenditure on food and this may be traceable using time-series analysis as well.

4.2. The environmental and health aspects of food consumption

There is more and more research in the field of environmental and ecological economics which is designed to examine both the environmental and ecological aspects of food consumption. However, there have only been a few diet-related studies which have supplemented examination of health aspects with environmental and sustainability arguments. Not many research and health recommendations exist which link these two topics.

Research by Gussow and Clancy (1986) was the very first to define a sustainable diet as a combination of environmental and health factors, following an examination of American agriculture. The authors studied environmental and health arguments together and their health recommendations were supplemented by environmental arguments which highlighted the importance of these two aspects.

Herrin and Gussow (1989) analysed local food consumption from health and environmental perspectives. They looked for alternative healthy and balanced diets which were based on local products, taking into account the seasonality of the products and their local availability. The need for a sustainability-based dietary guide is emphasized.

Gussow (1999) lists the environmental and health advantages of local food consumption and reacts to the reviews of his previous article (Herrin and Gussow, 1989). Later, Leitzmann (2003) provided a survey of the history and definition of nutrition ecology and called attention to the role of dietetics in sustainability issues.

Horrigan et al. (2002) evaluate the environmental impacts of different production methods based on a literature review. They call attention to the relationship between the structure of food consumption and its health impacts. They find that decreases in meat consumption would be favourable both for environmental and health reasons. Furthermore, they frame the conditions required for sustainable agriculture, stress the need for individual and collective solutions and stress that not only resource use but the future perspectives of food security should be analysed.

Wallén et al. (2004) looked at the impacts of dietary changes on energy use and greenhouse gas emissions. Typical Swedish diets were compared to a 'sustainable diet' which the authors defined. The concluded that only minor energy and GHG savings could be realised by changing the structure of diets without changing the conditions of food production. According to their results, greater reductions could be made by changing agricultural conditions which are presently based on fossil energy use, and changing distribution systems.

The results of Michaelowa and Dransfeld (2008) point out that healthier food consumption and a reduction in obesity would not only lead to the reduction of GHGs, but if people had lower body weights the greenhouse-gas emissions from transportation would decrease as well.

Duchin (2005) examined the health and environmental aspects of food consumption and claims for the (mostly plant-based) Mediterranean diet. This diet fulfils requirements from both health and environmental perspectives and is based on Greek nutritional patterns of the 1960s. According to Duchin's arguments, besides analysing the consumption patterns of countries separately, more comprehensive research with more countries and regions is needed. Such research could contribute to the strategy of the WHO. Duchin points out that the present Western and American diet can lead to obesity and other chronic illnesses, primarily due to its high caloric value, animal-based dishes and added sugar.

Research from Walker et al. (2005) also presents environmental and health aspects and is one of the few pieces of work which draws the attention to preserving both the health of humans and the health of ecosystems. The authors, after presenting the connections between environmental and health issues, conclude by giving recommendations for public policy De Boer et al. (2006) analyses the structure and quantity of protein consumption (g/person) from animal and plant-based diets in the EU-15. The authors used the database of protein consumption of FAOStat and Eurostat and conducted a multivariate principal component analysis. The consumption of animal and plant-based protein differs significantly in countries with different food production and supply systems. Portugal, Greece and Italy are one pole of consumption (where most of the protein comes from consumption of vegetables and cereals) while the Netherlands, Sweden and Finland represent the other pole, where animal-based protein consumption is dominant.

Frey and Barett (2006) examined (in Scotland) the ecological footprint of food products taking into account the source of production and the impacts of imported products. Results show the high impacts of meat-based and imported food. The authors compared the actual average ecological footprint with the footprint of a diet based on nutritional recommendations, called attention to the need for structural changes and to changes in quantities as well. With a healthy diet the ecological footprint could be decreased by 15% and with a vegetarian diet the reduction could be 34%. Consuming organic products would not provide for a significant reduction in the ecological footprint (estimated at 1%). Frey and Barett (2007) calculated the differences between actual and healthy diets in the United Kingdom as well. They find that a healthy diet would reduce the ecological footprint by 22% and a vegetarian diet would contribute to a reduction of 18% (and organic food consumption by 2%). The authors call for greater harmonisation of environmental and health policy measures.

Carlsson-Kanyama and González (2009) discuss the need for integrating environmental and health education and ensuring their combined application.

Friel et al. (2009) compare the opportunities for reducing CO_2 and GHG emissions: reduction from the production side by using more efficient technology, or reduction from the consumer side stemming from changes in diets. The analysis was conducted using the example of the United Kingdom and Sao Paolo and possible consequences on human health were analysed. The authors state that technological reduction alone would not lead to any health impacts but that consuming less meat would contribute to lowering CO_2 emissions. Additionally, according to their model, coronary heart disease would decrease in the United Kingdom because of the decrease in consumption of animal fats.

Lock et al. (2010) developed four scenarios for examining the health and economic consequences of consuming according to the WHO guidelines, using the United Kingdom and Brazil as locations for the analytical procedure. Results show that, in the United Kingdom, a country with a higher income, the health impacts of decreasing meat consumption would be greater than for Brazil. As for economic impacts, reducing meat consumption would be more harmful to Brazil (i.e. lead to a decrease in GDP and a rise in unemployment) where food production and agriculture has a bigger role in the economy and the reduction in demand for meat would create a surplus labour force.

Tukker et al. (2011) investigated the impacts of making a change towards a healthier diet in Europe by analysing the food consumption clusters of the EU-27 countries, taking into account meat and vegetable consumption. According to these results, Hungary belongs to the Western European cluster, having the highest calorie intake per person (according to 2003 data). The high caloric value is due to consumption of animal fats, dairy products and alcoholic beverages. Five consumption clusters can be defined according to Tukker et al. (2011); they are more or less named after their geographical locations:

- Nordic countries and France: very low vegetal/animal energy ratio
- Western Europe: less animal-based consumption (in terms of calorie, protein and fats) than in Northern Europe, but low vegetal/animal energy ratio
- South-Western European: low animal fat consumption, high vegetable and fish consumption
- Eastern Europe: high vegetal/animal energy ratio, lower fish consumption than in Southern Europe
- South-East-European: high vegetal/animal energy ratio, high cereal consumption

The authors examined three possible scenarios for changes in diets using a status quo: 1. the recommended healthy diet; 2. a recommended healthy diet, with less consumption of red meat; and, 3. a Mediterranean diet with less meat consumption. They assessed impacts on the following environmental areas: climate change potential, ozone depletion, eco-toxicity, freshwater eutrophication, terrestrial acidification, etc. Environmental input-output tables were used to model the impacts of calorie and dietary changes on the environmental indicators. In the case of a shift to a healthy diet there would not be any significant changes in environmental impact. Impacts could be reduced by 8% if consumption of red meat was replaced with poultry, fish and cereals (this would mean a total reduction of 2% of household environmental impacts). The results take into account the rebound effects as well, but land use change was not analysed. Shifting to a Mediterranean-type diet would result in a 10% reduction in environmental impacts, but according to the authors it is not totally obvious if this type of diet would be ideal from an environmental or health point of view. The authors draw our attention to the secondary impacts of dietary changes: they note that the import-export balance of the EU-27 would change as a reduction in meat consumption could have impacts on external trade; it could therefore mean a decrease in meat imports from non-European countries. Such a reduction in meat consumption could have an impact on the European meat industry itself as well, and the reduction in demand would likely be compensated for by growing exports. The study highlights the fact that the greater the reduction in meat desired from a dietary perspective, the more drastically changes are needed in consumption structure. Furthermore, the Mediterranean diet is rich in fish and seafood, so the environmental impact of increasing fish consumption should be investigated in the future.

Macdiarmid et al. (2011) examined the possible effects of a low-impact and healthy diet until the year 2020. They claim that there are no significant differences between a healthy diet and a low-impact diet. The emphasis is on consuming less meat and diary products and more vegetables. The study does not take into account the seasonality or local nature of the food products.

Fazeni and Steinmüller (2011) analysed changes in land and energy use and CO_2 and GHG emissions. Emissions from agriculture could be decreased by 37%, energy use by 38% and significant changes could be made in land use as well if healthy food consumption patterns were adopted. The recommendations of the German Nutrition Society were applied when developing a healthy diet. Meat consumption could be decreased by 60%, but the consumption of vegetable and fruit could increase. The impacts would be lower energy use and GHG emissions and a significant increase in the area of available land which could be suitable for producing renewable energy. Various scenarios were developed which included examination of factors of self-sufficiency and the importation of products.

Wilkins et al. (2008) call for the need to integrate food system awareness into professional practice and the need to ensure that health and environmental issues are handled together.

Peters et al. (2007) have investigated the land requirements of 42 diets which measured the impacts of fat and meat consumption. The authors concluded that almost a fivefold difference in per capita land demand (0.18–0.86 ha) is possible according to which diet is followed, and that a high-fat vegetarian diet can require more land to produce than a lower fat diet containing meat.

Wilkins et al. (2008) examined the land demands of low-carbohydrate, high-protein diets and those of a diet based on official nutritional recommendations. A high-protein diet has a land requirement that is twice as high as the recommended diet.

In some countries guidebooks exist which present details on how a sustainable diet could be realised by integrating health and environmental aspects – for example, in Great Britain (Reddy et al., 2009), and in Sweden (National Food Administration, 2009). These guidelines are based on environmental considerations and not primarily on health-related factors. A recommendation published in the United States (The 2010 Dietary Guidelines Advisory Committee, 2010) advises people to consume less meat and more vegetables but does not recommend a diet without meat because of the possible health risks. According to the publication, the replacement of meat with dairy products would not necessarily decrease the environmental impact of the diet, which was also the conclusion of other research (e.g. Stehfest et al., 2009). Research by the Health Council of the Netherlands (2011) summarises findings on the topic of healthy food consumption and its related environmental impacts and confirms that there is a strong correlation between environmental impact and diet.

4.3. Summary of the literature review

Different methodologies exist which are designed to measure environmental impact but the results lead to the same conclusion – namely, agricultural production has the largest environmental impact when taking into account the whole lifecycle of food consumption. The impacts of transportation and packaging follow, but they are usually lower than agricultural production itself. Fuchs and Lorek (2000) summarised the literature on household food consumption patterns and they conclude that food consumption should be analysed using a global model, and that global measures are needed to decrease its impacts.

I may therefore conclude that the production of vegetables and fruit requires less land and energy and causes less GHG emissions than the production of meat – but only if the transportation impacts of the vegetables do not negatively compensate for their production benefits.

White (2000), Gerbens-Leenes and Nonhebel (2002a-b) and Tukker et al. (2006) analyse the environmental impacts of meat consumption and draw the reader's attention to the importance of consuming less meat. Results from Gerbens-Leenes and Nonhebel (2002a-b) show that food consumption patterns (and consumption structure) could play more important role in questions of resource use than population growth in the future, and that the topic of growing land use should be dealt with as well.

There is a growing need for a diet which is more healthy than the present one and from an environmental perspective this could be a low-impact diet, as it requires less land use and causes fewer CO_2 emissions (Stehfest et al., 2009; Gerbens-Leenes et al., 2002a-b; Frey et al., 2007).

After this survey of the relevant research, as presented here, I can state that the following important research topics were dealt with concerning the literature on the environmental impacts of food consumption:

- The environmental impacts of meat and plant-based diets
- Time-series analysis of the impacts of food consumption
- The environmental impacts of food categories
- Potential reductions in impacts from changing the food consumption structure

There is further research which takes into account both environmental and health aspects but this constitutes a separate field of research.

The following two tables give a systematised overview of the relevant research. Table 13 shows work which has been conducted primarily from an environmental point of view. Table 14 shows studies which have integrated environmental and health aspects more or less equally.

The research is grouped by the type of methodology utilised.

Table 13: A summary of studies on the environmental impact of food consumption

Author	Year	Journal	Subject of analysis	Applied methodology and indicator	Main results and conclusions
de Boer et al.	2006	Ecological Economics	structure and quantity of protein consumption in the EU-15	Clustering the consumption structure of countries	There are two poles of protein consumption
Garnett	2009	Food Policy	global livestock production	CO_2 and GHG accounting	Political recommendations in order to reduce emissions
Huber et al.	2011	Sustainable Consumption- Towards Action and Impacts Conference	food consumption of German lifestyle groups	CO_2 accounting	Lifestyle group with a higher income and social status have higher CO2 emissions
Chen et al.	2010	Agriculture and Agricultural Science Procedia	food consumption in rural China between 1980 and 2010	ecological footprint	Increasing ecological footprint due to structural changes, which is compensated for some of the increases in requirements for land
Deutsch and Folke	2005	Ecosystem	Swedish food consumption between 1962 and 1994	ecological footprint	Increasing ecological footprint and increase in the supply of imported products, consumption of locally-produced products has dropped to one half of former times

Author	Year	Journal	Subject of analysis	Applied methodology and indicator	Main results and conclusions
Palmer	1998	Electronic Green Journal	US food consumption	ecological footprint	Red meat consumption accounts for 79% of the ecological footprint
Wackernagel	1999b	Ecological Economics	Italian food consumption	ecological footprint	Methodology for bottom-up calculation of the ecological footprint
White	2000	Ecogical Economics	American, European and Oceanic diet	ecological footprint	Diets with higher meat consumption have higher footprints
Duchin	2005	Journal of Industrial Ecology	Western and American diet	literature review	Mediterranean diet (mostly plant-based) has lower environmental impact
Elferink and Nonhebel	2007	Journal of Cleaner Production	Dutch livestock production and meat consumption	land use	There could be up to three times the difference in the land requirements of poultry and cattle production
Gerbens-Leenes and Nonhebel	2002a	Ecological Economics	international comparison of 14 European countries	land use	Demands for land might increase, not only due to population growth but because of changing consumption patterns
Gerbens-Leenes and Nonhebel	2002b	Agriculture, Ecosystems and Environment	100 food categories in the Netherlands	land use	Development of methodology designed to define the land requirements, methodology can be applied to other countries
Schmid and Lohm	2005	Human Ecology	food consumption in the Swedish town Linköping between1870-2000	land use	Due to consumption and the supply of imported products the need for land has doubled

Author	Year	Journal	Subject of analysis	Applied methodology and indicator	Main results and conclusions
Cowel and Parkinson	2003	Agriculture, Ecosystems and Environment	food consumption in the UK, 14 food categories	land use; energy analysis	Local food production could become a reality by changing consumer wants
Gerbens-Leenes and Nonhebel	2007	Pathways towards Sustainable Food Consumption Patterns	Dutch food consumption between 1950 and 1990, 17 food categories	land use; water use; energy analysis	Increasing reource demand because of changes in consumption structure
Pimentel and Pimentel	2003	American Journal of Clinical Nutrition	meat and plant-based diets in the USA	land use; water use; energy analysis	Significant differences between resource demand of meat and plant-based diets
Fiala	2008	Ecological Economics	global meat consumption and future changes in demand	GHG accounting	Agriculture will have a greater role in decreasing emissions
Risku-Norja	2009	Ecological Economics	Finnish food consumption and structural changes	GHG accounting	70% of total emissions result from primary production in Finnish agriculture, a diet without consumption of any products made from ruminant animals could decrease the total Finnish emissions by 5-8%

Source: Author's own compilation (2012)

Table 14: A summary of studies on environmental and health aspects of food consumption

Author	Year	Journal	Subject of analysis	Applied methodology and indicator	Main results and conclusions
Wallén et al.	2004	Environmental Science and Policy	typical Swedish diets were compared to a 'sustainable diet'	energy analysis and GHG accounting	Minor energy and GHG savings could be realised by changing the structure of diets without changing the conditions of food production
Tukker et al.	2011	Ecological Economics	food consumption clusters of the EU-27 countries	environmental impact analysis	Food consumption clusters of the EU-27 countries, three possible scenarios for changes in diets, shifting to a Mediterranean-type diet would result in a moderate reduction in environmental impacts
Collins and Fairchild	2007	Journal of Environmental Policy and Planning	food consumption in Cardiff	ecological footprint	Actual food consumption is moderately healthy, minor changes in food consumption could result in significant changes of the ecological footprint
Frey and Barrett	2006	Report for Scotland's Global Footprint Project	food consumption in Scotland, typical Scottish diets were compared to a healthy diet	ecological footprint	With a healthy diet the ecological footprint could be decreased by 15%

Author	Year	Journal	Subject of analysis	Applied methodology and indicator	Main results and conclusions
Frey and Barrett	2007	International Ecological Footprint Conference	food consumption in the UK, differences between actual and healthy diets	ecological footprint	A healthy diet would reduce the ecological footprint by 22%
Stehfest et al.	2009	Climatic Change	global food consumption between 2010 and 2050	land use, CO_2 and GHG accounting	CO_2 emissions could be globally reduced by 20% if people had healthier diets
Fazeni and Steinmüller	2011	Energy, Sustainability and Society	agricultural production and food consumption in Austria	land use; energy analysis and GHG accounting	Meat consumption could be decreased by 60%, emissions from agriculture could be decreased by 37%
Friel et al.	2009	Lancet	food consumption and state of health in the United Kingdom and Sao Paolo	GHG accounting	Technological reduction alone would not lead to any health impacts but that consuming less meat would contribute to lowering CO2 emissions
Macdiarmid et al.	2011	World Wildlife Fund Report (Livewell report)	differences between a healthy diet and a low-impact diet	GHG accounting	There are no significant differences in structure and environmental impacts between the two types of diets

Source: Author’s own compilation (2012)

4.4. Food consumption in Europe and in Hungary

In this section I examine the changes in the quantity and structure of food consumption in Europe and Hungary.

Expenditure on food has risen by 10% in absolute terms during the last decade in Europe (Eurostat, 2009); food purchases account on average for 12% of total household expenditure. In lower income countries expenditure on food consumption takes 20% of household expenditure. Despite increasing expenditure and growing incomes, expenditure on food is continuously decreasing (as part of total expenditure). Between 1995 and 2005, the proportion spent on food fell from 14.1% to 12.5% (EEA, 2005). The price and income elasticity of food consumption is already low. Expenditures on food consumption have decoupled from GDP growth trends across the European region but if we look at structural changes, tendencies are revealed that compensate for this development.

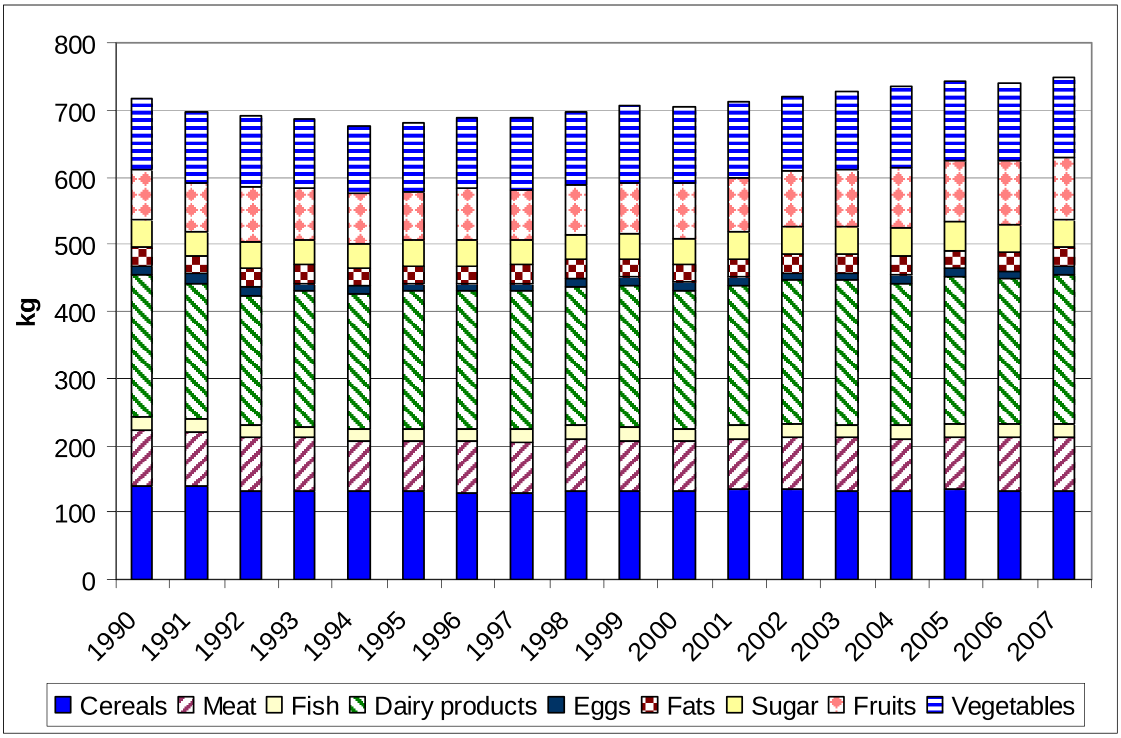
According to a report by the FAO (2010), calorie intake has increased both in developed and developing countries and the share in the diet of animal-based products and vegetables is increasing. Consumption of vegetables, meat and milk per person have increased worldwide. Fat intake has risen (especially the consumption of fats and oils of vegetable origin) – by 112% in developed countries and by 191% in developing countries in the years from 1961-1963 to 2001-2003.

Meat consumption has tripled during the last 50 years across the world (275 million tons in 2007) while the world's population has only risen by 81%, so meat is increasingly consumed. Rising income levels have influenced the consumption of food as well. According to Grigg (1994), in Northern and Western Europe a rising income level has contributed to a preference for animal-based products. Calorie intake is rising in Europe as well (by 7% between 1994-2007) so the average daily calorie intake per person is now 3400 kcal, which is above the recommended level. Despite increasing health consciousness, the numbers of those who are overweight or obese is high in European countries.

There has been a change both in the quantity and in the structure of the food that is being consumed. Consumption of resource-intensive products has increased within the European Union: a trend towards increasing consumption of meat, cheese, fruits and bottled beverages can be observed.

Figure 2 shows changes in European food consumption. Between 1990 and 1994 the quantity of food consumed per person decreased slightly while from 1994 consumption increased. The quantity of food consumed increased by 10% between 1994 and 2007. Consumption of cereals lessened but the consumption of other foods increased. Consumption of meat, fruit and vegetables particularly increased. There is a significant difference between the meat consumption of developed and developing countries, as 78.6 kg of meat/person are consumed on average in developed countries and 31.9 kg/person in developing countries. The world average consumption is 42 kg/person (FAO, 2011a). Consumption of fruit grew between 1990 and 2007 by 26% because of the increasing supply and the decreasing price of imported fruit.

Figure 2: Food consumption in Europe (1990-2007)



Source: Author's own compilation based on FAO (2012)

There have not been any significant changes in the structure of food consumption; the proportion of cereals in the average diet slightly decreased (from 19% to 17%), the share of fruit consumption grew from 10% to 12%, and the proportion of other food products was stable between 1990 and 2007.

It is important to note that a dramatic increase in imported products occurred (EEA, 2010) due to the increasing globalisation of the food market. Demand for fresh, seasonal vegetables and fruits decreased but demand for imported products grew, thus the environmental impact of transportation also grew.

An increasing amount of food waste presents a problem as well. In Europe and North-America, food waste from households amounts, on average, to 95-115 kg per person, while in Africa and South and Southeast-Asia it is only 6-11 kg (FAO, 2011b).

In order to evaluate the characteristics and trends in food consumption, analysis of the consumption quantity and structure might not be enough; food consumption that takes place outside the home can play an important role in overall household consumption (Payer et al., 2000; OECD, 2002; EEA, 2005). Changing lifestyles have lead to there being less time available for food preparation and new food consumption habits have developed (Szabó, 1998; Gaál, 1998; Orbánné Nagy, 2006). People eat out more frequently due to rising income levels and an increase in the number of small and single households (EEA, 2005). Omann et al. (2007) states that consumption of pre-prepared and frozen food occurs more frequently, and this implies an increase in the consumption of ready-to-eat, highly processed food.

The same trends can be observed in Hungary as for Europe regarding food expenditure. Expenditure on food per person has risen but accounts for a decreasing share of total household expenditure. Between 2000 and 2009, expenditure on food rose by 50% although it accounted for 28% of total expenditure in 2000 and 22% in 2009. In this period the consumer price index grew as well.

Examining the changes in the quantities of food consumed shows that, after the economic downturn in the 1990s, the quantity of food consumed decreased compared to the previous decades in all food categories except for dairy products and milk consumption (KSH, 2011). Since the 1990s meat consumption has decreased and the structure of diets has changed favourably as well. In Hungary the consumption of poultry comprises a great part of all meat consumed. This tendency is favourable in environmental terms as poultry has a lower environmental load than pork or beef.

Analysing food consumption in the period between 2002 and 2009 shows that the quantity of food consumed decreased by 18%. This may be due to rising food prices. A decrease can be observed for all food categories with the exception of yoghurt, sour cream, cheese products and other dairy products. Besides these items, the consumption of peaches (+33%) and cabbages (+23%) increased after 2002, while the consumption of other vegetable and fruit categories decreased.

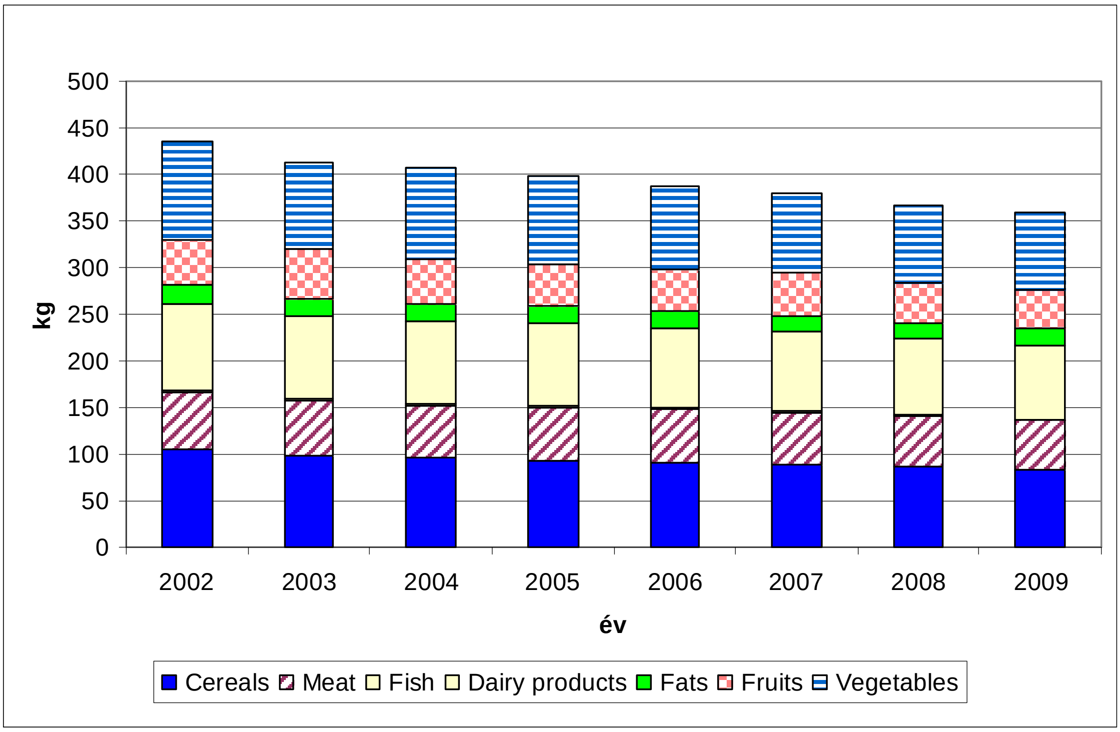
The proportion of bread and cereals consumed did not change in the last period; it accounts for 23% of all consumption. The share of poultry and pork, meanwhile, grew as a percentage of total meat consumption. Poultry products comprised 18% of total meat consumption in 1980 while in 2009 they accounted for 45% of all meat consumed. Consumption of pork grew from 40.2% to 43.8% and beef fell from 9.6% to 4.2% (KSH, 2011).

Consumption of meat products slightly increased as a part of total consumption. 13% of all the poultry consumed nationally and 40% of all pork consumed was imported in 2009 (KSH, 2011). During the last few years consumption of milk and dairy products has not changed a lot; they account for 22 % of all products consumed. The quantity of fat consumed (37 kg/persons) did not change notably; its share remained the same. However, the structure of fat consumption did change (consumption of vegetable fats has doubled since 1990, while the consumption of animal fats has decreased by 44%. This can be regarded as a favourable change).

Consumption of potatoes fluctuates significantly; they account, on average, for 10% of all food products consumed. The share of consumption of fruit and vegetables has increased since 1990 and they now account for 31% of all products consumed. The quantity of production, the amount imported and available income influence how much fruit and vegetables are consumed. Some of these items are considered to be basic foods while others are seen to be luxury goods with high prices and income elasticity.

Figure 3 shows food consumption after 2002. A surprising trend can be noted: decreasing food consumption in comparison to the growing European trend.

Figure 3: Food consumption in Hungary (2002-2009)



Source: Author's own compilation based on KSH (2012c)

Energy intake exceeds the recommended level by 21% according to nutritional data. This is due to the excessive consumption of fat (Table 15). Levels of consumption of carbohydrates are optimal while protein consumption also exceeds the recommended level (KSH, 2011).

Table 15: Nutritional intake per person

Category	2008	2009	Average of 2004-2008	Recommended[3]
Energy, kJ	13372	13199	13519	10886
Protein, g	101	100	103	80
Fats, g	143	143	145	85
Carbohydrates, g	380	371	384	370

Source: KSH (2011)

[3] The recommended nutritional intake for an adult who undertakes moderate physical activity (KSH, 2011)

Gulyás et al. (2007) has stated that the perception and treatment of environmental problems is less well recognised by Hungarians and some development has taken place in areas that are supported by the media, such as selective waste collection, which in reality has a marginal environmental impact compared to changes that could be made in other more significant fields of consumption (food consumption, transportation, and housing). There have been no serious efforts to make consumption more sustainable. Infrastructural conditions are missing and there are shortcomings with environmentally friendly consumption attitudes as well. Environmental consciousness plays an important role in making consumption more sustainable (Zsóka, 2007).

A growing amount of imported products contributes to an increase in the environmental load as well. 30% of all food products are imported into Hungary today. This figure was only 7-10% in 1990, so in the last twenty years the share of imported products has tripled, which contributes to increasing the environmental load from transportation at a global level.

After analysing the status of European and Hungarian food consumption patterns I now examine the differences between them. Table 16 summarises the changes in quantity and structure for the most important food categories between 1990 and 2007.

It can be clearly seen that (with the exception of consumption of fat), the average Hungarian consumes less food (in all food categories) than the average European. When comparing this data to the Western European average, the difference is even greater. The same trend can be found with the consumption of cereals, vegetable and fruit. The quantity and share of fat in the diet did not change in Europe or in Hungary. Different trends can be seen with consumption of meat: while meat consumption is increasing in Europe and its share does not appear likely to change (or perhaps only marginally) according to expectations, in Hungary the amount of meat consumed is decreasing and its share is not expected to grow in the future.

From an environmental point of view the Hungarian trend towards consuming less meat, which is opposite to the trend in Europe, is favourable. The same can be said about consumption of dairy products: despite the trend to growth in Europe, Hungarian consumption is declining.

The quantity and share of imported products in the diet is increasing dynamically both in Hungary and in Europe, especially with meat, vegetables and fruit products. This means an increasing environmental load because of the often resource-intensive methods of production and transportation.

Table 16: Comparison of European and Hungarian food consumption trends (1990-2007)

	Europe		**Hungary**	
Consumption category	**Change in quantity (kg/person/year)**	**Proportion of total food consumed (%)**	**Change in quantity (kg/person/year)**	**Proportion of total food consumed (%)**
Cereals	138 kg → 131kg decreasing	19.3% → 17.6% decreasing	110 kg → 88 kg decreasing	16% → 13% decreasing
Meat	81 kg on average, but growing tendency	11% no change/increasing	73 kg → 63 kg decreasing	9% - 11% no change
Dairy products	210 kg → 221 kg increasing	29% no change	169 kg → 163 kg decreasing	25 % no change
Fats	28.5 kg no change	3.8 % no change	38.6 kg → 37.4 kg no change	6 % no change
Fruits	73 kg → 93 kg increasing	10.2% → 12.4% increasing	155 kg → 194 kg increasing	23% → 31% increasing
Vegetables	107 kg → 117 kg increasing	15% → 15,6% increasing		
Share of imported products in consumption	meat +120% cereals +83% vegetables +174% (FAO, 2010)	increasing	increasing	7-10% → 30% increasing

Source: Author's own compilation based on FAO (2012) and KSH (2012c)

To sum up, we can see that for some food categories Hungarian trends are different to European trends. The total amount of food an average Hungarian consumes is less than an average European. Consumption of fish and milk is lower than the European average – in fact, consumption of fruit, fish and cheese in East and Central Europe is about the half of the consumption of the EU-15 countries. Looking at these changes in consumption patterns we can see the trend that was highlighted by Lehota (2004): the quantity of food consumed has peaked with high income countries, but structural changes are significant. In Hungary, as a middle-income EU country, both changes in quantity and structure are still foreseeable. Consumption of cereals and carbohydrates may have plateaued, while more fruit and vegetables are being eaten. Because of the increasing share of imported products Hungary is liable to become increasingly dependant on the natural resources of other countries. This may lead to social and environmental problems in the future.

Food consumption trends cannot be solely evaluated based on statistical data. GFK Institute has carried out a representative survey of adult Hungarians every two years to analyse food consumption patters since 1989. According to the results of the 2009 survey (GFK, 2009), the preference for meat has not changed in the last few years. 94% of respondents prefer poultry and they eat poultry three times a week on average. Results also show that Hungarians eat on average 3.5 times a day.

The GFK survey supports the indication that consumption has decreased in most food categories. In 2008, GFK together with TÁRKI created a typology of eight typical consumer groups based on consumption patterns using the new model of universal consumer segmentation. The structure of these groups is characterised in their publication (GFK, 2009). The GFK survey measures preferences for food categories and not actual consumption quantities.

Knowing the results of previous research studies summarised in Chapter IV, I present the research aims and hypotheses in the next chapter.

V. Research aims and hypotheses

The central focus of this dissertation is to analyse the environmental impacts of food consumption in Hungary, with a particular view to looking at both the environmental and health aspects of food consumption. In this chapter I present my research questions and hypotheses which reflect on the previous research questions and the results emerging from the relevant literature.

My research is designed to provide answers to such questions that fit with the presented theoretical background and supplement the previous results and shortcomings of previous academic research.

5.1. Empirical research aims

The aim of my research is to reveal the theoretical and empirical shortcomings of the international literature and to supplement it using empirical results. Based on the international and national research studies which were presented in Chapter IV, the following statements can be made:

- Less research has so far been done on food consumption compared to other consumption areas, though its importance and environmental impacts are significant (Lorek and Spangenberg, 2001b; Csutora, 2012). In my research I present the importance of this consumption sector by quantifying its environmental burden and I take into account health recommendations as well in order to examine what the opportunities are for decreasing environmental impacts by changing consumption levels and structures. My research is done using under the banner of strong sustainability and recognises the environmental consequences of resource consumption and the need for lifestyle changes to be made.
- Former research on this topic was typically not done using surveys but rather using statistical databases of food consumption compiled by statistical institutes. These previous studies do not necessarily show the actual food consumption patterns of consumers. Some pieces of research which use surveys in their research methodology did not use representative surveys. These research studies are mostly based on Western European samples, but as for the impacts of food consumption there can be great differences between countries, as the findings of Tukker et al. (2011) confirm. Because of these previously mentioned facts it is

hypothesised that better, more accurate results can be obtained using a database based on a representative survey which can allow the analysis of real, actual food consumption patterns. This is why I use a database based on a survey in my research.

- Furthermore, there has not yet been a representative survey undertaken in Hungary which was designed to measure the ecological footprint of food consumption patterns. I intend to use the ecological footprint indicator in my methodological approach; its methodological suitability has been presented and proven in Chapter III. Few pieces of research have used this indicator so far, though both from a methodological point of view and from the perspective of communicating results, this indicator is highly appropriate.
- Previous academic studies did not differentiate by occupational activity and social segments in their examination of food consumption and its environmental impacts. Many studies have simply examined averages (i.e. have not differentiated using food consumption structure), although when analysing food consumption the various demands for energy and nutrient intake have to be taken into account based on different activities and occupational activities. Research which investigates food consumption patterns and impacts based on occupational activity has yet to be done. My research is designed to provide a new perspective and improve and extend the findings of previous research in the academic literature.
- Food consumption directly determines the health and well-being of individuals, so I think it is necessary to take into account health aspects when examining the environmental impact of food consumption. I carry out a scenario analysis concerning possibilities for reducing environmental impacts. I examine whether changing the structure of consumption is sufficient for decreasing the ecological footprint or if there is a need to modify the level of consumption as well.

Based on the statements above, I present the hypotheses of my research below.

5.2. Research hypotheses

In the literature review (Chapter II and IV) it was seen that socio-demographical variables influence the consumption of food in various ways in different countries and according to different social groups. By investigating the first four hypotheses we can receive an answer to the question of which socio-demographic variables influence food consumption to a great extent. Variance analysis was used during this part of the research (using a significance level of 5%) (H1-H4).

H1: Ecological footprints are significantly different according to level of education

I expect that people with higher education degrees have lower ecological footprints, as they are more environmental and health-conscious, as presented in pervious scientific research (e.g. Irala-Estevez et al., 2000; Trichopoulou et al., 2002).

H2: Ecological footprints are significantly different according to gender

H3: Ecological footprints are significantly different according to age groups

H4: The ecological footprint of more actively working people will be higher than that of people with lower intensity jobs

Gender, age and type of occupation basically determine nutritional requirements and the structure of food consumption (James and Schofield, 1990; FAO, 2001).

In H2, H3 and H4 hypotheses I analyse the ecological footprint of food consumption using these factors. I expect that ecological footprints are significantly different as people of different genders and ages have different nutritional needs. In H4 I suppose that people who undertake different physical activities have significantly different ecological footprints.

H5: The ecological footprint of higher income groups is offset by their healthier consumption structure

With hypothesis H5 the relationship between the level of income and the ecological footprint of food consumption is a particularly interesting question. Having a higher income could be presumed to increase the quantity of food consumed. However, it may also be supposed that people with higher incomes are more likely to lead more health conscious lifestyles and could therefore consume more moderately. It is an important question whether a higher income makes our consumption of food healthier.

H6: Well-defined consumer groups can be defined based on the structure of their food consumption

I hypothesise that consumers in Hungary can be characterised according to food consumption structures. Identifying typical food consumption structures can help in reaching consumers by an environmental policy aiming at decreasing environmental impacts.

H7: Environmental and health aspects are compatible with each other: modifying consumption structure can lead to both a healthier and a more sustainable way of consuming food

I examine in this hypothesis whether environmental and health aspects could be compatible and I expect that healthier consumption of food has lower ecological footprints in Hungary.

VI. Research results

6.1. Survey and database used in the research

Quantitative analytical methods are needed due to the research aims. During this research I carried out a cross-sectional analysis where I used the database of a survey which was carried out within a sustainable consumption project. I personally took part in compiling the survey questions. Research based on surveys is adequate for "descriptive, explanatory and explorative goals and they are mostly used in such studies where the individual is the unit of analysis" (Babbie, 2003, p.274.)

The survey method is especially suitable for examining large data samples in a descriptive way. When preparing the survey we took into account methodological recommendations concerning survey formulation; furthermore a test-survey inquiry was done before the final survey was conducted and we piloted the questions of the questionnaire using a small sample. During the formulation of the survey the necessary mathematical/statistical requirements were considered and taken into account.

The survey was done within the monthly survey 'Omnibus' conducted by TÁRKI Zrt. in April 2010. Interviewers were used to help individuals complete the questionnaire. Filling out the questionnaire using interviewers increases the reliability of the survey results as experienced interviewers have already done the survey, have been presented with the scientific background of the research beforehand and have been coached about how to help conduct the survey. Furthermore, using interviewers has been shown to increase the willingness to answer of respondents.

The population unit of the research is the total Hungarian population. A large sample survey was undertaken with a sample size of 1012 persons. The sample included adults (those above the age of 18, with a permanent address and not living in an institution) who represented the Hungarian population. A large sample size makes it possible to generalise the results although avoidance of 'overgeneralisation' has to be taken into account, and outliers should be examined (Babbie, 2003).

With a big sample survey, probability sampling should be done. Accordingly, the sampling for the survey/questionnaire was nationally representative probability sampling in 80 settlements in Hungary. The sample was chosen to be representative for the following variables: habitat, gender, age and level of education. Multistage sampling was carried out, whereby in the first stage the settlement was chosen, and in the second stage (within the settlement) a random walk method combined with the Leslie Kish-key method was used to select the household. The random walk method provides for testing the probability of the sample. After choosing a household, a member of the household (who had been chosen through a probability estimation technique using the Leslie Kish-key) was asked to answer the survey. The Leslie Kish-key process can be used to choose the member of a household on a random basis. The key provides a clear and pre-fixed method for selecting respondents (Kish, 1949; 1965).

The survey was mainly comprised of closed questions. The survey comprised questions regarding the frequency of consumption of food items and the quantity of consumed food by primary food categories: vegetable-based dishes; fruits and vegetables; meat; tea and coffee; bread and bakery products; potatoes and rice; muesli; cold cuts; milk; dairy products; pasta; eggs, and vegetarian meals. The survey can be found in Appendix 2.

The final size of the sample which I analysed was 975 persons. These respondents were filtered out from the complete database of 1012 persons. When a missing answer to a question concerning at least one of the food consumption categories was found, respondents were eliminated from the analytical process — in such a case the total sum of the food consumption categories could not be defined so the total ecological footprint of food consumption could not be calculated.

The survey included the category of ‘other food items’ for breakfast, lunch and dinner. 5.2% of respondents selected ‘consumption of other food item’ for breakfast, 16.9% of respondents for lunch and 18% for dinner. However, respondents specified the type of food they consumed and its quantity. The named food items were classified using the 13 food consumption categories of the survey when it was unambiguously clear to which category they belonged.

The representativeness of the sample was tested, and I compared the basic demographical variables to national statistics. It was verified that the sample represented the population well and this made possible the drawing of conclusions. However, it is allowed that even with a representative sample sampling errors can be present (Babbie, 2003) which need to be taken into consideration during the research process. The main characteristics of the sample can be found in Appendix 3.

For testing H5 hypothesis I used the database of the Hungarian Central Statistical Office (KSH, 2012e), which includes food consumption data according to income deciles.

6.2. Quantifying the ecological footprint of food consumption of Hungarian consumers using a bottom-up approach

In the database the quantity consumed per meal and the frequency of consumption of each item from each food category were available for analysis (regarding the three main meals of the day). The weight of each food item was defined according to the weight specifications of Rodler (OÉTI) (2004) and the food consumption statistics of KSH (2012b) (Appendix 4). The consumption of each food item in kilograms per year was calculated for each respondent by multiplying the frequency of food consumption by the quantity per meal and by the weight per food item. The average quantity of food actually consumed per person in kilograms can be seen in Appendix 5.

The ecological footprint was calculated using the following formula:

$$\text{ecological footprint (gha)} = \text{quantity consumed per year per person (kg)} * \text{ecological footprint intensity (gha/kg)} \quad (1)$$

The ecological footprint shows the environmental impact of the real, actual consumed food quantity for an individual. It can be seen from the formula that in order to quantify the ecological footprint of food consumption, ecological footprint intensities regarding Hungarian food consumption need defining.

6.2.1. Results from analysis of secondary databases: quantifying the ecological footprint intensities

Ecological footprint intensities were quantified based on the latest database from the Global Footprint Network for Hungary (published in 2011). The database of the Global Footprint Network (GFN, 2011) includes the ecological footprint of 160 primary agricultural/crop products. This database is the best-acknowledged database used in scientific and academic research for quantifying the ecological footprint. It includes in a very detailed way the data which are needed to quantify the ecological footprint. As a result, I used this database in my research. Using this database, the quantity of a product produced, the yield, the equivalent factor and the value for the ecological footprint were at my disposal. The quotient of the ecological footprint (gha) and the quantity produced (t) give the ecological footprint intensity per product (gha/t).

In the database of the Global Footprint Network (GFN, 2011) the ecological footprint values for both locally produced and imported products were at my disposal. I quantified the ecological footprint intensities of both locally produced and imported products and the average ecological footprint intensities for each food item were calculated as the weighted average of the footprints of the locally produced and imported products. This way the combined footprint size of local and imported products was defined on product level. It was important to take into account the environmental impact of both local and imported products when quantifying the total footprint intensity due to reasons of methodology and the approach to consumer responsibility which is applied through my research undertakings.

After quantifying the product level ecological footprint intensities, I aggregated the intensities for the 13 food consumption categories which were used in the survey. During the aggregation process the product level ecological footprint intensities were weighted using the food consumption statistics of the Hungarian Central Statistical Office (KSH, 2012c).

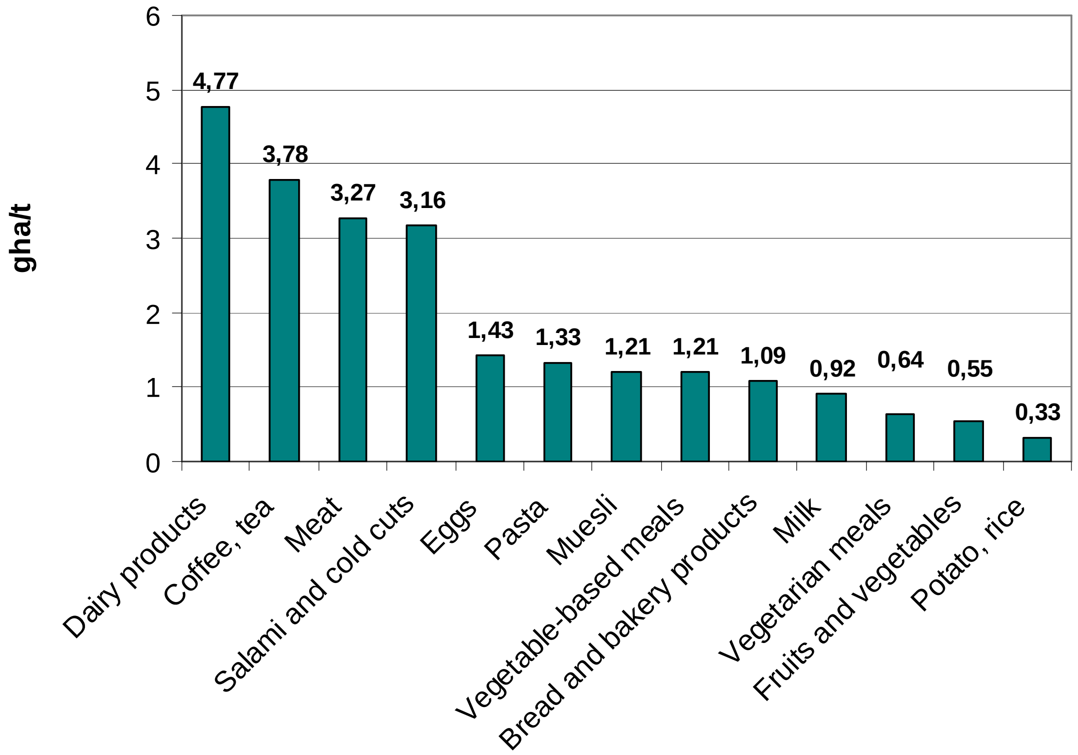
When quantifying the ecological footprint intensity of vegetable-based meals and vegetarian meals, the following primary ingredient categories were taken into account: in the case of vegetable-based meals, vegetables, eggs and meat; and in the case of vegetarian meals only vegetables.

Figure 4 shows the ecological footprint intensities of the main food consumption categories in decreasing order. It can be seen that the intensity of the ecological footprint per tonne is notably higher for animal-based products and for tea and coffee.

The ecological footprint intensity of dairy products is higher than that of meat products. This is remarkable, because when examining the environmental impact of food consumption in many cases, meat is highlighted as being the food category with the highest environmental impact and is the item whose consumption should be moderated, although the ecological footprint intensity of dairy products is also large. The reason for this may partly be the fact that the consumption of meat is, in many developed countries, above the recommended *healthy* level, while the impact of the consumption of dairy products is probably more variable.

The ecological footprint per one tonne of tea and coffee is relatively high, but the absolute quantity of these items consumed is notably smaller than for meat. This is probably why the environmental impact of the consumption of tea and coffee could be considered a less salient issue. After these products, eggs have the fifth highest ecological footprint intensity (about half of the ecological footprint intensity of meat products). Bakery products and cereals have fairly low ecological footprint intensities. Fruits and vegetables have the lowest ecological footprint intensity of all.

Figure 4: Ecological Footprint intensities of food categories in Hungary



Source: Author's own calculations based on GFN (2011)

The analysis of ecological footprint intensities (taking into account both locally produced and imported food) and the results for the food categories are accurate to an order of magnitude and are in line with results from the international academic literature (e.g. Gerbens-Leenes and Nonhebel, 2002a; Wallén et al., 2004; Kramer et al., 1999).

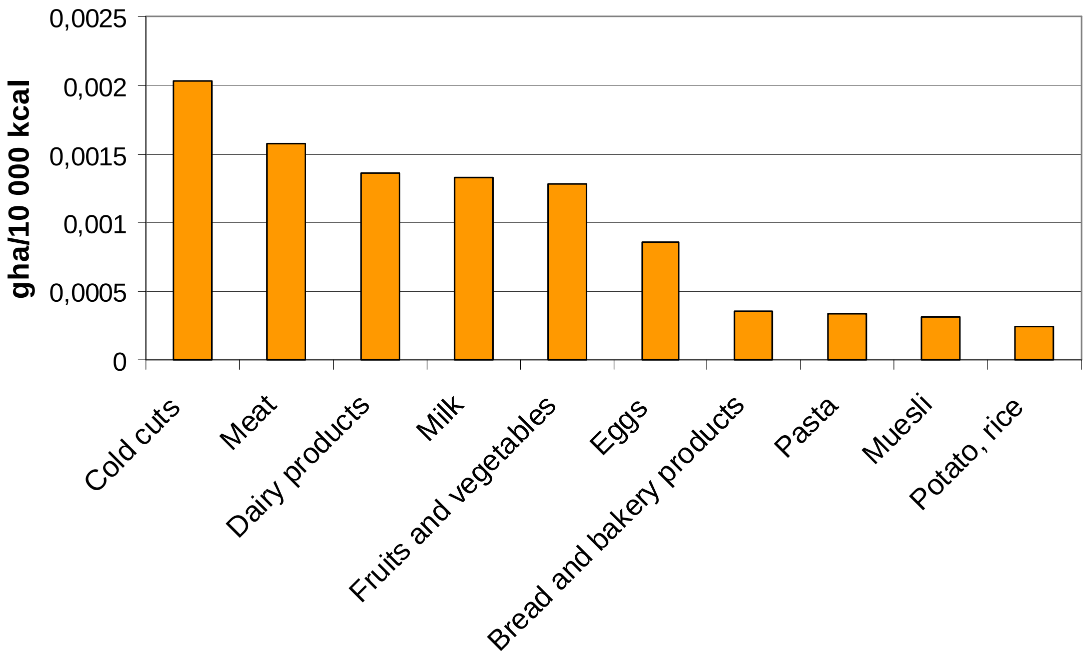
When examining the ecological footprint intensities of food consumption, it is not only the footprint intensities calculated by weight that may be important and interesting, but ecological footprint per calorie can be considered as well (n.b. calculating and analysing footprints using a ‘by-weight’ basis can lead to misleading results as some food types are of high weight due to their water content, while their dry material content, and environmental impact, is lower). The average calorie content of the food categories can be found in Appendix 7.

Figure 5 shows the values of the ecological footprint per 10,000 calories for each food category. It can be seen that the order of the food categories has changed compared to the chart of the (descending) ecological footprint values per tonne. However, it remains true that foods of animal origin have the largest ecological footprint intensity (ecological footprint per 10,000 calories).

After cold cuts, meat and dairy products it is milk which has the largest ecological footprint intensity. Milk is followed by fruits and vegetables which have relatively large ecological footprints compared to their caloric value (greater than that of eggs). Bakery products, cereals and potatoes have small ecological footprints per 10,000 kilocalories, which is a positive finding as many meals are based on the use of cereals and potatoes. The consumption of more potatoes and cereals is advantageous from an environmental perspective as their low ecological footprint intensities per calorie are due to their relatively high caloric value per unit of weight.

Knowing ecological footprint intensities can help us to quantify which food categories have the greatest impact on the total ecological footprint and can help define how ecological footprints would change if consumption patterns changed. Appendix 8 shows the sensibility analysis of ecological footprint intensities.

Figure 5: Ecological footprint values per 10,000 kcal in Hungary



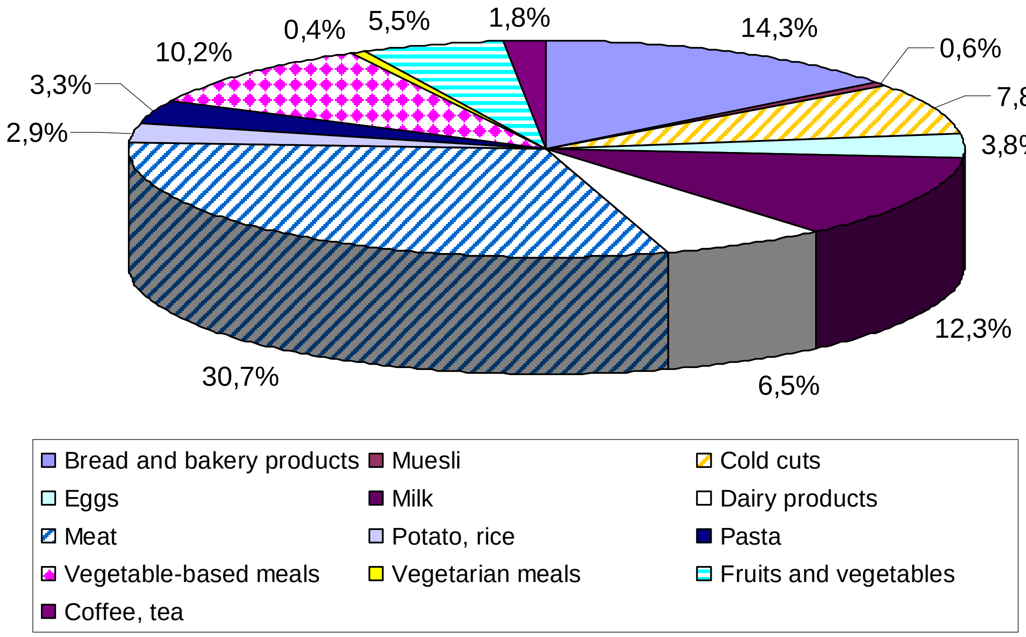
Source: Author's own calculations based on GFN (2011)

Measuring the environmental impact of food consumption using the ecological footprint indicator is only one way of quantifying environmental impact. I use this indicator in my research. However, it should be mentioned that by using other indicators as well the analysis of environmental impacts can be made more complete.

6.2.2. The average ecological footprint of food consumption of Hungarian consumers

Using formula (1) the ecological footprint for a year's food consumption was calculated for each respondent using the ecological footprint intensities and food consumption in kilograms per year (Appendix 9.). The ecological footprint of food consumption for an average consumer is 0.51 global hectares. Figure 6 shows the structure of an average ecological footprint.

Figure 6: The structure of the average ecological footprint per person



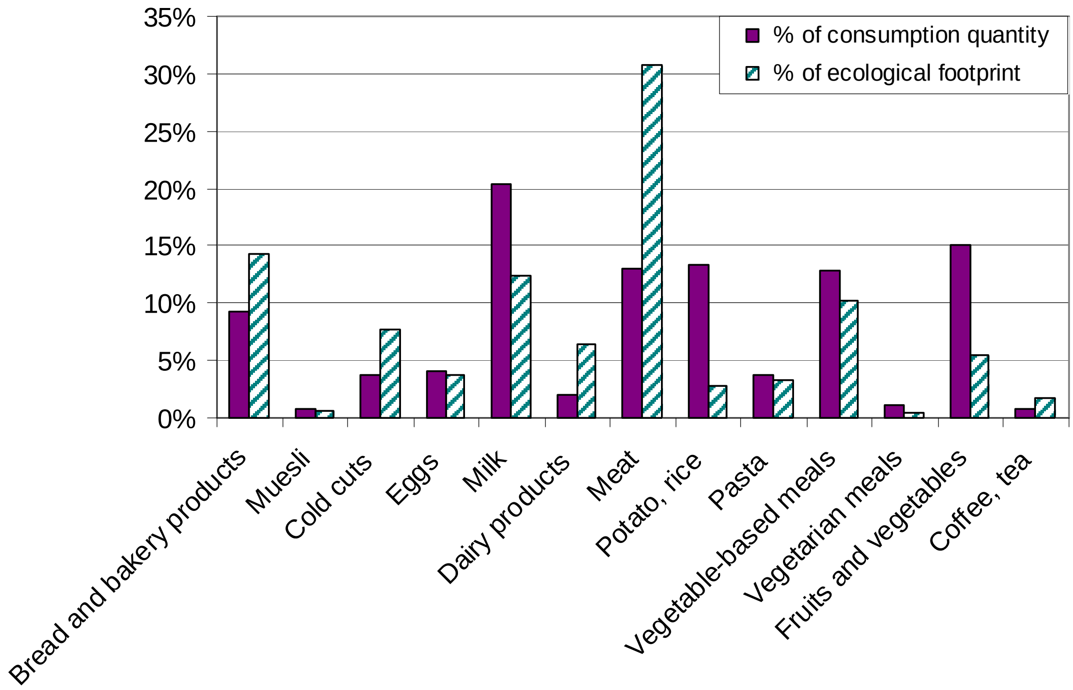
The greatest part of the ecological footprint is attributable to consumption of meat (31%) and milk and dairy products (18%). 61% of the average Hungarian ecological footprint for food consumption is of animal origin. Consumption of bread and bakery products (14%) and vegetables and fruits is less common; basically, a meat-based diet is the predominant choice of the population. Consumption of tea and coffee accounts for 2% of the ecological footprint of food consumption.

The size of the average ecological footprint of food consumption is smaller for Hungarians than estimates from other international studies. In the United Kingdom the average ecological footprint for food consumption is 0.8 gha (Frey and Barett, 2007). Collins and Fairchild (2007) came to a similar result regarding the size of the ecological footprint per person in Cardiff, U.K.

The smaller size of the average Hungarians' food consumption ecological footprint compared to the average Western European was expected as the quantity of food consumed in Hungary is less than the European average (see Chapter 4.4.).

It is interesting to examine the relative contribution of the food categories to the total quantity of food consumed (kg) and to the total ecological footprint (Figure 7). This comparison highlights the fact that analysing only the *quantity* of food consumed and the *consumption structure* does not show which food consumption categories have significant environmental impact. This knowledge can supplement analysis based on environmental indicators.

Figure 7: The relative contributions of categories of food (compared to the quantity and ecological footprint of the food consumed)



It can be seen that consumption of meat makes the largest contribution to the total ecological footprint, despite it not being the foodstuff consumed in greatest quantity. The contribution of dairy products to the ecological footprint is notable. Despite this, vegetables and fruits account for 15% of food consumption in quantity while their contribution to the total ecological footprint is lower.

6.2.3. Limitations of the research into quantifying the ecological footprint of food consumption

The calculations for estimating the ecological footprint are based on some assumptions which may restrict how the results can be used. It is necessary to take into account the limitations of this research when evaluating the results and drawing conclusions.

The questionnaire survey on which the database used in the research is based measured the direct food consumption of individual respondents for the 13 food consumption categories. Indirect food consumption (for example, ingredients which are used while preparing a meal such as sour cream or oil) was not included in the survey. Measuring the waste from food consumption was not the aim of the analysis. (I quantified the food consumption of private households, the results can be compared to statistics measuring the consumption of households.)

I estimated food consumption and its ecological footprint for the three main meals of the day for 13 food categories so food consumed between meals was not included into the analysis. According to a representative survey by GFK (2009) about food consumption, Hungarian people eat on average 3.5 times per day; the most popular meals are breakfast and a (hot) lunch. 53% of the population do not eat between these times at all. 9% of the population have a snack in the afternoon every day, 37% only occasionally do this and 54% never do. According to these findings it is stated with some confidence that the main consumption patterns and structures and their environmental impacts and relative differences can be deduced from an analysis of the three main meals. For some food categories it is possible that the quantities of food consumed are underestimated. (Fruits and vegetables can be consumed between meals, furthermore bread consumption might be underestimated as it was calculated from the consumption of bakery products and in case of cold cuts consumption bread consumption was supposed as well based on the frequency of consumption). Regarding the differences in quality within categories of food there was no possibility to differentiate; other international studies and statistical analyses are also based on research which uses aggregate categories as well.

The aim of the research was to better understand the environmental impacts of food products. Tea and coffee were included in the research as beverages. While details on direct consumption were included in the database, consumption of other fats, oil, salt and sugar do not appear in the results. International research and academic studies have primarily examined the quantity of direct consumption of food and its environmental impacts. Changes in the consumption of salt and trans-fatty acids does not have a remarkable environmental impact (Tukker et al., 2011), which is perhaps why their inclusion into such analyses is not common.

The height and weight of respondents is not known, but the testing of the hypotheses and the drawing of conclusions are based on the group level.

The ecological footprint calculated in the analysis underestimates the total ecological footprint of food consumption in some ways, but in the analysis the examination of the structure of food consumption is strongly emphasised. Regarding the results and conclusions this limitation should be taken into account. Because of the methodology of the ecological footprinting itself, this indicator gives an approximate value of environmental impact and I regard the ecological footprint which I calculated in my research like this. For the aims of the research, I think this approach is appropriate.

The limitations of this piece of research suggest great opportunities for future research regarding measuring the environmental impacts of food consumption.

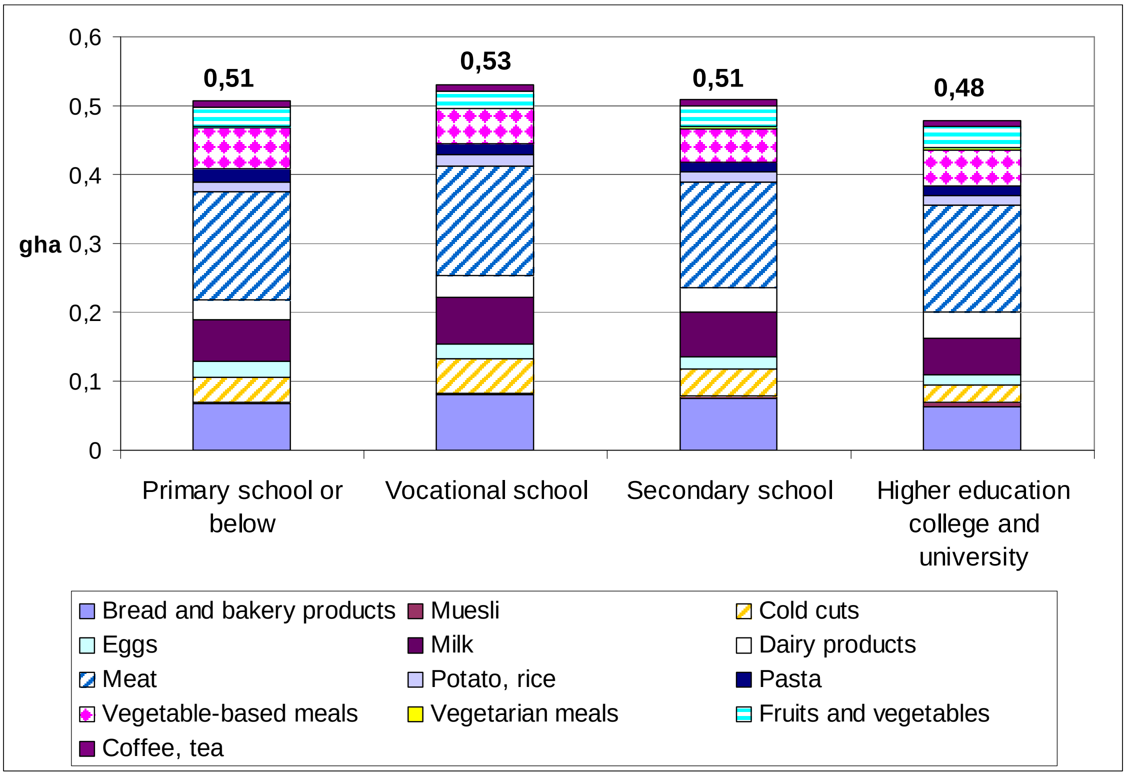
6.3. The impact of level of education on the ecological footprint of food consumption

I expect that the ecological footprint of food consumption is significantly different according to level of education (H1).

For educational level (differentiated into 4 categories) there was no significant difference found between the ecological footprints. This is a suprising result, as it could be expected that people with the highest educational level have significantly lower ecological footprints (Figure 8).

However, there was found to be a difference in the *structure* of the ecological footprint within the different educational groups. There is a significant difference in consumption of the following items: bread and bakery products, muesli, cold cuts and eggs. Furthermore, regarding the quantity of pasta, vegetable-based dishes and vegetarian dishes consumed there is a statistically significant difference (for details of statistical tests see Appendix 10).

Figure 8: The ecological footprint according to educational level



As for the consumption of muesli, respondents with a university or college degree consume significantly more (five times more) than those with only primary school or vocational degrees, and two times more than those with secondary school degrees. This difference can be seen in the ecological footprint for muesli as well.

Consuming vegetarian meals is more typical of respondents with higher education degrees where vegetarian dishes account for 0.9% of the total ecological footprint compared to the average of 0.4%.

Ecological footprint from consumption of cold cuts is the lowest among those respondents who have university or college degree. They consume half as much as respondents with vocational school education who have the highest cold cuts consumption. Consumption of people with primary and secondary school education can be regarded as average.

Consumption of eggs is in a negative relationship with increasing levels of education; people of primary school education consume 68% more eggs on average than those with university or college degrees. This can be seen in the ecological footprints as well: egg consumption accounts for 3% of the total ecological footprints of people with university degrees and 4.5% of the footprints of people with only primary school education. Furthermore, consuming pasta and vegetable-based meals is more characteristic of people with lower levels of education than those with university degrees.

In analysing the quantity and structure of food consumption we can see that while people with higher level of education consume more from some food categories (muesli, vegetarian meals), the consumption of people with lower level of eductation is higher from bread, cold cuts and eggs. It can be noted that there is no significant difference between the ecological footprints of respondents with different educational levels, but their consumption structure is different. People with a higher level of education do not consume less from those food categories which influence strongly the size of the ecological footprint. More highly educated people eat no less meat or vegetables and fruit. Altoghether there is no significant difference between the footprints.

6.4. The ecological footprint of food consumption according to gender, age and nature of occupation

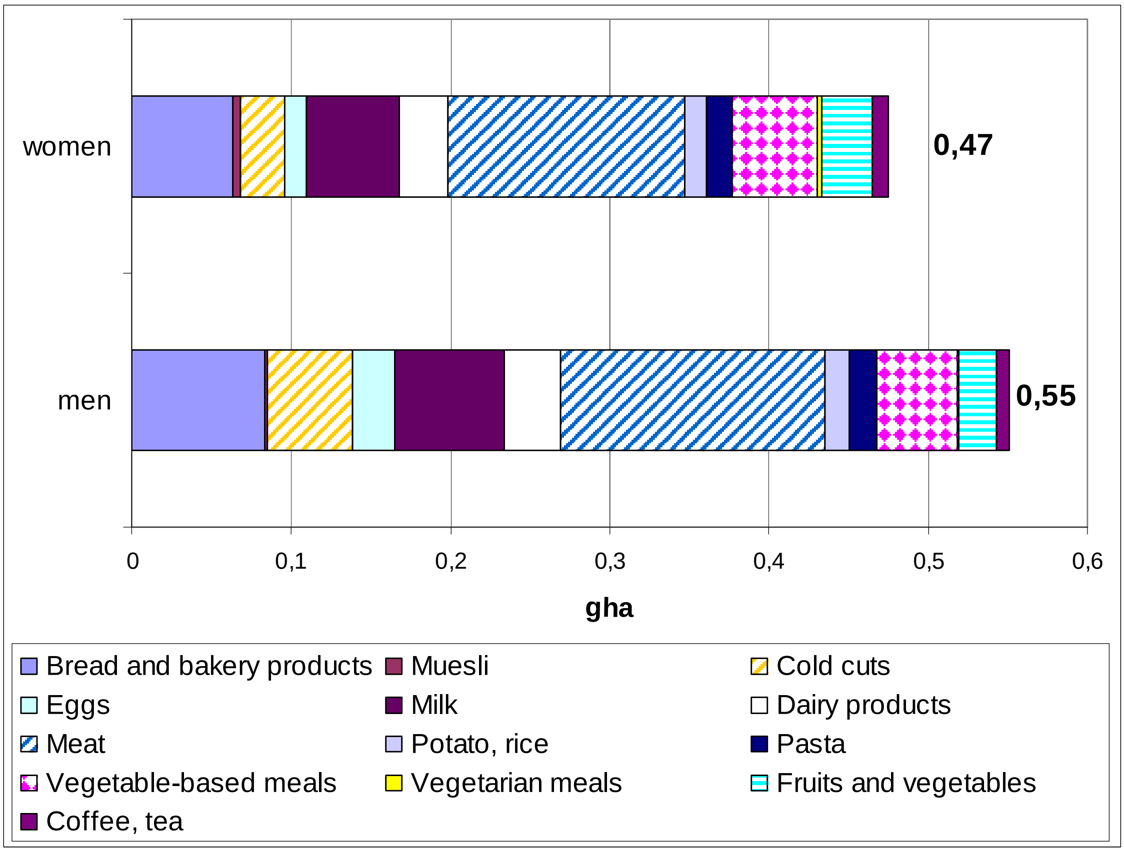
Research that has examined the environmental impacts of food consumption has not always taken into account the differing nutritional needs of people who undertake different physical activities and have different occupations. In this chapter I attempt to go part of the way towards rectifying this omission by describing the results of an analysis carried out using the variables of gender, age and type of occupation, which also took into account nutritional recommendations.

6.4.1. The ecological footprint of food consumption according to gender

When analysing the differences between the genders it can be observed that the ecological footprint of men is 0.551 gha and that of women 0.475 gha. The ecological footprint of men is higher by 14% and this difference is statistically significant. This result was expected, as men in general weigh more and have greater calorie needs. The structure of the different ecological footprints are worth further analysis.

Looking at the ecological footprints of men and women, significant differences can be found in the following categories: bread, muesli, cold cuts, eggs, meat, vegetarian meals, fruit, vegetables and tea and coffee. The ecological footprint for men derived from consumption of bread is higher by one third, and for cold cuts and eggs it is nearly double of that of women and thus their related ecological footprint is higher. Women have higher footprints for consumption of muesli and vegetarian meals (they eat twice the quantity of these foods as men). Besides these items, consumption of fruit, vegetables, tea and coffee are also significantly higher for women (correspondingly, the ecological footprint is greater by 26% for these food categories). Men generally eat meat more frequently so their meat footprint is greater. Regarding the consumption of animal-based foods, men's contribution to the total ecological footprint is 63.4%, and women's 58.8%.

Figure 9: The ecological footprint of men and women



Finding significant differences in ecological footprints according to gender is not surprising as men and women have different energy demands. Results are in line with the findings of OTÁP survey (2009) which found that men's consumption of meat and egg products was significantly higher than women's.

Women eat less food from most food categories and this can be seen in the size of their ecological footprints. Women eat more of the food categories that have low ecological footprint intensities (fruits, vegetables and vegetarian meals) and of foods where the consumption level is so low (muesli, tea and coffee) that it has no remarkable impact on the ecological footprint. From these results it can be stated that the difference between the ecological footprints of the two genders can be traced back to their having both different consumption quantities and structures.

6.4.2. The impact of age on the ecological footprint of food consumption

Analysing the impact of age on the ecological footprint of food consumption is important as people of different ages have different nutritional needs and nutritional recommendations are differentiated by age as well. In this section I examine whether there is a difference in the ecological footprints for food consumption groups according to age, and to what extent it can be explained by the structure of consumption.

The age group categories used in this research were created based on the categories used in typical nutritional recommendations (19-30 years, 30-60 years, above 60).

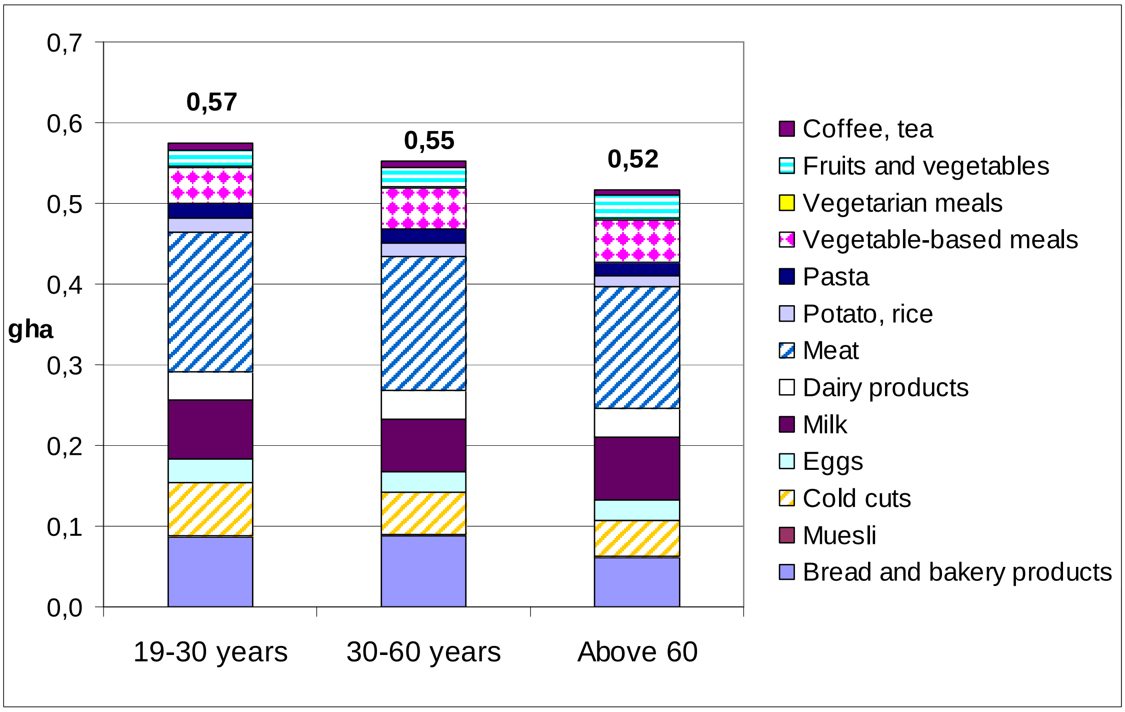
Statistically, there is no significant difference between the ecological footprints of the three age groups. This is a surprising result as people have different nutritional needs, according to dietary guidelines.

As for the structure of food consumption, significant differences can be seen with consumption of bread and bakery products, cold cuts, potatoes and rice and vegetable-based meals (statistical test can be found in Appendix 12).

As the ecological footprints of men and women are significantly different, I analysed the two genders separately. After analysing the ecological footprint of men and women separately, the same statement can be said to be true; namely, that there is no statistically significant difference between the ecological footprints for food consumption for the three age groups.

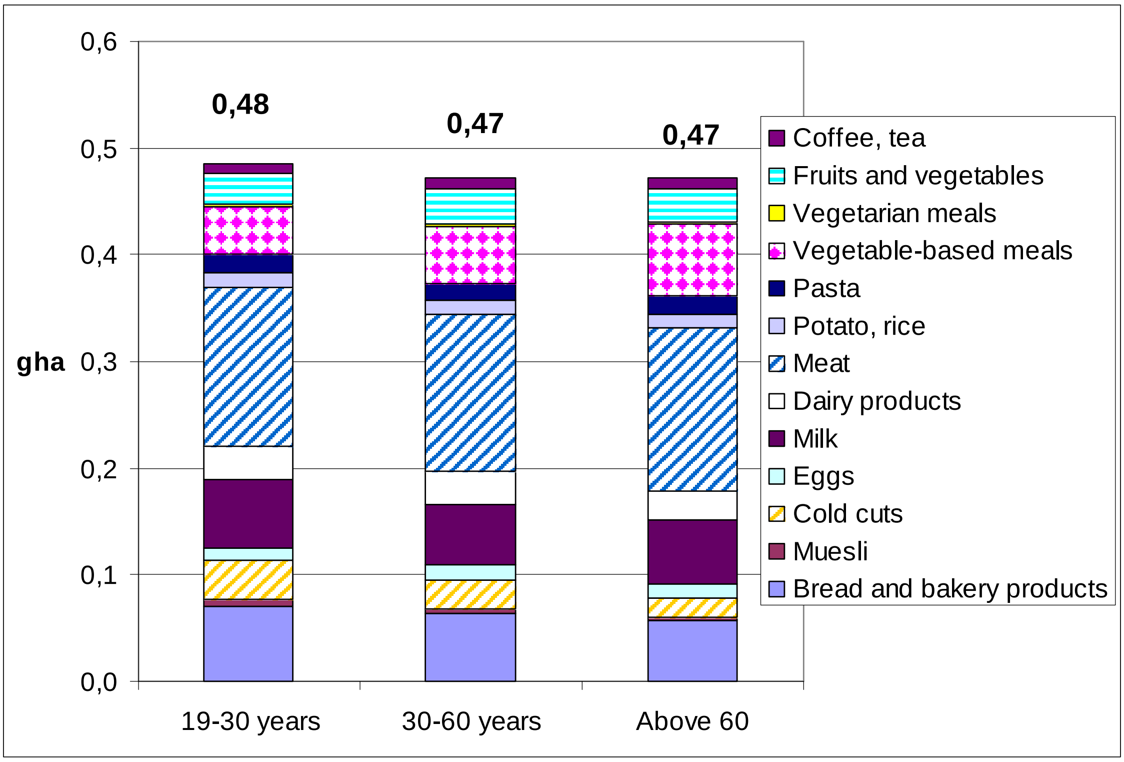
There is a significant difference in the consumption of bread and bakery products, cold cuts and potatoes for men. The consumption of bread and bakery products of people above 60 is significantly different from that of younger respondents; they consume 26% less bakery products than average. Consumption of cold cuts is significantly different for all three age groups: the youngest group consumes 22% more and the oldest age group consumes 15% less than consumers aged between 30-60 years. This is observable in the ecological footprints in Figure 10.

Figure 10: The ecological footprint of men in the three age groups



Looking at the ecological footprint for the food consumption of women, there is no significant difference between the age groups either (Figure 11, statistical test can be found in Appendix 14). Consumption of bread and bakery products is highest for respondents from the youngest group (they consume 11% more), while respondents in the 'oldest' group consume 10% less than people between 30-60, and this is observable in their ecological footprints as well. There is a significant difference with consumption of cold cuts between the three age groups: the youngest group consumes 33% more and the older group (above 60) consume 33% less than average (people between 30 and 60 yrs). The ecological footprint of vegetable-based meals for people above 60 is significantly 53% larger than for the youngest group.

Figure 11: The ecological footprint of women in the three age groups



6.4.3. The ecological footprint based on occupational activity

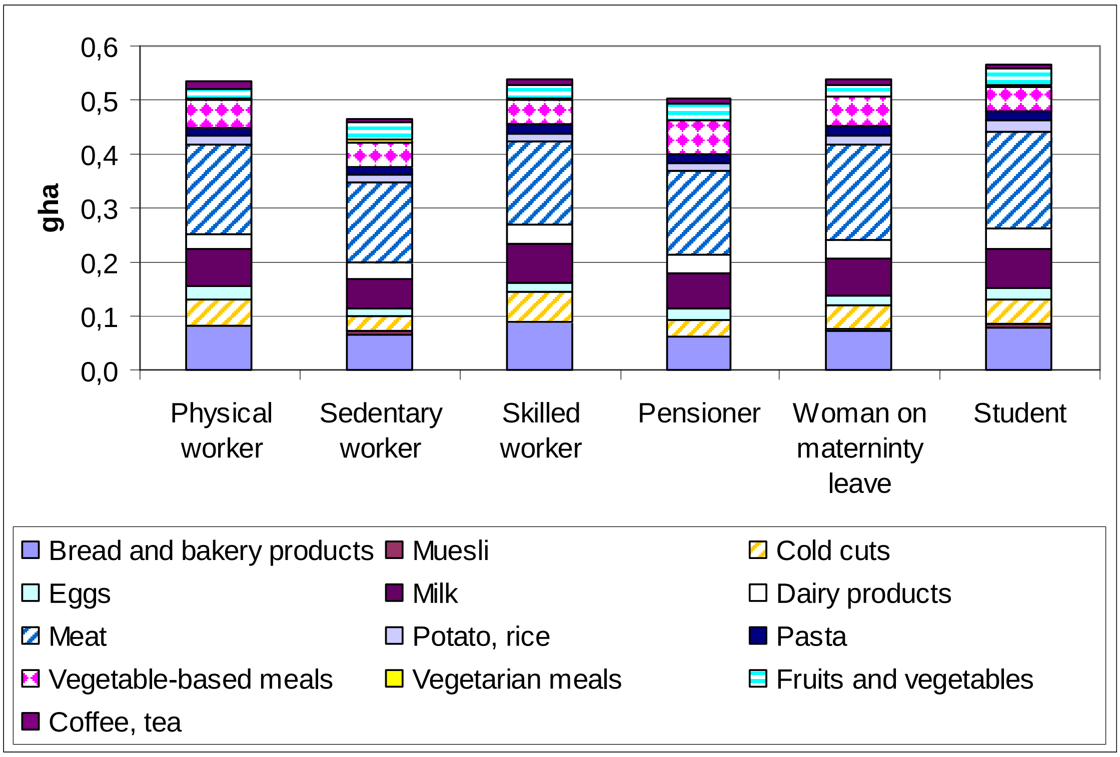
The H4 hypothesis examines the actual ecological footprints for food consumption according to the occupational activities of respondents. I assume that the level of physical activity has an impact on the quantity of food consumed and that this can be revealed in the ecological footprint values as well. I carry out an analysis based on gender, age and occupational activity. As for occupational activity, two groups can be differentiated: active workers (intellectuals, moderate physical workers and heavy physical workers) and inactive people (students, pensioners, women on maternity leave and the unemployed).

I assume that intellectual workers carry out mostly sedentary work and light physical activity; skilled and unskilled workers do moderate physical activity, and heavier physical work is done by agricultural physical workers and some entrepreneurs.

4% (39 persons) of the respondents in the database were not included in this analysis as they gave answers to the question regarding occupational activity which could not be categorised (e.g. I don’t know, other). 8.9% of the people in the database are unemployed.

As for the ecological footprint of food consumption for active and inactive groups, there is a significant difference. It can be seen that when differentiating between the consumers only on the basis of occupational activity there is significant difference between the ecological footprints. It is the ecological footprint of intellectual workers which is smaller than the average, while the footprint of pensioners is around average. The footprint of other occupational groups is higher than average. Students and women on maternity leave have the largest ecological footprints (Figure 12).

Figure 12: The ecological footprint of food consumption according to different occupational activity



In the following section I analyse the ecological footprints of active and inactive groups separately.

Making a difference between the food consumption of active and inactive groups partly incorporates other differences inherent in age groups. 96.3% of people above 60 are pensioners and are not actively working, while 96% of pensioners are above 60. As a result, handling the group of pensioners (n=247) separately is important while analysing the food consumption of people with differing nutritional needs. Students (n=56), with the exception of one person, belong to the age group 19-30 years and they comprise 26.9% of that age group. They consume more food (per dietary recommendation). Women on maternity leave (n=41) can be distinguished because of their different physiological needs.

The ecological footprint of people with active occupations

H4 hypothesis was based on the fact that (according to nutritional guidelines) there are differences in the energy intake of sedentary workers, moderate physical workers and heavy physical workers (Bíró and Lindner, 1988; Bíró and Lindner, 1999). If we suppose that the structure of the recommended diet stays the same while the level of physical activity increases, then the recommended intake of energy should also increase according to the level of physical activity so ecological footprints should grow (Appendix 16).

In this analysis I assume that the quantity of food consumed grows with an increasing physical activity level and so does the ecological footprint of food consumption. Active workers from the database can be found in the 19-30 year and 30-60 year age groups (people above 60 are mostly inactive from an occupational point of view as they are mainly pensioners). As for people younger than 30, there was a very small sample size for each occupational category (sedentary workers n=30, skilled workers n=65, physical workers n=5). Analysing such small subsamples would not necessarily provide a representative picture which is why this agegroup was not analysed separately.

The subsample of people between 30 and 60 years is large enough for separate analysis. Examination of this subsample shows that, for both the male and female subsample, there is no statistically significant difference between the ecological footprints of food consumption regarding different occupational activities (statistical tests are in Appendix 18).

When analysing the subsample of 30 and 60 years (undifferentiated by gender), a significant difference between the ecological footprints of different occupational groups can be revealed (Appendix 17). This can be explained by the different quantities and structures of the ecological footprints for food consumption of the two different genders; namely that women have lower ecological footprints and they consume more low footprint intensity products.

The ecological footprint of sedentary workers is significantly lower than that of either skilled or physical workers. When analysing the gender ratio in the occupational groups we can see that for skilled and physical workers the proportion of the two genders is almost equal while 72% of the sedentary workers are women (and whose food consumption is significantly lower than that of men. This is probably why there is a significant difference between the ecological footprints for food consumption based on occupational activity but not for gender). Among sedentary workers the proportion of women who have lower ecological footprints is higher, and this creates a significant difference between the ecological footprints of different occupational groups. This finding illustrates that the need to differentiate between genders is crucial when analysing food consumption patterns, as analysing the two genders together would be misleading and not representative of reality.

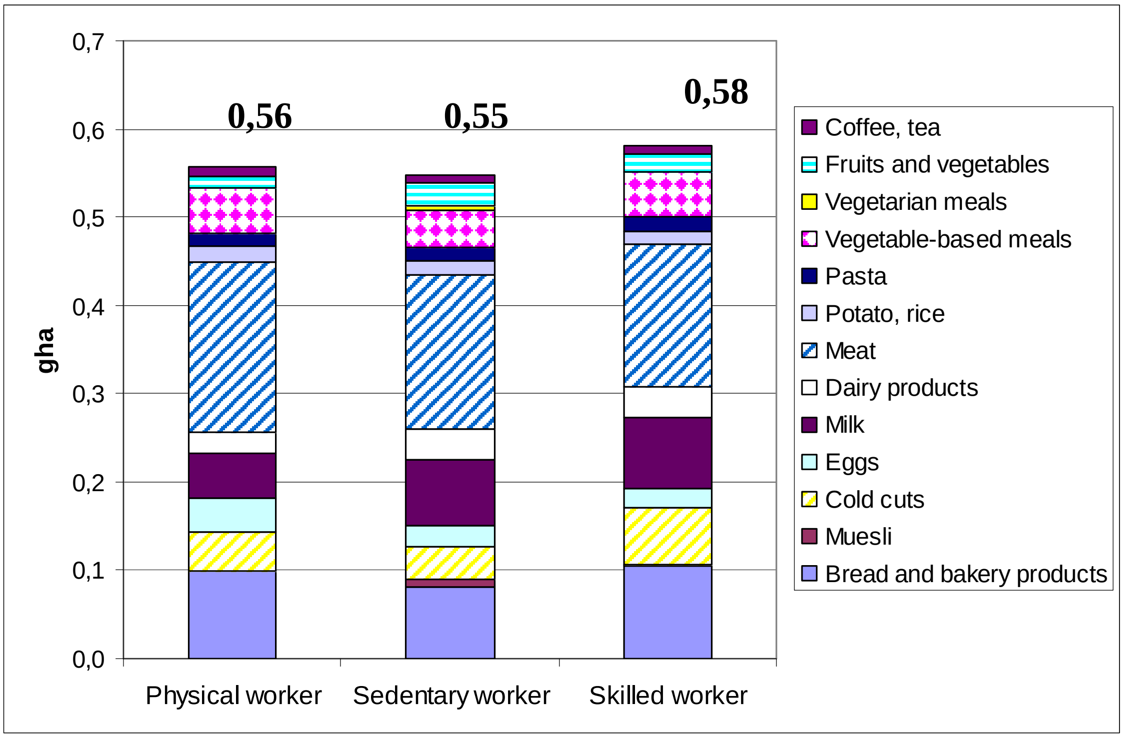
When analysing the ecological footprint of occupational groups for the two genders separately (in the age group of 30-60 years), the result is that there is no significant difference between the ecological footprint of food consumption for occupational groups. This is a surprising result, as it could be expected that people who do less physical activity (i.e. have lower energy demands) would have lower ecological footprints than people who undertake moderate or heavy physical activity (Figure 13). For some food products there is a significant difference between ecological footprints (e.g. muesli, cold cuts, eggs and vegetarian meals).

Men who undertake physical activity do not eat muesli at all, while intellectual workers eat three times more than the average. The egg consumption of physical workers is 1.5 times higher than that of sedentary workers or skilled workers. The consumption of cold cuts is the highest for skilled workers while sedentary, intellectual workers eat the least cold cuts. The ecological footprint of the intellectuals is, however, compensated for by their increased consumption of dairy products.

As for meat consumption, there is no significant difference between the occupational groups. Physical workers do not eat vegetarian dishes at all; consumption of vegetarian dishes is highest for sedentary workers.

It was expected that sedentary workers would have a lower ecological footprint for food consumption. While their consumption of muesli and vegetarian meals is greater than that of workers who do heavier physical activity, there is no significant difference with consumption of meat. Because they consume more plant-based food products but do not consume less meat (and consume more dairy products) the ecological footprints of sedentary workers are in fact not significantly lower than for respondents who do heavier physical activity. As for the ecological footprints of skilled workers and physical workers, a great difference is seen with consumption of eggs and milk. Physical workers eat the most eggs and the least dairy products.

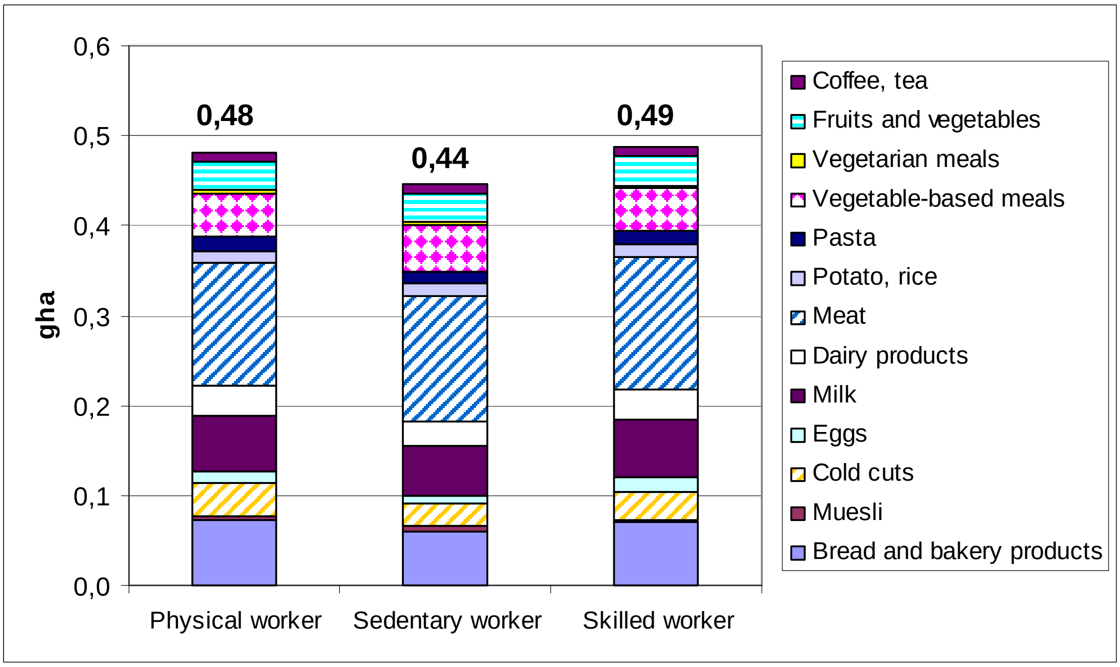
Figure 13: The ecological footprint of food consumption for active men (30-60 years)



After analysing the quantity and structure of the ecological footprint of food consumption it can be stated that, because of the different structures, no statistically significant differences can be revealed for the ecological footprints of people with various occupational activities. The quantity of food that sedentary workers consume is not less than for the other categories, despite the fact that sedentary workers have lower energy demands (based on nutritional recommendations).

For active women between the age of 30-60 years, no significant differences can be revealed between the ecological footprints of food consumption either. Structural differences are however considerable; these can explain the size of the ecological footprint. There is a significant difference between the consumption levels and ecological footprints of the three occupational groups for cold cuts, eggs and pasta. Women with sedentary jobs consume significantly less cold cuts, pasta and eggs than the other two groups where no significant differences can be seen. As for the other food products there is no significant difference.

Figure 14: The ecological footprint of food consumption for active women (30-60 years)



In this section, analysis revealed that there were no significant differences between the ecological footprints of different occupational groups for men or women. Results of this analysis were found to be contrary to expectations that there would be differences between the ecological footprints of food consumption for the occupational groups. Results confirm the suggestion that workers who undertake less physical activity consume more than the recommended amounts of food.

These results can be explained by different factors. For peoples' heights, I do not suppose that there is a significant difference according to their type of occupational activity. For the issue of the body weight of respondents, consuming more food cannot be justified according to the research on the basis of their different physical activities, but if body weight does influence the amount of food consumed (and sedentary workers may be heavier because of their higher-than-recommended intake of food/energy), this confirms the existence of the problem of excessive intake of calories. As the height and weight of the occupational groups are not known, firm conclusions cannot be drawn about this; however, the results which emerged and the necessary rejection of the related hypothesis point out the importance of further examining this relationship.

It is important also to take into consideration that not only is the type of occupational activity important in relation to nutritional demand but leisure time activities can have an influencing role.

Leisure time activity can be a determinant of food consumption. The greater-than-expected ecological footprints of sedentary workers could be explained by their having more active leisure time. I have examined the frequency of different leisure time activities for the different occupational groups in order to get know to what extent their ecological footprints can be explained by the leisure time activities.

For both men and women it can be stated that (with the exception of spending time with family, friends and shopping) there are significant differences between the three occupational groups in how they spend their leisure time (Appendix 19). For men, skilled workers and physical workers spend their free time more often with DIY work, gardening and work around the house than sedentary workers (there is a significant difference between sedentary workers and skilled workers in this regard). Spending leisure time with cultural activities is more common for sedentary workers than for the other two groups (where there is no significant difference for them). Pursuing sports and travelling during leisure time is more typical of sedentary workers and the frequency of doing sport during leisure time is significantly different for both skilled and physical workers.

The same patterns of leisure time activities can be observed for women as well, with some exceptions. Sedentary workers spend their free time less often doing work around the house and gardening (this may be due to the fact that a smaller proportion of sedentary workers live in family houses). As for cultural activities and sports, there is a significant difference between the frequency of these activities in case of sedentary workers and skilled workers. Sedentary workers and physical workers spend their leisure time more often with cultural activities than skilled workers (Appendix 19).

After examining the frequency of leisure time activities it can be said that physical workers of both genders spend their free time more often working around the house, doing DIY and gardening, which are more active leisure time activities. However, doing sport is more typical of sedentary workers, so it is not possible to say with confidence which occupational group spends their leisure time in a more active way. Leisure time activities may partly explain the not significantly different ecological footprints of food consumption.

In summarising the results it can be stated that, after analysing the ecological footprint of food consumption differentiated by gender, age and occupational activity, there are no significant differences between the ecological footprints of food consumption according to the occupational activities of respondents within the same gender and age group. The level and structure of ecological footprints cannot be explained by differences in leisure time activities either.

For men there is a significant difference between the three occupational groups regarding household income, which can confirm the conclusion that men who undertake sedentary, intellectual work (and receive higher household incomes) spend some of this higher income on food - in quantities above that suggested by nutritional guidelines. This result indicates that the quantity of food consumed is higher than the recommended healthy level. These results and conclusions are in accordance with the results of the OTÁP (2009) survey (National Diet and Nutritional Status Survey) which examined the nutritional status of the Hungarian adults based on a nationally representative sample. According to the results of the OTÁP (2009) survey, two thirds of the adult population is overweight or obese: 26.2% of men and 30.4% of women are obese, and 35.6% of men and 30.3% of women are overweight (Martos et al., 2012). Being overweight is most typical of middle-aged people. Malnutrition and a state of emaciation are less frequently present: 0.9% of adult men and 2.6% of adult women can be considered to be underweight (Martos et al., 2012). Consumption of unhealthy food and a lack of exercise play a great role in obesity. This fact is supported by data on energy intake which shows that a positive energy balance in the long run means that energy intake exceeds the recommended quantity. Regarding energy intake there is a significant difference between men and women, and there is a significant difference between the youngest and oldest age group. Energy intake decreases by age (Martos et al., 2012).

The ecological footprint of inactive groups

The ecological footprint of food consumption is smaller for pensioners than for active workers. The reason for this is that, with ageing, energy needs decrease. According to the Nutritional table of Bíró and Lindner (1988), recommended calorie intake decreases remarkably after the age of 60. With all occupational activities fewer calories are needed for people above 60 than for people between 19-30 or 30-60 years (on average 20% fewer calories are recommended compared to people who are between

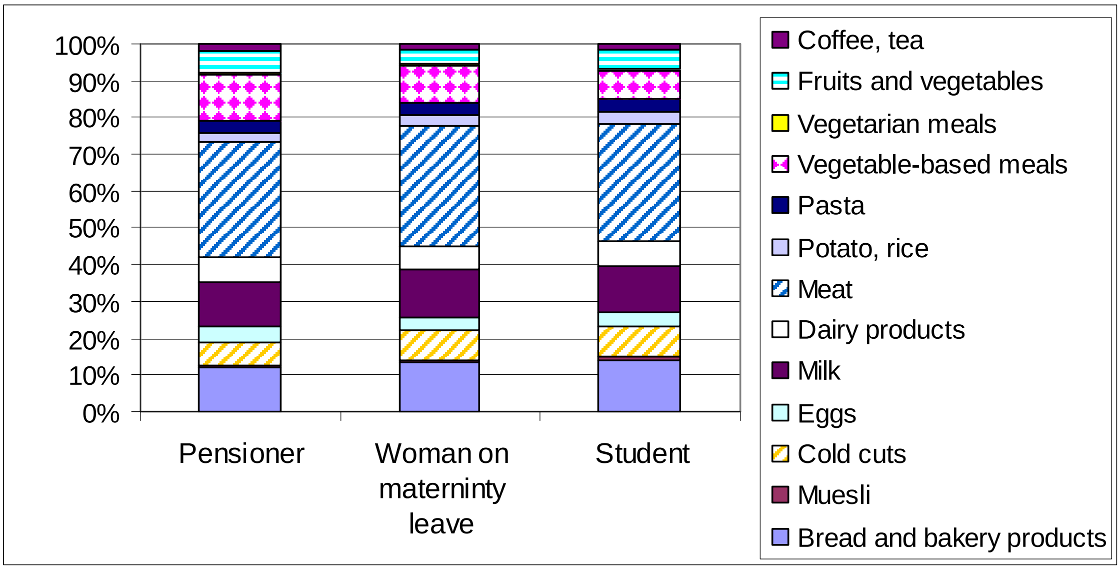
19-30 years of age). Because of this, it could be expected that pensioners would consume less and have smaller ecological footprints than active, working people.

The ecological footprint of pensioners is in fact greater than that of intellectual, sedentary workers; the reason for this is their different consumption structure (Figure 15). The meat consumption of pensioners is higher than average and the consumption of dairy products is higher as well. As these food groups have quite high ecological footprint intensity, the higher than average meat and dairy consumption compensates for the smaller than average consumption of other food groups. This can be seen in the value and structure of the ecological footprint as well.

The structure of the ecological footprint of women on maternity leave does not differ greatly from the average ecological footprint. They consume (with all food categories) more than average (with the exception of eggs, fruits and vegetables, tea and coffee) which is why their ecological footprints are greater. Their increased consumption can be explained by their increased physiological needs.

Students have the biggest ecological footprint, a fact which can be explained by their high energy demands. Their ecological footprints are higher because they consume more food - with the exception of vegetable-based meals they consume more than average of everything. Their muesli consumption is twice as much as average, while their consumption of bread, bakery and dairy products is quite high as well.

Figure 15: The structure of the ecological footprint for inactive groups



6.5. The ecological footprint of non-meat eating respondents

Looking at the international academic literature, the need to quantify and analyse the ecological footprints of those who do not eat meat at all is indicated. According to expert estimations, 1.5% of the population in Hungary can be regarded as being vegetarian (they do not consume meat at all). Exact data are not available about the number of vegetarians as so far no statistical survey has been done (Kökény, 2009).

In the Tárki database on which my analysis is based, a similar proportion (in the order of the experts' estimation) of vegetarians were found to be present (from the 975 individuals, eight people (0.8%) do not eat meat at all, but do eat eggs and dairy products). Based on the consumption data of the nine people no statistically valid conclusions can be drawn. It is interesting to mention that this group substituted for the lack of meat in their diets by consuming a higher quantity than average of vegetarian meals and muesli.

From previous academic research it can be concluded that meat-based mixed diets have greater environmental impacts than plant-based diets (Pimentel and Pimentel, 2003; González et al., 2011 etc.), because of the greater ecological footprint intensity of meat consumption. Kocsis (2010b) confirms that it is more efficient from an energetic point of view to consume food products of plant origin than to source the necessary calorie intake from animal-based food products, as animals use a great part of the energy which they get from plants in order to sustain functions necessary to life.

However, following a vegetarian diet does not mean in all cases having a significantly lower environmental impact, as a decrease in environmental impact from not eating meat can be compensated for by consuming imported fruits and vegetables which may have a big environmental impact as well. (Furthermore vegetarian consumption is not necessarily healthy.) Examining the consumption patterns and environmental impact of vegetarians is a topic for further research.

6.6. The ecological footprint of food consumption according to income

The disposable income of an individual or household may be an important influencing factor of what foods they consume.

With hypothesis H5 the relationship between the level of income and the ecological footprint of food consumption is a particularly interesting question. Having a higher income could be presumed to increase the quantity of food consumed. However, it may also be supposed that people with higher incomes are more likely to lead more health conscious lifestyles and could therefore consume more moderately. I expect that people with higher incomes consume more moderately and this can be seen in their ecological footprints as well.

In the database the income data for individuals is somewhat incomplete as only 65.4% of respondents provided details about their personal or household income or income level. As H5 hypothesis can be relevant in these missing income categories, I examined the relationship between the income level and the ecological footprint of households based on a database from KSH (2012e) - the Hungarian Central Statistical Office database entitled: ‘yearly food consumption per capita’ (this means that I used a secondary database for calculating the ecological footprints according to income, but I think that this hypothesis is connected to the socio-demographycal variables logically, that is why I present my results here). This database describes the quantity of food consumed in 2010 by income deciles[4]. This database (KSH, 2012e) shows the quantity of food consumed in kilograms. These data and the ecological footprint intensities calculated from the GFN (2011) database are used to quantify the ecological footprint of food consumption of the income deciles (formula (1)). In the KSH (2012e) database some food categories are different from those used in the Tárki database on which my other calculations are based: the dairy products group also includes kefir (a fermented milk drink), sour cream and cottage cheese, for example. This explains why the quantity of dairy products consumed (and the ecological footprint) is greater when examining food consumption by income decile.

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[4] Income deciles (KSH, 2012e): deciles of the population ranked according to the annual net income per capita.

Figure 16: The ecological footprint of food consumption according to income decile

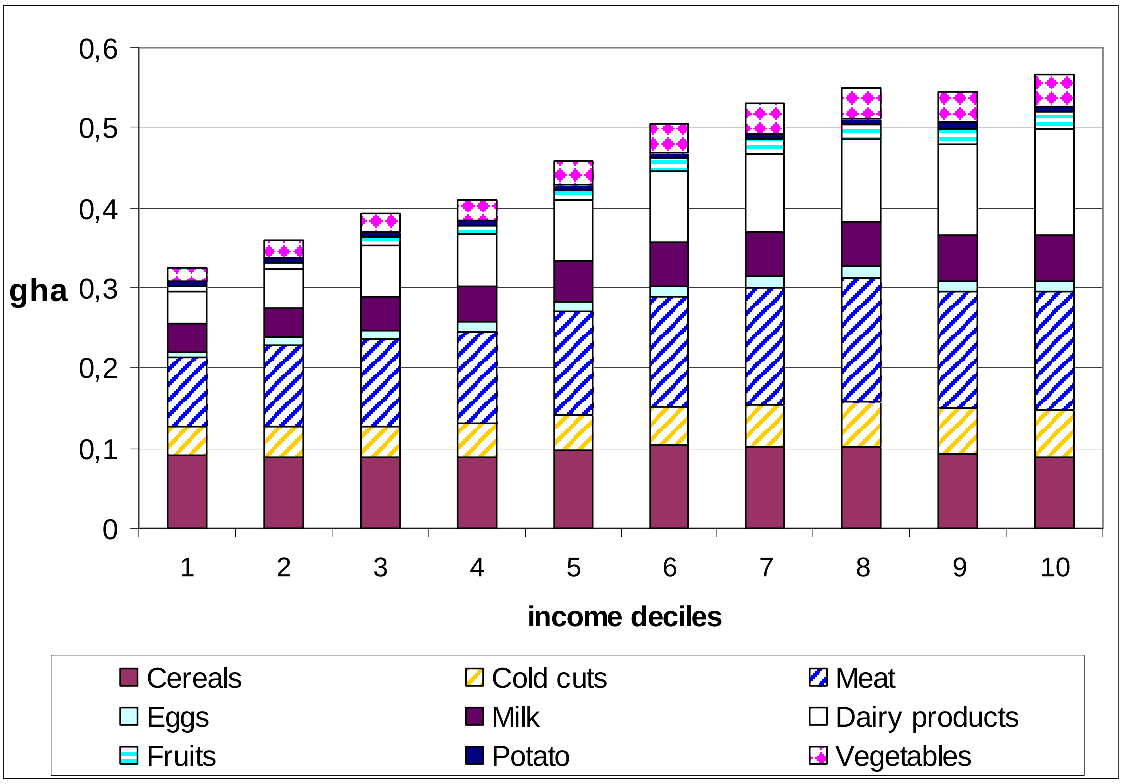


Figure 16 demonstrates an obvious tendency: the ecological footprint of food consumption grows as income increases. With a higher income the quantity of food consumed increases along with the ecological footprint. People in the lowest income decile have 30% smaller ecological footprints than the average footprint, while people in the higher income decile have 22% larger ecological footprints than average. With increases in income the ecological footprint increases significantly but only until a certain level: from the 8^{th} income decile the ecological footprint increases only slightly and there is only a slight difference.

After examining the ecological footprint of certain food categories I can state the following: the ecological footprint of dairy and fruit consumption increases with income until the eights decile. Slight variance can be seen with the ecological footprint for cereal consumption but it is not significant - cereal consumption is responsible for nearly the same size of ecological footprint for all income deciles. It can be observed that, with the exception of the consumption of cereal, the quantity (and thus the ecological footprint) of all the other food categories increases according to income decile.

With growth in income the ecological footprint grows moderately for consumption of meat, eggs and milk but with dairy products, vegetables and fruit the ecological footprint increases more vigorously.

In order to examine the differences in consumption better I compared the lowest and highest income deciles (Table 17). The greatest difference is with consumption of fruit and dairy products. The ecological footprint for consumption of fruit is 3.56 times greater for the highest income deciles and the footprint of for dairy product consumption is 3.21 times larger compared to the lowest income decile. Consumption of fruit was analysed in more detail. With the following fruits there is a great difference in consumption and the ecological footprints of the lowest and highest income deciles: apricot, sour cherries, grapes, cantaloupe and strawberries.

The least difference is with consumption of cereal (as mentioned before) and with consumption of potatoes; the ecological footprint for cereal and potato consumption is nearly equal for the lowest and highest income deciles.

There is only a moderate difference in consumption of meat products and its ecological footprint for respondents of different income statuses. The reason for this is that the greatest difference in the quantity of meat consumed is with consumption of poultry and pork. Here, there is a moderate difference in the quantity consumed by respondents with different income levels. The consumption of beef (with a high ecological footprint intensity), even for the highest income decile, comprises 10% of total meat consumption. The highest income decile has an ecological footprint for beef consumption that is five times as great as that of the lowest income decile, but because of the relatively low quantity of beef consumed it does not generate a great difference in the total meat footprint.

Table 17: The ecological footprint of the highest and lowest income groups for the main food categories

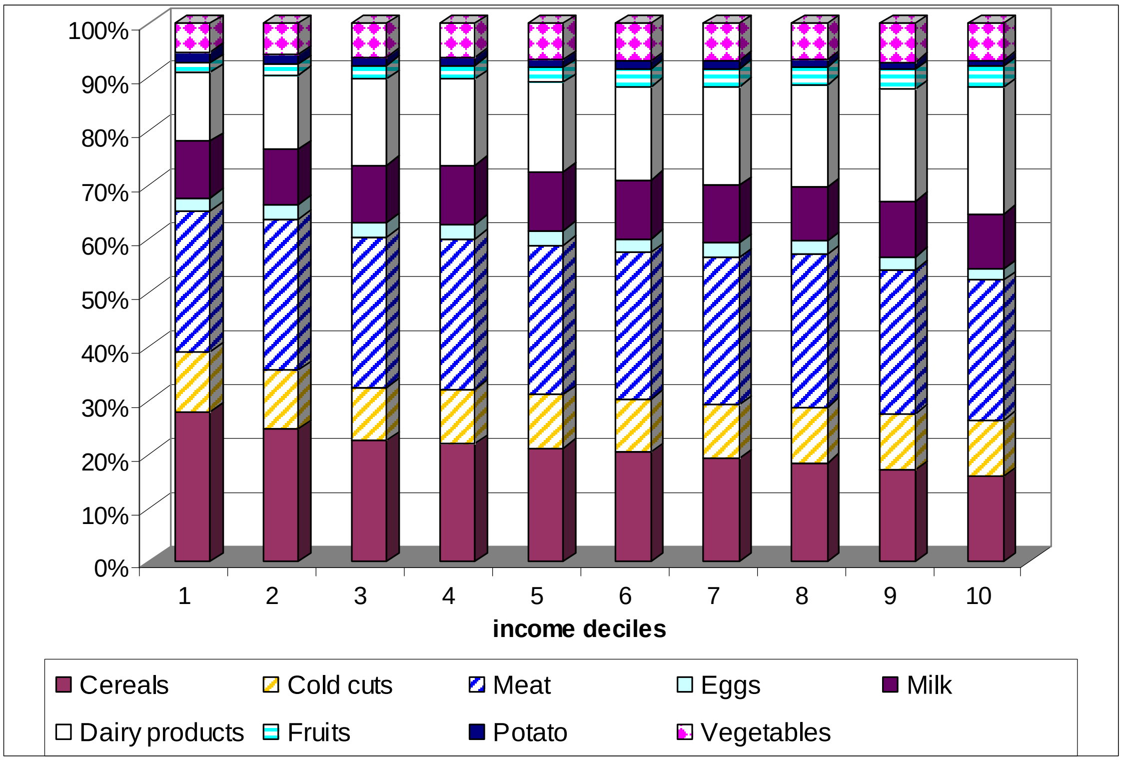
	Ecological footprint of highest income decile/ lowest income decile
Fruits	3.56
Dairy products	3.21
Vegetables	2.18
Meat	1.72
Milk	1.68
Cold cuts, ham	1.63
Eggs	1.50
Potatos	1.07
Cereals	0.99

When analysing the structure of food consumption, it can be seen from Figure 17 that for respondents from the lower income deciles a greater part of the ecological footprint is taken up by consumption of cereals, potatoes and eggs, while for respondents from higher income deciles, the proportion of the ecological footprint derived from consumption of dairy products, vegetables and fruit is considerably greater.

Many people claim that lack of income can hinder healthy food consumption. Results show that people with higher income consume more food. Increasing meat consumption can be seen until the eighth income decile, while fruit and vegetable consumption increases as well. For the two upper income deciles the ecological footprints of meat, bread, eggs and potato are smaller than for the eights income decile. The two upper deciles do not consumer more from these food, but their fruit and vegetable consumption is higher.

The KSH (2012e) database includes data about consumption of fat and sugar as well. When analysing the quantity of fats and sugar consumed by different income groups it can be seen that the quantity of sugar and fat consumed grows continuously from the lowest income decile until to the 8th income decile. Only with the two upper income deciles can it be seen that the quantities consumed decrease slightly (Appendix 21). Thus only the wealthiest 20% of respondents appear to be eating more healthily (at least concerning consumption of sugar and fat). Respondents with an average income level do not appear to be using the opportunity provided by their relatively high incomes to eat more healthily - they use their higher incomes to consume more of each category of food.

Figure 17: The structure of the ecological footprint for food consumption according to income deciles



To sum up, it can be stated that the level of income is an influencing factor of the quantity and structure of food consumption. People with higher income do not have lower ecological footprints, only the wealthiest 20% appear not to increase their footprints by having different consumption structure.

The KSH (2012f) database includes data about expenditure on food for the income deciles. It can be seen that expenditure on food per capita in the year 2010 increases according to level of income. However, greater expenditure does not necessarily mean greater consumption, in terms of quantity. I calculated for each income decile how much they spent on one gram of food from each of the main food categories. Results show that, for all food categories, respondents from the lowest income decile spend less than those from the highest income decile (Appendix 22). This indicates that with increasing income respondents spend more on each gram of food. Income status can show better the differences in food consumption and this calls attention to the fact that when analysing the impacts of consumption of food, calculating environmental impact based on monetary data alone (i.e. expenditure on food) could be an erroneous approach, as higher income is not necessariliy in line with consumption of greater quantities of food. I believe this was necessary to note when analysing food consumption according to income.

From chapter 6.7., my empirical results are based on the survey again.

6.7. Consumer groups according to the structure of food consumption

The aim of this chapter is to identify typical modern consumption structures. I hypothesise that consumers can be categorised into well-differentiated groups according to the structure of their food consumption (H6). Identifying typical food consumption structures can help in understanding for which food categories there are great differences in the amounts of food consumed.

I identified typical consumption groups using cluster analysis combined with multidimensional scaling (MDS). For the cluster analysis I used non-hierarchical k-means clustering and, for testing the reliability of the clusters, a two-step cluster analysis was also undertaken.

Cluster analysis was carried out to examine the consumption structure of the individuals (more precisely, on the energy intake of respondents for the food categories compared to their total energy intake). Clusters which were created this way show typical consumption structures (regarding energy intake)[5].

As a first step in the cluster analysis I examined the distribution of the variables of the main food categories. When studying the variables the distribution of consumption of milk and dairy products was conspicuous as 18.9% of respondents (n=178) reported that they did not consume milk and dairy products directly. I think this feature is in itself a determining factor of food consumption structures (especially as about a fifth of all respondents belong to this group and milk and dairy consumption is one of the four major food groups). Consumption of milk and dairy products (or its absence) can determine the quantity of other food items consumed and the ecological footprint as well. The need to separately treat the group of zero consumption milk and dairy product respondents was confirmed by the two-step cluster analysis, where two

[5] As data on the quantity of directly consumed food and energy intake were at my disposal during the research (see section 6.2. Limitations of the research), the food consumption structures are not equal to the total energy consumption structures. In the present overview of the research I describe the proportion of different food groups compared to each other, regarding energy intake.

clusters were created. Those who did not consume dairy products unambiguously comprised a separate cluster, while the other milk and dairy consuming respondents made up the other cluster (for the k-means cluster analysis a separate cluster was created for low and no-milk and dairy consumers as well).

Because of these findings I analysed respondents who did not directly consume milk and dairy products as a separate group.[6]

Cluster analysis is sensitive to the existence of outlier data which can mask identification of genuine structure. This is why before clustering I analysed the outliers. I identified them with a box plot figure and as a result 35 respondents could be excluded from the analysis, but this did not influence the final result of the clusters.

I carried out correlation analysis on the variables in the analysis as well, as using highly correlated variables in a cluster analysis can lead to redundancy and error (Hajdú, 2004). Cluster analysis was carried out on the following variables: the proportion of the total energy intake from vegetable-based meals, fruit and vegetables, meat, bread and bakery products, cold cuts, milk, dairy products, pasta and eggs.

For the next step of the research I performed non-hierarchical k-means cluster analysis combined with multidimensional scaling in order to group the unit of observations (individual respondents) with the same consumption structure into the same group.

I applied the methodology in the following way: I started by using double the number of clusters which were theoretically expected (in this case, ten clusters). For the next step I analysed the ten clusters using multidimensional scaling, creating a distance matrix from the cluster centres, using the Alscal process. This is the Alternating Least Squares (Alscal) approach to multidimensional scaling; it minimizes the sum of squared residuals. The main product of the method is the plotting of cluster centres in a multidimensional space and then a calculation of the Euclidean distances of the centres.

As a result of the multidimensional scaling process we obtain two-dimensional coordinates for the cluster centres, and then those centres which are not greatly different from each other and which are closest to each other are merged. Thus in one step, two clusters are merged. In the next step of the process non-hierarchical k-means cluster analysis was undertaken for nine clusters through inputting the final cluster centres of

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[6] Two-step and k-means cluster analyses were undertaken for the whole sample without treating separately those who do not consume milk and dairy products directly. Both two-step and k-means cluster analysis created a separate cluster for them, so regarded justified to handle this cluster separately in further analysis.

the previous cluster analysis and then recalculating the distance of the nine cluster centroids. I continued this combination of multidimensional scaling and cluster analysis until I obtained a spatial configuration where (in a minimal dimensional space) the dissimilarity of the data represent well the dissimilarity between the individuals (Füstös, 2009, p.234.) The clustering solution for this process stretches the multidimensional space, thereby creating clusters which are the best differentiated clusters.

By examining the cluster centres and the space configuration in each step, I obtained five well-differentiated clusters that filled the space well and had stable cluster centres. [7] (The initial and final cluster centres can be found in Appendix 23).

The Table 18 shows the distribution of cluster membership wherein five clusters are from the cluster analysis and the sixth cluster represents those who do not consumer milk and dairy products directly. The distribution of cluster membership can be regarded as balanced.

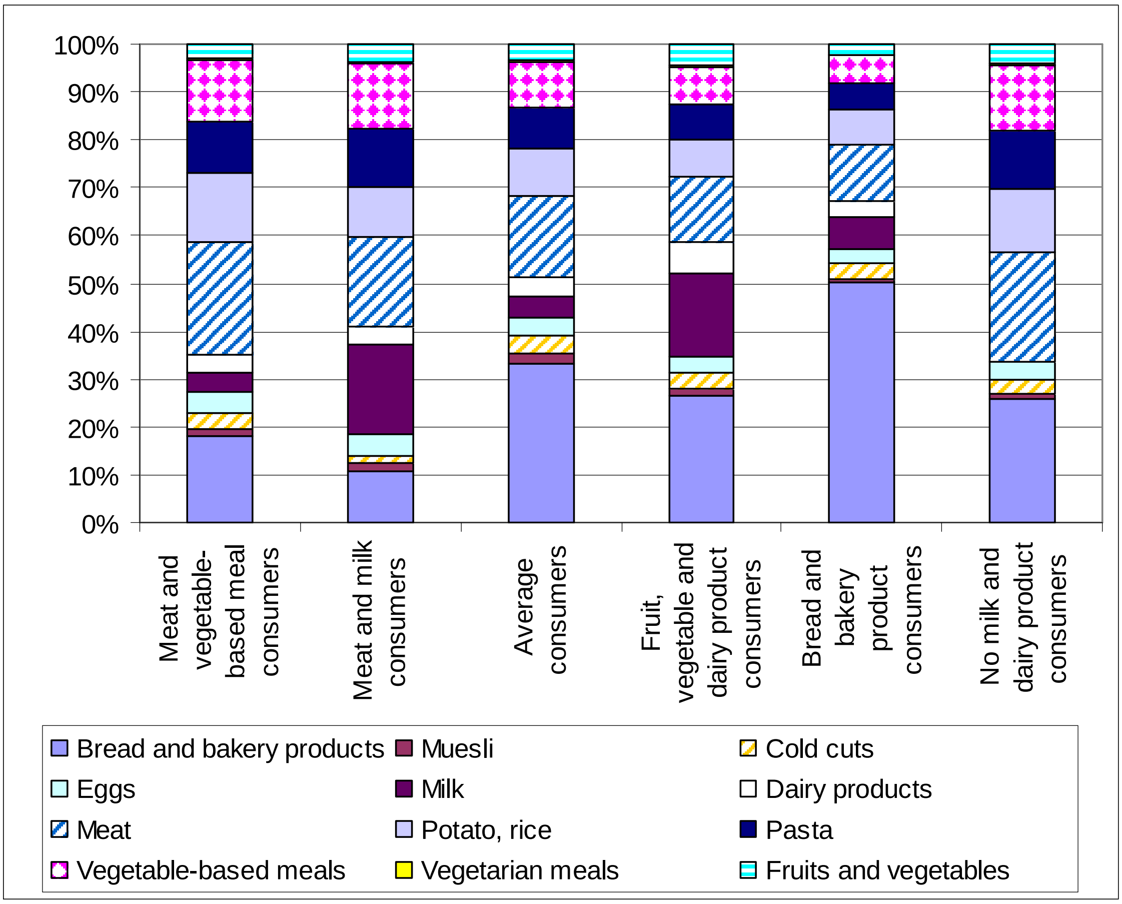
Table 18: Cluster membership based on the structure of food consumption

Cluster	Size	Share (%)
1	159	16.9%
2	72	7.7%
3	217	23.1%
4	141	15.0%
5	173	18.4%
6	178	18.9%
Total	940	100%

Figure 18 illustrates the clusters created according to the structure of food consumption.

[7] The stability of clusters were tested by omitting variables by k-means and two-step clustering. The clusters presented in the section have proven to be stable.

Figure 18: Clusters according to the structure of food consumption



Cluster 1: Consumption of meat and vegetable-based dishes is dominant; the proportion of energy intake from the consumption of meat and vegetable dishes is higher than average. Besides this, consumption of eggs is somewhat higher than average, while the proportion of energy intake from bread and bakery products is below average.

Cluster 2: The energy intake from milk and consumption of meat is dominant is this cluster (the highest proportion for consumption of milk). The proportion from consumption of bread and bakery products and cold cuts is relatively low, while the consumption of other food products can be regarded as average.

Cluster 3: The consumption structure of those who belong to this cluster can be seen as ‘average’; the only exception is with consumption of milk where the proportion of respondents’ energy intake (4.6%) is slightly less than average (7%).

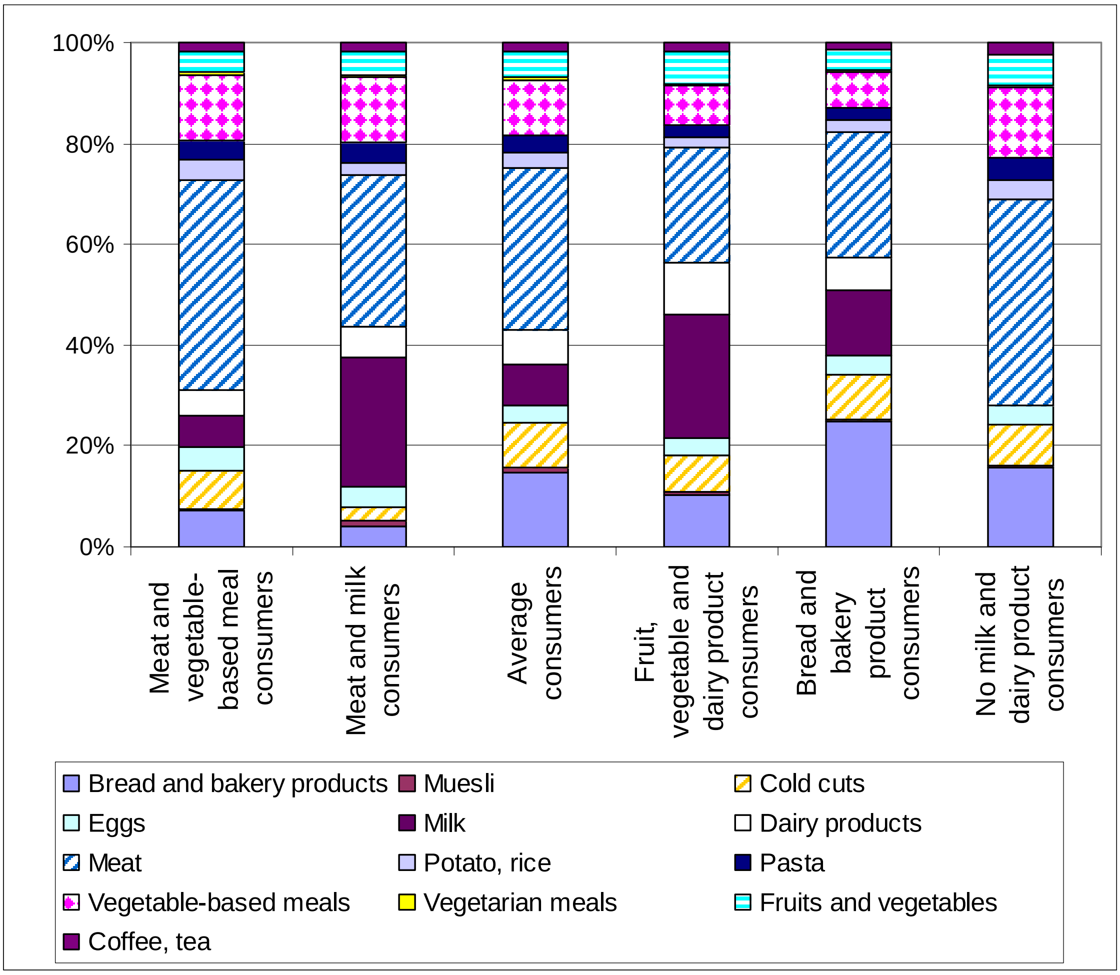
Cluster 4: This cluster is defined by having a relatively high energy intake from consumption of fruit, vegetables and dairy products. Direct consumption of fruit and vegetables is greatest for this cluster, and consumption of milk is dominant. The relative contribution of dairy consumption to total energy intake is two times higher (6.8%) than average (3.4%). Consumption of milk is quite high although the relative contributions of consumption of pasta and vegetable dishes is lower than average.

Cluster 5: consumption of bread and bakery products accounts for 50% of the energy intake of the cluster member; furthermore, the proportion of energy intake from the consumption of cold cuts is notable as well. Meat consumption is below average, the consumption of other food products is around average.

Cluster 6: Respondents who belong to this cluster do not consume milk or milk products directly. This is compensated for by their relatively high consumption of meat, pasta and vegetable dishes. The proportion of direct consumption of fruit and vegetables is the second highest here, after cluster 4.

The differing structure of the clusters according to energy intake is highlighted when looking at the structure of the clusters regarding the ecological footprint (Figure 19).

Figure 19: The structure of the ecological footprint for typical food consumption clusters



In the first cluster the proportion of the ecological footprint derived from meat consumption is the highest (41.5%) of all clusters and the proportion of the ecological footprint from consumption of vegetable dishes (13.1%) is higher than average (10.4%). In the second cluster, consumption of milk accounts for 25.8% of the total ecological footprint of food consumption, while the size of the ecological footprint from consumption of bread and bakery products is the lowest with this cluster (4.1%). Cluster 3 can be regarded as an average cluster, so the structure of the ecological footprint is ordinary as well. In the case of cluster 4 it can be seen that the ecological footprint from the consumption of fruit and vegetables is the highest (6.4%), diary consumption accounts for 10.5% and consumption of milk requires 24.4% of the total ecological footprint. In cluster 5 it is bread and bakery products which take a considerable 24.8% of the ecological footprint while consumption of meat is less than average and the ecological footprint for the consumption of coffee and tea is the lowest. In the cluster for which respondents do not consume milk and dairy products, consumption of meat accounts for 40.7% of the ecological footprint and the ecological footprint of coffee and tea consumption is the highest here from all clusters (2.3%; the average is 1.8%).

In the following section I analyse these clusters using socio-demographical characteristics.

Cluster 1: Meat and vegetable-based dish consumers

Members of this cluster live both in villages and towns. Settlements with populations of 1-5 thousand inhabitants and 5-10 thousand inhabitants are typical. As for their educational level, a lower than average education predominates (the proportion of people with degrees in higher education is low (13.2%) and people with primary school education are overrepresented (30.2%) compared to average (23.2%)). Elderly people are well represented in this cluster. The proportion of people between 40 and 49 is the highest here compared to other clusters; furthermore, the proportion of people between 60 and 69 years (12%) and respondents above 70 (12%) is higher than average. The number of unemployed respondents is the highest in this cluster. The proportion of single households is also the highest (23.5% of single respondents belong to this cluster). Members of this cluster are less environmentally-conscious. They are less happy and satisfied in general and even less satisfied with the status of their health. For leisure time activities they go less frequently to cultural events. Window-shopping and shopping is most typical for this cluster. Consumption of fresh local fruit and vegetables and local food is the lowest of all clusters.

A typical member of this cluster is a single, less educated, elderly person living in a smaller settlement, with less active leisure time.

Cluster 2: Meat and milk consumers

Members of this cluster are more urbanised: more people than average live in Budapest, in county towns and in towns. The typical size of their settlements is a town with above 50 thousand inhabitants. Respondents are highly educated; the highest proportion of respondents with university degrees (22.2%) is found here. This is the 'oldest' cluster with 20% of respondents above 70. The proportion of pensioners in this cluster is the highest; furthermore, the proportion of women is quite high as well (62.5%). Household size is smallest in this cluster; the reason for this being the high proportion of single households (27.8%) and double-member households (33.3%). Their environmental consciousness is average; they are somewhat happier and more satisfied in general with their lives but they are the least satisfied with their health status. Travelling is not typical of them and members of this cluster are quite passive regarding other leisure time activities as well. Consumption of convenience food is least frequent and the proportion of local fresh fruit and vegetables consumed is the highest.

To sum up, a typical member of this cluster is an elderly person without much active leisure time who has a conservative Hungarian diet. They are more educated, live in bigger settlements and are more conscious than cluster 1 members.

Cluster 3: Average consumers

The level of education of respondents from this cluster is higher than average. This cluster is younger than average; the age group of 30-39 years is well-represented (27.6%). Respondents with intellectual, white-collar workers are found in the highest proportions here. The size of households is larger (an average 3.03 persons) than average. This group is the most environmentally conscious and the happiest as well; they are also more satisfied with their health status than average. Members of this group spend their leisure time in an active way. Their frequency of travelling is higher than average and leisure time spent window-shopping and doing sport is the highest.

A typical member of this cluster is a young-middle aged person who lives probably as part of a family and who has an intellectual job. Their life is happy and balanced and they spend their leisure time actively.

Cluster 4: Fruit, vegetable and dairy product consumers

This cluster is rather urbanised; the number of respondents living in villages is low in this cluster. The educational level and the size of households are average. This is a younger cluster with respondents between 20-29 and 30-39 well-represented. The proportion of students and women on maternity leave is higher. The proportion of respondents who undertake physical work is the lowest. Their environmental consciousness is above average, and they are more satisfied with their lives than average. Travelling and pursuing sports are typical leisure time activities. Consumption of local food is the highest in this cluster.

The environmental consciousness of respondents is higher than average and the high proportion of fruit and vegetables consumed and respondents' more frequent sporting activities could point to the conclusion that members of this cluster lead a more conscious lifestyle from both environmental and health perspectives.

Cluster 5: Bread and bakery product consumers

This cluster contains the highest proportion of respondents who live in the capital, Budapest; fewer respondents live in country towns. Members of this cluster are educated; few members have only completed primary school. This is the youngest cluster with 26.3% of respondents under 19 years and 23.8% of respondents between 20-29 years. The proportion of men is highest in this group (58.4%). The proportion of physical workers is the highest here; the number of skilled workers and students is also high. The cluster has the largest household size. Members of this cluster are more environmentally conscious and happier than average; they are the most satisfied of all clusters with their lives and their health status. This is an active group regarding leisure time activities. The frequency of attending cultural events is the highest for this group which can be explained by the high number of respondents who live in Budapest. Travelling and spending time with family and friends is most typical of this group.

A typical member of this cluster is a young man who lives with his family and who travels actively and undertakes cultural activities. The average younger age explains the higher-than-average consumption of bread and bakery products (presumably due to the higher need for carbohydrates and more active lifestyles).

Cluster 6: Consuming no milk and dairy products

The share of respondents living in the capital city of Budapest is the lowest here (12.9%, compared to the average of 17.4%). Members of this cluster commonly live in smaller towns; living in villages is not typical of them. The educational level of an average member is lower than average. As for average age, from 30-39 or 40-49 is typical. The number of respondents living alone and in two-person households is high.

This group is the least environmentally conscious, least happy and least satisfied. Travelling and spending time with friends and family is done least frequently; other leisure time activities are done at an average frequency. Eating convenience foods is most typical of this cluster.

Table 19 summarises the cluster characteristics.

Table 19: Summary of cluster characteristics

Clusters	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
Name	Meat and vegetable consumers	Milk and meat consumers	Average consumers	Fruit, vegetable and dairy product consumers	Bread and bakery product consumers	No milk consumers
Share (%)	16.9%	7.7%	23.1%	15.0%	18.4%	18.9%
Gender	Both genders	More women	More women	Both genders	More men	More women
Age	Rather older	The oldest cluster	Younger	Younger	The youngest group	Average
Level of education	Slightly lower level of education	Highest level of education	Slightly higher level of education	Average	Slightly higher level of education	Slightly lower level of education
Type of settlement	Live both in villages and towns	Rather urbanised	Live both in villages and towns	Rather urbanised	Urbanised, with the highest number of respondents from the capital city	Rather urbanised, less respondents from the capital and villages
Income level	Slightly lower	The lowest	Higher	Average	The highest	Lower
Household size	Many single households	One or two-member households	Big households	Average	Big households	Smaller households
Leisure time activity	Less cultural activities, but more shopping and window-shopping	Quite passive	Travelling, sports and window-shopping	Travelling, sports and less cultural activity	Travelling, cultural programs, spending time with family and friends	Average, spending time with family and friends is less typical

* Note: All characteristics compared to average

Knowing the characteristics of clusters and their members can help in identifying and communicating with consumers with varying food consumption patterns. The clusters which result from this analysis show typical consumer groups according to the structure of their food consumption. As the cluster analysis was carried out exclusively on consumption structures, it should be taken into account that consumption of a higher proportion of higher ecological footprint intensity food products does not necessarily mean greater quantities of food are consumed per se. This is why the ecological footprint of the first cluster (meat and vegetable dish consumers) is smaller than the average ecological footprint. The reason for this is that while the consumption of meat and vegetable-based meals is higher than the average, they consume half as much bread and milk as the average and their fruit consumption is lower as well. (The ecological footprints of the clusters can be found in Appendix 24). Meat and milk consumers (cluster 2) have lower ecological footprints, they consume less bread and cold cuts. The high proportion of meat does not mean greater quantities of meat consumption. The ecological footprint of average consumers (cluster 3) can be regarded as average, while the ecological footprint of fruit, vegetable and dairy product consumers (cluster 4) and bread and bakery product consumers (cluster 5) is 20% greater than average. This is due to the fact that these consumers do not consume less from other food products, but they consume more fruits, vegetables and dairy products and bread, while their consumption can be regarded as average from other food products. Members of cluster 6 do not compensate their lack of consumption of milk and dairy products by consuming more than average from other food products, thus their ecological footprint is 28% lower than average.

As a result of this cluster analysis we can come to know which food groups should be consumed more or less in each of the different clusters so that members' food consumption patterns have lower environmental impact and are healthier. These results justify the previous findings (see Chapter 6.4.) from analysing the food consumption of the income deciles based on the KSH (2012e) database. Those respondents who are more environmentally conscious than average and have higher incomes (cluster 4 and 5) do not make 'sacrifices' by reducing their food consumption. Consuming more healthy food (more fruit and vegetables) occurs *in addition* but these respondents do not consume less food, nor do they have lower ecological footprints. Those respondents who have lower incomes (cluster 1 and 2) do not have lower footprints because of consuming less meat, but because of consuming less fruits and vegetables.

The primary aim of the analysis was to indentify different consumption structures. (The size of the ecological footprints can be different in case of the whole population.)

6.8. Scenario analysis about the possibilities for decreasing ecological footprints

Responding to the pressing question for academic research about the environmental impacts of food consumption should not only involve an analysis of the quantity and structure of consumption. The need to take into account both environmental and health perspectives is clear (Gussow and Clancy, 1986; Wallén et al., 2004). Previous research has not unambiguously proven that the structure of food consumption is clearly linked to both health and environmental impacts.

In this section I examine to what extent the ecological footprint of food consumption can be decreased when the structure of food consumption is modified towards healthier diets. Using a scenario analysis approach I define fixed diets which are used to show up how environmental impact is modified when consumption patterns change. This methodology is often used and is popular when measuring the environmental load of food consumption.

Many scenario analyses do not start by using real food consumption patterns but they use ‘ideal diets’. These are diets which satisfy dietary recommendations from a health perspective. The environmental impacts of these kinds of diets are calculated. However, the diets that they are based on are not always realistic or typical. I base my analysis on the actual food consumption patterns of surveyed respondents and I present alternatives which are achievable and realizable in scenario group A. I undertook scenario analysis for the ecological footprint of an average Hungarian consumer so that results could be compared to international research results. I supposed that an average consumer has an active lifestyle and undertakes a medium level of physical activity (which corresponds to the average consumer according to energy intake data (Sarkadi Nagy et al., 2012)).

Table 20 shows the first group of scenarios.

Table 20: Scenarios for changing the structure of food consumption (A)

Scenario		Quantity (kg)	Ecological footprint (gha)	Change in ecological footprint (%)
Basic scenario	Actual consumption	377	0.510	-
1	Meat consumption is reduced by one occasion per week, no replacement	369	0.485	**-5.0%**
2	Meat consumption is reduced by one occasion per week, replacement with fruits and vegetables	407	0.506	**-0.9%**
3	Meat consumption is reduced by one occasion per week, replacement with pasta	373	0.4903	**-3.9%**
4	Meat consumption is reduced by one occasion per week, replacement with dairy products	374	0.507	**-0.6%**

If a decrease in the consumption of meat is not substituted for by consumption of other foods, the ecological footprint can be reduced by 5%. In this case, calorie intake decreases as well (this scenario, although it may seem far-fetched, is however not baseless. On average Hungarians consume an excess of calories (KSH, 2011)). In the next cases I defined scenarios where a decrease in consumption of meat is substituted for by other food products (i.e. maintaining the original calorie intake) so that results can be compared to international research findings.

The greatest reduction in ecological footprint could be realised by consuming more pasta or cereals. Increasing the consumption of fruit, vegetables or dairy products does not decrease the ecological footprint much (below one percent). The reason for this is that these products have relatively high ecological footprint intensities per unit of calories.

In the next group of scenarios I analysed the impact of changing diest according to the recommendations of the Hungarian National Institute for Food and Nutrition Science (OÉTI). During the research I used the recommended, normative food consumption basket compiled by OÉTI for the minimum existence guidelines of KSH (2010) (which relates to the diet of a moderately active, healthy person who consumes 2400 kcal per day). I modified the consumption structures with lower meat and egg consumption using the recommendations of OÉTI and I analysed changes in the ecological footprint.

I calculated not only with a reduction in consumption of meat but with a reduction in consumption of eggs as well and analysed the scenarios with and without replacement of calories. Recommended meat consumption is 32% lower (40.8 kg/year) and recommended egg consumption (161 pieces/year) is 44% lower than present consumption level.

Table 21: Scenarios for changing the structure of food consumption (B)

Scenario		Quantity (kg)	Ecological footprint (gha)	Change in ecological footprint (%)
1	Meat consumption recommended by OÉTI, no replacement	357.15	0.45	**-12.3%**
2	Meat and egg consumption recommended by OÉTI, no replacement	349.66	0.44	**-14.4%**
3	Meat and egg consumption recommended by OÉTI, replacement with fruits and vegetables	459.16	0.50	**-2.6%**
4	Meat and egg consumption recommended by OÉTI, replacement with dairy products	363.11	0.50	**-1.8%**
5	Meat and egg consumption recommended by OÉTI, replacement with pasta	361.67	0.45	**-11.3%**
6	Meat and egg consumption recommended by OÉTI, replacement with fruits, vegetables and pasta	416.42	0.48	**-5.4%**

The ecological footprint can be reduced by 12.3% if less meat consumed according to the recommendations and there is no substitution of calories. When cereals (e.g. muesli) substitute for processed meat, the ecological footprint decreases by 4.1%. In this scenario group, replacement with fruit and vegetables with low caloric value reduces the ecological footprint least of all (by 2.5%). The ecological footprint decreases by 14.4% if we consume meat and eggs according to the recommendations and there is no substitution of calories. Maintaining the original calorie intake and replacing reduced meat and egg consumption with other food products, Table 21 shows that the ecological footprint decreases the least in case of replacement with dairy products. The greatest decrease can be reached by replacement with pasta (the ecological footprint decreases by 11.3%), as this food category has the lowest ecological footprint per unit calories. Replacing meat and egg consumption with other foodstuff can show to what extent the ecological footprint of food consumption could be reduced when combining food categories which are recommended as healthy food and tailored individually.

According to the research results of McMichael et al. (2007) who are often cited in the academic literature, in order to moderate the effects of climate change, consumption of meat should be radically reduced. McMichael et al. state that a daily average of 90g of meat is a recommended maximum and he does not recommend consuming processed meat. The present ecological footprint could be decreased by 17.5% if these recommendations for meat reduction are applied without calorie replacement. A notable reduction in the ecological footprint would be witnessed in the case that 90g of meat were consumed and that calories were replaced with dairy products or fruits and vegetables (namely, a decrease in the ecological footprint by 4.6% and 3.8%). In the case that consumption of meat were replaced with cereals then the ecological footprint could be reduced by 13% on average. (Details of calculations can be found in Appendix 25.)

In this section I presented potential alternatives for moderating the ecological footprint. It can be stated for each person, based on their individual needs, to what extent and in what direction the structure of food consumption should be modified to create a healthier and more sustainable food consumption structure. Exact values can be defined by dietary experts.

Summing up the results of the scenario analysis, I can state that the greatest reduction in the ecological footprint could be accomplished by supplementing the consumption of meat with food products which have relatively low ecological footprints/caloric value intensity. Results show that a moderate reduction in the ecological footprint can be made by modifying consumption patterns in small steps and to a small extent.

A greater reduction in the ecological footprint could be accomplished only through radical changes to diets. However, even the possibility of a moderate reduction should not be undervalued. By moving and changing the structure of food consumption step-by-step in a healthier direction the environmental load is mitigated. By small changes in consumption we can arrive closer to our goal of consuming food more sustainably. The result achievable depends greatly upon which food products are used to supplement any reductions in the consumption of meat, and what their ecological footprint per calorie item is.

Additionally, these further reductions could be made by reducing the quantity of food consumed and the calorie intake, which would be desirable from a health perspective as well. It is important to note that the only modest possibility for reducing the ecological footprint results from the fact that the current consumption of meat in Hungary is below the European average.

Changing food consumption habits is a long-term process. Food consumption itself cannot be substituted but the structure of consumption can be modified in favour of health and sustainability considerations. Not only should consumers be motivated to change independently but the development of public policy instruments for this purpose is needed as well. Scenario analysis can help us to visualise with which diet we can reduce the ecological footprint the greatest. It is possible to make food consumption healthier and lessen the ecological footprint at the same time.

6.9. Evaluation of the research hypotheses

In this section I summarise the research results and the main research findings are compared with results of international research. The Summary section summarises and evaluates the main conclusions and lessons from the research.

H1: Ecological footprints are significantly different according to level of education

Results did not prove that there are significant differences between the ecological footprint according to educational level. Respondents of higher educational level do not have lower ecological footprints, but the consumption structure is different.

H2: Ecological footprints are significantly different according to gender

The ecological footprints of men and women are significantly different, as expected. This is due to different consumption quantity and consumption structure as well. The hypothesis for genders was confirmed.

H3: Ecological footprints are significantly different according to age groups

As for age groups, results did not confirm that ecological footprints are significantly different either for men or for women, but structural differences exist.

H4: The ecological footprint of more actively working people will be higher than that of people with lower intensity jobs

Results have shown that if we examine the ecological footprint of food consumption differentiated by gender and age group according to occupational activities, no significant difference can be revealed. When no distinction is made between genders and age groups, significant differences are revealed, but this is due to the varying proportion of the genders within the occupational groups.

H5: The ecological footprint of higher income groups is offset by their healthier consumption structure

Analysing the ecological footprints according to income deciles (using secondary database), we could see that ecological footprint increases until the eigth income decile. The upper two income deciles consume more fruit and vegetables and their consumption of meat and bread does not increase. Revealing the relationship between income and ecological footprint confirms the assumptions of Zhu et al. (2006); namely, that people with a higher income (in my analysis, the upper two income deciles) live somewhat healthier lives, but this is not enough to decrease the environmental load. A decrease in the consumption of those with an average income is necessary in the future.

H6: Well-defined consumer groups can be defined based on the structure of their food consumption

As a result of the cluster analysis, consumers can be categorised into well-differentiated groups according to the structure of their food consumption and these clusters are different regarding social characteristics as well.

H7: Environmental and health aspects are compatible with each other: modifying consumption structure can lead to both a healthier and a more sustainable way of consuming food

Results concerning the modification of the structure of food consumption confirm and supplement previous research. Results show that modifying food consumption towards a healthier structure could contribute to lessening the environmental load. My results indicate that reducing consumption of meat would be beneficial both from a health and an environmental point of view. The ecological footprint can be reduced if less meat and eggs are consumed. In case of substitution of calories, the largest reduction in the ecological footprint can be made by consuming those food products which have lower ecological footprints per calorie (e.g. pasta).

Much research has investigated the possible impact of changing diets. When interpreting the results (in terms of impact on health and environment) it is necessary to take into account which indicator/s were used in the research and what the starting level of consumption was.

As Western and Northern-European food consumption is currently higher than the present Hungarian level of consumption, international studies done in these countries show greater potential for reductions than results concerning Hungarians' consumption of food (Johansson, 2005; Risku-Norja et al., 2009; Tukker et al., 2011).

When comparing these results with other international studies it is important to look at the system boundaries. It is only those results which are interpreted and measured within the same system boundaries that can be used for comparison. It is necessary to look at what was examined during a piece of research when measuring the environmental impact of food consumption (for example, whether the impact from transportation and preparation was taken into account during the analysis). System boundaries should include the size of food portions, which can vary from country to country. Cultural factors can have a great influence on what food is consumed, and in what quantities.

VII. Summary

The aim of my research was to quantify the environmental impacts of food consumption of Hungarian consumers and to analyse this from a consumption-based approach, thereby showing the environmental responsibility of consumers regarding food consumption. I applied the ecological footprint methodology during the research to define the environmental impact of food consumption. Food consumption cannot be substituted for by anything else until after physiological needs are met but its environmental impacts are notable, despite the fact that the evaluation of environmental impacts receives little emphasis in environmental policymaking.

In the first chapter of the dissertation I summarised the development of the consumption-based results and I analysed definitions of sustainable consumption which then served as a theoretical basis for understanding and analysing my research goals. I presented an overview of the environmental impacts of food consumption and a definition of sustainable food consumption in Chapter II, where the many interpretations and nuances of the concept support the proposition that the research topic should be approached from more perspectives. One of the most important aims and results of the dissertation, regarding the theoretical part, was a synthesis of the definitions of sustainable food consumption (Chapter II).

I used the ecological footprint indicators in the research to measure the environmental impact of food consumption; Chapter III confirms the suitability of using this methodology.

The antecedents in the scientific literature, which were presented in Chapter IV, served as a basis for my research. I then formulated my own research hypotheses. A summary and systematization of the scientific literature on the environmental load of food consumption (Chapter IV) is an important result of the theoretical part of the dissertation. This kind of categorization has not been done in the international literature before.

The research aims, hypotheses and the data sources were presented in Chapter V.

The empirical results of the dissertation were presented in Chapter VI. In my research I aimed to present a new perspective and to improve and develop existing scientific research. Based on the results from my empirical research, I now summarise the conclusions of my research and the contribution of my results to the research topic analysed.

7.1. Conclusions and review of the significance of results

The aim of my research was primarily to create a descriptive study of the ecological footprint of food consumption of the Hungarian population. Little research has presented an analysis so far of the environmental impacts of food consumption, using real survey-based data. I quantified the ecological footprint of Hungarian respondents which stems from direct food consumption using bottom-up methodology. The ecological footprint intensities were calculated from the latest database of the Global Footprint Network (2011), while the quantity of food consumption data came from a nationwide representative survey database. The reliability of my results is improved by the fact that my data are based on a large, representative nationwide survey-based sample. There has, until now, not been survey-based research undertaken in Hungary to evaluate the environmental impacts of food consumption.

Looking at the size of the ecological footprint it can be stated that Hungarians consume less food than Western Europeans. The relatively small Hungarian ecological footprint (compared to the European size of ecological footprint) does not entitle Hungarians to increase their consumption of food in the future. Results highlight that the real level of consumption of food of Hungarians (defined using surveys and statistics) does not correspond with perceptions that Hungarians are significant consumers of meat.

In the structure of an average respondent’s footprint, animal-based products are dominant (61%). The size of the ecological footprint is mostly influenced by consumption of meat, dairy products and bread.

After analysing the ecological footprint of food consumption according to level of education it can be said that there is no significant difference. The *structure* of consumption is, however, different for differently educated groups of respondents. It is surprising, however, that in contrast to expectations there is no significant difference between the ecological footprints of meat, vegetables and fruit.

When making conclusions from my research results it is important to take into account the limitations of the research (see Chapter 6.2.). During the research I analysed the ecological footprint of directly consumed food.

In my research I revealed that there are significant differences in the structure and ecological footprints for food consumption according to gender. Men's ecological footprints are not only higher because of the greater quantities they consume, but because of the differing structure of food consumption (more food consumed with higher ecological footprint intensity).

When I analysed the ecological footprint of food consumption according to gender, age and type of occupation, results of the analysis showed that there are no significant differences within the same age group and gender regarding occupational activity, which is a surprising result. The hypothesis that there are significant differences between the ecological footprints of people with different occupational activities was not confirmed. Leisure time activities do not explain this result sufficiently. I think that more analysis is needed to reveal the cause for the greater consumption of food by people with a lower level of physical activity. This analysis has highlighted the significance of differentiating between genders and age groups when the food consumption of people with different physical occupational activities is analysed otherwise misleading conclusions could be drawn. This is proven by the result that if no distinction is made between genders and age groups and we analyse food consumption and its ecological footprint in combination according to occupation, then significant differences are be revealed in the ecological footprint (though this can be tracked back to the varying proportion of the genders within the occupational groups). The ecological footprint for food consumption for those who are inactive from an occupational point of view (pensioners, women on maternity leave, students) is significantly different, a result which fits prior expectations.

Examining the income status, the ecological footprint results showed that people with higher income consume more food. The ecological footprint increases according to this by income decile; however, the structure of consumption changes: the largest difference is with consumption of fruit, dairy and vegetables. It is an interesting result of the research that in case of the upper two income deciles the ecological footprint for food consumption does not increase notably - these groups use their higher incomes to consume more fruit and vegetables and their consumption of meat and bread does not increase. Here, a higher income does not mean more consumption per se but greater consumption of healthier food products. This appears in respondents' ecological footprints as well. Middle income level groups use their relatively high incomes (i.e. higher than the lower income groups) to consume more food and their consumption of fruit and vegetables appears to be supplementary (i.e. it does not replace other food products).

One important result of the dissertation is that I identified significantly different consumer groups regarding the structure of food consumption using cluster analysis. Understanding this typology can help to reach consumers when there initiatives are undertaken to change the structure of food consumption. Those who consume more fruit, vegetables and dairy products do not have lower ecological footprints, regarding total food consumption. Those consumers whose consumption structure is dominated by meat consumption, which is of higher ecological footprint intensity, do not necessarily have higher ecological footprints. Consumers who do not directly consume milk or dairy products have lower ecological footprints. The clusters which result from the cluster analysis not only differ according to consumption structure but they are characterised by their distinct socio-demographic features and result from different lifestyles.

In my dissertation I analysed the possibility of decreasing the ecological footprint of Hungarian consumers through changing their diets. I succeeded in revealing that by modifying the consumption structure towards healthier options environmental impact can be reduced. With the example of reducing step by step the consumption of meat and processed meat and eggs towards an optimal level I showed the impact of dietary changes on the ecological footprint. The results indicate that if a reduced consumption of meat is substituted for by the consumption of other food (i.e. calorie intake is maintained), the largest reduction in the ecological footprint can be made by consuming those food products which have lower ecological footprints per calorie. Analysis revealed as well that in order to significantly decrease the ecological footprint of food consumption, radical changes are needed. However, it is necessary to highlight realizable changes to consumers, and even these changes can realistically reduce environmental impact. These results are in accordance with international findings; the reason for the smaller scale of results is that the quantity of food that Hungarians consume is lower than that of the average European (especially Western-European).

Measures for changing food consumption patterns should not separately treat environmental and health issues. The ecological footprint can be a great means for communicating about suitable levels and types of food consumption in the future. Closer cooperation of expert groups is needed in the future in order to develop alternatives which are adequate both from environmental and health perspectives. Changing the structure of food consumption is made more difficult by the lock-in effect which is why the support of the public policy is needed to change consumption patterns. Informing and motivating consumers is needed to ensure that they have the knowledge that changing their food consumption can lead to not only favourable health effects but also to lessening of environmental impact.

Creating sustainable food consumption clubs would support a change in the structure of food consumption and help moderate environmental impact. Consumers need an unambiguous message about the healthiness and environmental impacts of food products. Furthermore, if food offerings in public catering were modified this could contribute significantly to changing consumption patterns.

These recommendations and conclusions are more applicable to developed countries as the subject of the analysis was the ecological footprint of food consumption in developed countries (where the level of food consumed is higher than the world average and so is the environmental impact). The level of food consumption is lower in Hungary than in Western Europe. Harmonizing treatment of environmental and health issues would have greater impact in countries with greater food consumption per capita.

7.2. Directions for future research

Beyond answering the hypotheses it addressed, this research bought up issues which need further research and analysis. The aim of this research was not only to answer the specified research questions but to help pinpoint directions for further research. Of these I would like to specify the following:

With more detailed knowledge about types of food categories, further analysis would be possible. Having available data on the height and weight of respondents would allow the research findings to be expanded and could help in drawing deeper conclusions. Besides these data, knowing the total calorie intake of respondents would support quantification of the difference between actual and recommended consumption baskets and the precise ecological footprints of the individuals concerned. Based on these differences it could then be defined what kind of changes in the consumption of different food categories would be necessary to meet health recommendations. It is not enough that changes are made towards healthier food consumption structures but there is a need for the analysis of the *quantities* consumed as well (it may be possible that the consumption structure is adequate but overconsumption is a concern). Sustainable food consumption would be supported by knowing which foods consumers should consume to reduce their environmental impacts.

My research did not include an evaluation of the possible rebound effect arising from reducing the consumption of food and nor did it include consideration of the opportunities presented by alternative types of land use, therefore quantifying these effects could be useful as well.

It is necessary to take into account that the ecological footprint is only one indicator of sustainability and relates to resource consumption. The use of other indicators could supplement this instrument.

I think that fostering the international comparability of the results could be very useful and this would be supported though having a standardised, comparative database on a European level. This would allow research findings to be generalised more easily.

The emerging problems and questions that arose during the research efforts primarily concern individuals from developed countries, as they typically have high levels of consumption. At the same time, with developing countries it would be interesting to examine in what ways an adequate level of nutrition could be provided with a fairly low environmental load, especially for regions with a growing population. Food consumption and its sustainability in developing countries requires further analysis.

To sum up, the research highlighted the role of consumers in mitigating environmental impacts. Research using a consumption-based approach can help us to reassess previous research findings which examined resource use and environmental impact from a production-based approach. The diversity of research that is based on a responsibility-for-consumption approach can help highlight those pressing environmental issues which need intervention and attention. My empirical results extend and improve the findings of previous research in the academic literature.

Appendix

Appendix 1: Status of health in Hungary

Environmental and health aspects are less important for Hungarians when they decide on food consumption (Hoffmann, 2006; Albert-Dávid, 2006). Results of OTÁP (2009) survey showed that the consumption of animal fats is higher than the recommended level. The status of health is developing in Hungary, but it is still far from the health status in the European Union. Life expectancy at birth is 74 years on average, 69.5 years for men and 78 years for women. Life expectancy at birth in Hungary is 5 years lower than in OECD countries, where the avegage life expectancy at birth is 79 years (OECD, 2009). Hungary has lower life expectancies than it would be predicted by the GDP per capita alone (WHO World Health Statistics, 2010).

The number of death due to circulatory system diseases is three times higher than in the EU-15 countries and situation is worse than in the EU-15 countries for other diseases as well. Circulatory system diseases and locomotor disorders are frequent. Higher alcohol consumption, inappropriate food consumption and lack of excercises contribute to the status of health in Hungary. Obesity presents a problem as well (OTÁP, 2009). 61.8% of Hungarian adults are obese according to the results of the OTÁP (2009) survey: every third adult is overweight and 28.5% is obese. The ratio of obesity was similar for men (63%) and women (61%). The ratio of obese adults has grown since the First National Representative Nutritional survey (1985-1988), the ratio has doubled for men, and has grown by 50% for women.

There were several surveys in Hungary from time to time that examine the status of health and food consumption patterns. The First Hungarian Representative Nutritional Survey was done between 1985 and 1988, with a sample size of 17 thousand people. The survey examined the nutritional patterns of Hungarian adults (Bíró, 1992). The Second Hungarian Nutritional Survey was done between 1992 and 1994. The survey examined food consumption patterns on a not representative sample of 2500 people. The Third National Nutritional Survey was done within the National Health Survey in 1992-1994, where the food consumption patterns of people above 19 years were analysed on a representative sample of 1179 people (Rodler et al., 2005; Bíró et al., 2007). The last national survey was undertaken in 2009, organsied by KSH and OÉTI together. This was the National Diet and Nutritional Status Survey 2009, where a representative sample of 1165 people was examined. The appendix presented an overview of the health status in Hungary.

Appendix 2: Research questionnaire

Consumption habits in Hungary

The survey is part of the Omnibus survey of Tárki Social Research Institute April, 2010

To be asked from everybody

You can find some questions about consumption habits in the following section.

1. How many times a week do you eat for breakfast …
IF YOU EAT AT LEAST ONCE A WEEK, then how many pieces or how many do you eat from the given food category?

		How many times a week do you eat for breakfast?			IF AT LEAST ONCE **a.** Quantity per one time?	
		never	times/week			
a.	Salami, cold cuts	0	……………..	X	………………piece	X
b.	Scrambled eggs	0	……………..	X	……………………egg	X
c.	Bakery products	0	……………..	X	………………………piece	X
d.	Muesli	0	……………..	X	……………………..dkg	X
e.	Coffee, tea	0	……………..	X	…………………cup	X
f.	Fruits, vegetables, jam	0	……………..	X	…………………… piece	X
g.	Dairy products	0	……………..	X	…………………… piece	X
h.	Others, namely:……..	0	……………..	X	……………………. piece	X

2. How many times a week do you eat for lunch …?

		How many times a week do you eat for lunch?		
		never	times/week	
a.	Meat with garnish (rice, potato)	0	……………..	X
b.	Pasta	0	……………..	X
c.	Vegetable-based meals	0	……………..	X
d.	Vegetarian meals, without meat and dairy products	0	……………..	X
e.	Others, namely:……..	0	……………..	X

3. How many times a week do you eat for dinner …?

		How many times a week do you eat for dinner		
		never	times/week	
a.	Salami, cold cuts	0	……………..	X
b.	Scrambled eggs	0	……………..	X
c.	Fruits	0	……………..	X
d.	Meat with garnish (rice, potato)	0	……………..	X
e.	Vegetable-based meals	0	……………..	X
f.	Others, namely:……..	0	……………..	X

4. What percentage of your yearly vegetable and fruit consumption is local (national) and fresh?

...............………… %

999 – NT X –

5. What percentage of your other food consumption that you eat at home is local (national)?

...............………… %

999 – NT X –

6. What percentage of your home food consumption is prepared food or semi-perpared food? For example pasta is semi-prepred food. ....………… %

999 – NT X –

7. How ofter do you eat in a restarurant or a canteen at the workplace in a week?

...............………… occassion/week

0 – never → Proceed to question 8

99 – NT X –

8. How typical is it to you to spend your leisure tiem with these activities? Please grade from 1 to 5: 5 means that you spend your leisure time with the activity very often and 1 means never! You can use the other grades as well! Do you spend your leisure time with …

		Never ⟷ Very often					NT	
a.	gardening around the house, dealing with animals, DIY work, needlework or having a creative hobby?	1	2	3	4	5	9	X
b.	going to cinema, theatre, concert, museum in your settlement?	1	2	3	4	5	9	X
c.	doing some sports?	1	2	3	4	5	9	X
d.	window-shopping and shopping?	1	2	3	4	5	9	X
e.	travelling?	1	2	3	4	5	9	X
f.	spending time with family and friends?	1	2	3	4	5	9	X

9. All in all how happy are you? You can see a scale from 1 to 10, where 1 means very unhappy, 10 meand very happy. Where would you place yourself in the „happiness-scale"?

Very unhappy 01 02 03 04 05 06 07 08 09 10 Very happy

88 – REFUSES THE ANSWER
99 – NT

10. All in all how satisfied are you? You can see a scale from 1 to 10, where 1 means very unsatisfied, 10 meand very satisfied. Where would you place yourself in the „satisfaction-scale"?

Very unsatisfied 01 02 03 04 05 06 07 08 09 10 Very satisfied

88 – REFUSES THE ANSWER
99 – NT

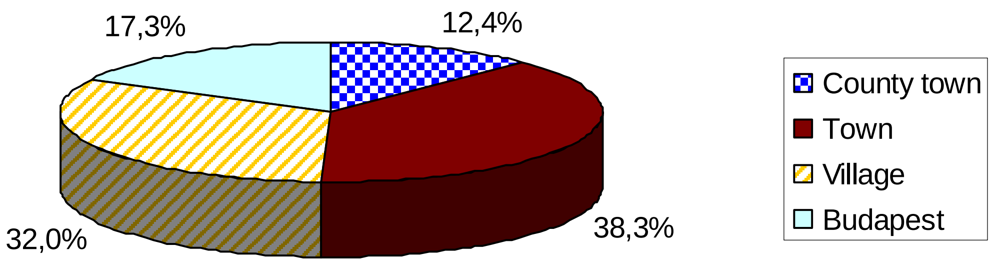
11. Tell us please how satisfied you are with the following things. If you are not satisfied at all, give 1, if you are completely satisfied give 10. How satisfied are you with ..

	Not satisfied at all									Completely satisfied	
a. Your present work?	01	02	03	04	05	06	07	08	09	10	X
b. Your present lifestyle?	01	02	03	04	05	06	07	08	09	10	X
c. Your health status?	01	02	03	04	05	06	07	08	09	10	X
d. Your familiy life, relationships in your family?	01	02	03	04	05	06	07	08	09	10	X
e. Your social life, relationships with friends?	01	02	03	04	05	06	07	08	09	10	X

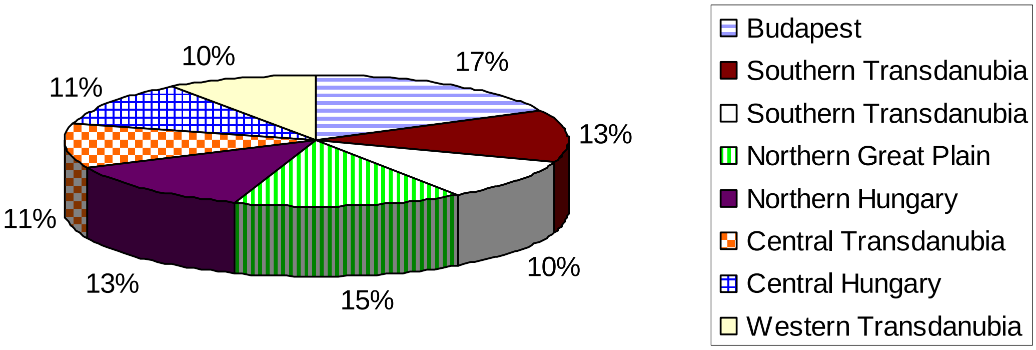
Appendix 3: Characteristics of the sample

The sample was chosen to be representative for habitat, gender, age and level of education and this is true for the sample of n=975 people that I analysed and used for calculating the ecological footprints of food consumption. The distribution of the sample by habitat can be seen first.

Distribution by habitat

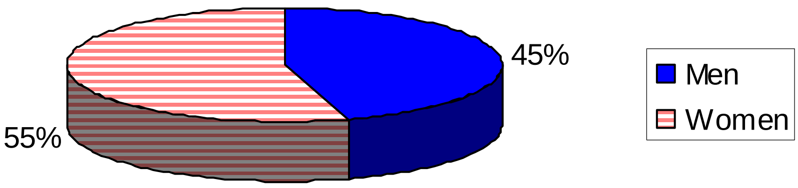


Distribution by region



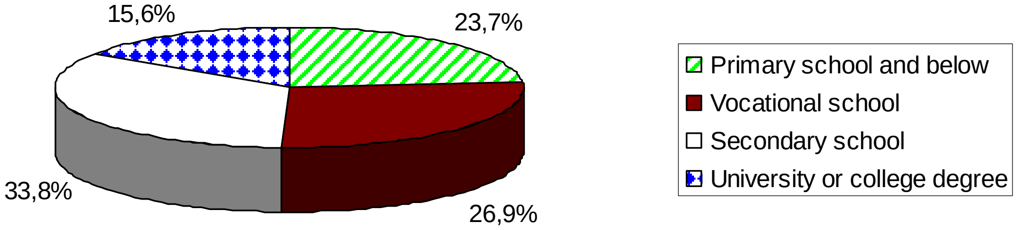
Distribution by genders is shown in the following chart. The distribution of genders in the total population was 48% men and 52% women according to the national statistics (KSH, 2010).

Distribution by gender

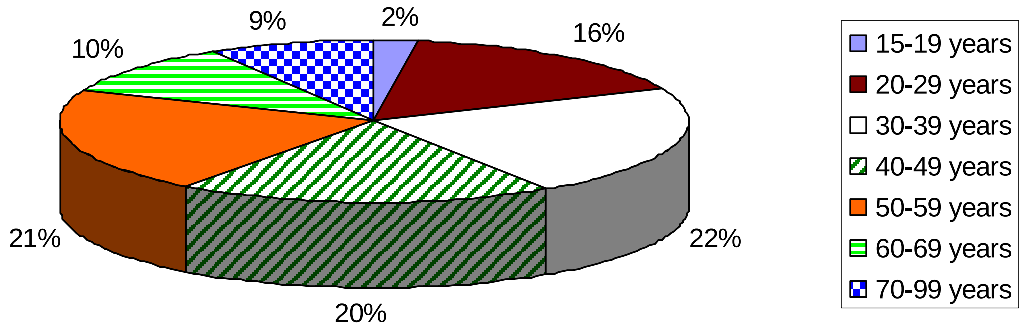


As for the educational level the distribution was representative as well.

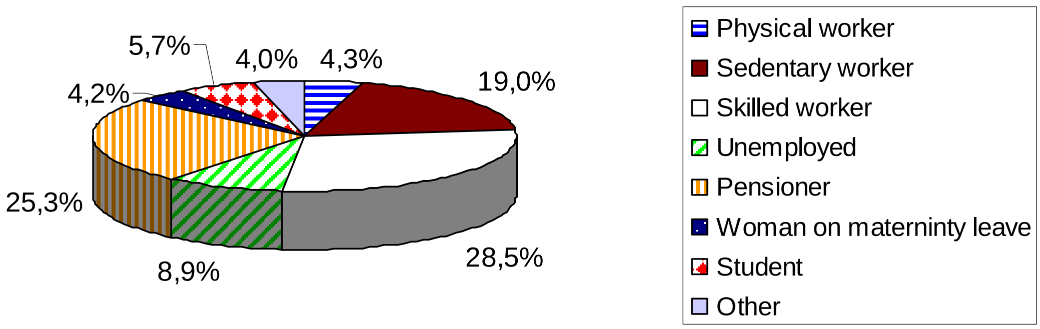
Distribution by level of eductaion



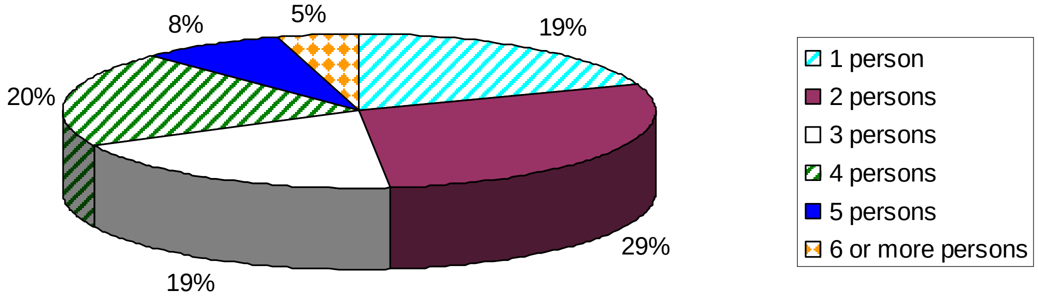
The distribution by age was the following:



The distribution by occupational activity was not completely representative for the sample.



The distribution of the size of households was the following:



Appendix 4: Converting one piece of food to kilograms

Food category	**Weight of one piece (kg/piece)**
Bread	0.040
Bakery products	0.070
Cold cuts	0.005
Eggs	0.057
Milk	0.200
Dairy products	0.035
Meat	0.150
Garnish: potato and rice	0.200
Pasta	0.120
Vegetable-based meals	0.300
Vegetarian meals	0.250
Fruits and vegetables	0.120
Coffee, tea	0.006

Source: KSH (2012) and Rodler-OÉTI (2004)

Appendix 5: Average food consumption in kilograms

Descriptive Statistics

	N	Mean	Std. Deviation
bread_kg_t	975	68.2740	64.34145
muesli_kg_t	975	2.6717	8.58084
coldcuts_kg_t	975	12.5092	13.43136
egg_kg_t	975	13.4889	16.70035
milk_kg_t	975	68.3590	96.31146
dairyproduct_kg_t	975	6.9253	10.35591
meat_kg_t	975	47.9000	20.22427
potatorice_kg_t	975	44.5547	22.96754
pasta_kg_t	975	12.4544	7.49713
vegetablebased_kg_t	975	43.1680	27.26004
vegetarian_kg_t	975	3.4933	9.76530
fruits_vegetables_kg_t	975	50.5215	84.11299
teacoffee_kg_t	975	2.4352	2.67749
Valid N (listwise)	975		

Appendix 6: Ecological Footprint intensities (gha/t) of food categories in Hungary

Food category	Ecological footprint intensity (gha/t)
Bread and bakery products	1.09
Muesli	1.21
Cold cuts	3.16
Eggs	1.43
Milk	0.92
Dairy products	4.77
Meat	3.27
Potato, rice	0.33
Pasta	1.33
Vegetable-based meals	1.21
Vegetarian meals	0.64
Fruits and vegetables	0.55
Coffee, tea	3.78

Source: Author's own calculations based on GFN (2011)

Appendix 7: Energy content of food categories (kcal/100g)

Food category	kcal/100g
Bread and bakery products	300
Muesli	385
Cold cuts	156
Eggs	165.2
Milk	69
Dairy products	350
Meat	207.3
Potato, rice	132
Pasta	392
Vegetable-based meals	129
Fruits and vegetables	43

Source: KSH (2012) and Rodler-OÉTI (2004)

Appendix 8: Sensitivity analysis of the ecological footprint intensities

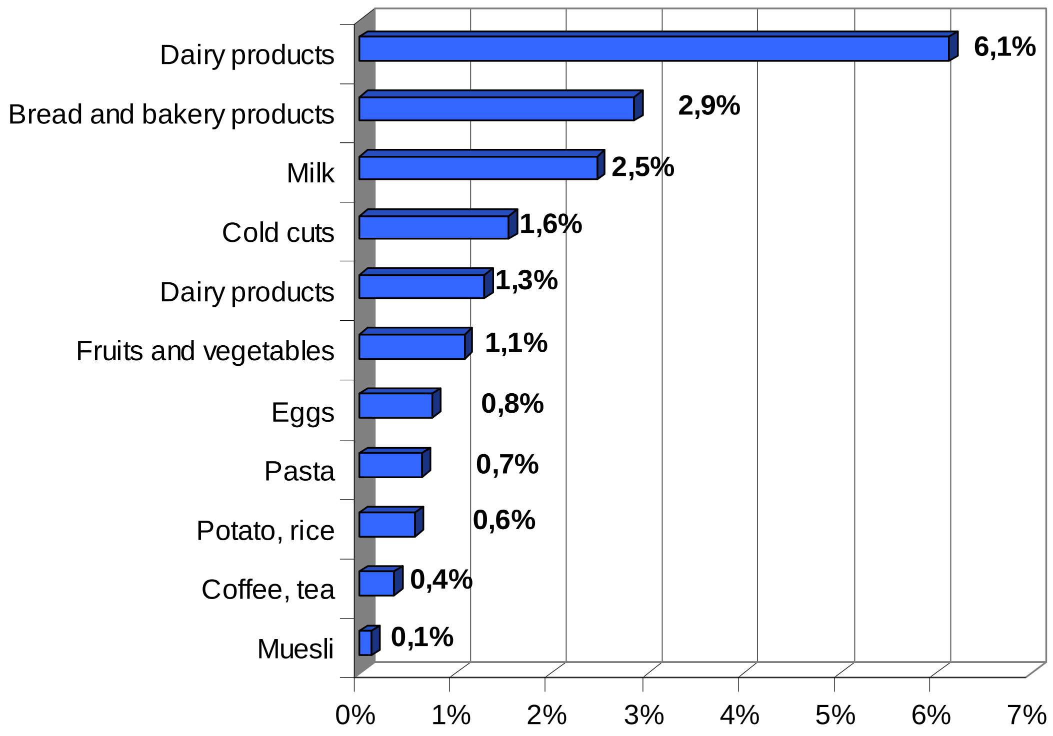
I carried out a sensibility analysis for the ecological footprint intensity values. I examined how the change in the ecological footprint influences the ecological footprint of an average Hungarian consumer. The value of one of the ecological footprint intensities was increased by 20% while the values of the other ecological footprint intensities were kept constant and I analysed how the change in one ecological footprint intensity modifies the ecological footprint.

In the Figure below it can be seen that the ecological footprint intensity of meat products has the largest impact on the ecological footprint. 20% increase in the ecological footprint intensity of meat increases the ecological footprint by 6.1%. It is followed by bread and bakery products (the ecological footprint increases by 2.9% in case of a 20% increase in the intensity), then by milk (2.5%) and cold cuts (1.6%).

Fruits and vegetables despite their low ecological footprint intensity have a sensibility of 1.1%, as they contribute to a larger extent to the quantity of food consumed. The proportions of the food categories compared to each other in the sensibility analysis are same as their proportions in the structure of the average ecological footprint.

Knowing the sensibility of the ecological footprint intensities can show the impact of the calculation methodology, the impact of the starting value of the intensities on the final ecological footprint.

Changes in the total ecological footprint when the ecological footprint intensitity changes by 20%



Appendix 9: The ecological footprint of an average consumer (gha)

Descriptive Statistics

	N	Mean	Std. Deviation
bread_EF	975	,0726	,06846
muesli_EF	975	,0032	,01035
coldcuts_EF	975	,0396	,04250
eggs_EF	975	,0193	,02384
milk_EF	975	,0629	,08862
dairyproducts_EF	975	,0331	,04944
meat_EF	975	,1562	,06594
potatorice_EF	975	,0147	,00756
pasta_EF	975	,0166	,01000
vegetablebased_EF	975	,0521	,03289
vegetarian_EF	975	,0022	,00621
fruit_vegetable_EF	975	,0278	,04631
teacoffee_EF	975	,0092	,01012
total_food_EF	975	,5095	,22021
Valid N (listwise)	975		

Appendix 10: The impact of level of education on the ecological footprint of food consumption

	Ecological footprint (gha)				
	Primary school or below	**Vocational school**	**Secondary school**	**University or college degree**	**Total**
Bread and bakery products	0,067	0,080	0,076	0,062	0,073
Muesli	0,001	0,002	0,004	0,007	0,003
Cold cuts	0,037	0,051	0,039	0,026	0,040
Eggs	0,023	0,021	0,018	0,014	0,019
Milk	0,060	0,069	0,064	0,054	0,063
Dairy products	0,029	0,031	0,036	0,037	0,033
Meat	0,157	0,160	0,153	0,156	0,156
Potato, rice	0,014	0,015	0,015	0,015	0,015
Pasta	0,020	0,017	0,015	0,013	0,017
Vegetable-based meals	0,059	0,051	0,048	0,052	0,052
Vegetarian meals	0,002	0,001	0,003	0,004	0,002
Fruits and vegetables	0,028	0,024	0,030	0,030	0,028
Coffee, tea	0,009	0,010	0,009	0,009	0,009
Total	0,507	0,531	0,508	0,479	0,509

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
bread_EF	Between Groups	,041	3	,014	2,932	,033
	Within Groups	4,524	971	,005		
	Total	4,565	974			
muesli_EF	Between Groups	,004	3	,001	13,295	,000
	Within Groups	,100	971	,000		
	Total	,104	974			
coldcuts_EF	Between Groups	,061	3	,020	11,650	,000
	Within Groups	1,698	971	,002		
	Total	1,759	974			
eggs_EF	Between Groups	,010	3	,003	5,756	,001
	Within Groups	,544	971	,001		
	Total	,554	974			
milk_EF	Between Groups	,024	3	,008	1,033	,377
	Within Groups	7,625	971	,008		
	Total	7,650	974			
dairyproducts_EF	Between Groups	,009	3	,003	1,288	,277
	Within Groups	2,371	971	,002		
	Total	2,381	974			
meat_EF	Between Groups	,008	3	,003	,585	,625
	Within Groups	4,228	971	,004		
	Total	4,235	974			
potatorice_EF	Between Groups	,000	3	,000	,719	,541
	Within Groups	,056	971	,000		
	Total	,056	974			
pasta_EF	Between Groups	,004	3	,001	14,251	,000
	Within Groups	,093	971	,000		
	Total	,097	974			
vegetable_based_EF	Between Groups	,016	3	,005	4,934	,002
	Within Groups	1,038	971	,001		
	Total	1,054	974			
vegetarian_EF	Between Groups	,001	3	,000	11,831	,000
	Within Groups	,036	971	,000		
	Total	,038	974			
fruit_vegetable_EF	Between Groups	,006	3	,002	,986	,399
	Within Groups	2,082	971	,002		
	Total	2,089	974			
teacoffee_EF	Between Groups	,000	3	,000	,317	,813
	Within Groups	,100	971	,000		
	Total	,100	974			
total_food_EF	Between Groups	,265	3	,088	1,825	,141
	Within Groups	46,968	971	,048		
	Total	47,233	974			

Appendix 11: The ecological footprint of food consumption according to gender (gha/person)

	Man	Woman
Bread and bakery products	0,083	0,064
Muesli	0,002	0,004
Cold cuts	0,053	0,028
Eggs	0,026	0,014
Milk	0,069	0,058
Dairy products	0,035	0,031
Meat	0,166	0,148
Potato, rice	0,016	0,014
Pasta	0,017	0,016
Vegetable-based meals	0,050	0,054
Vegetarian meals	0,001	0,003
Fruits and vegetables	0,023	0,032
Coffee, tea	0,008	0,010
Total	0,551	0,475

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
bread_EF	Between Groups	,094	1	,094	20,483	,000
	Within Groups	4,471	973	,005		
	Total	4,565	974			
muesli_EF	Between Groups	,001	1	,001	11,820	,001
	Within Groups	,103	973	,000		
	Total	,104	974			
coldcuts_EF	Between Groups	,156	1	,156	94,635	,000
	Within Groups	1,603	973	,002		
	Total	1,759	974			
eggs_EF	Between Groups	,038	1	,038	72,213	,000
	Within Groups	,515	973	,001		
	Total	,554	974			
milk_EF	Between Groups	,027	1	,027	3,491	,062
	Within Groups	7,622	973	,008		
	Total	7,650	974			
dairyproducts_EF	Between Groups	,005	1	,005	1,935	,165
	Within Groups	2,376	973	,002		
	Total	2,381	974			
meat_EF	Between Groups	,071	1	,071	16,605	,000
	Within Groups	4,164	973	,004		
	Total	4,235	974			
potatorice_EF	Between Groups	,001	1	,001	25,054	,000
	Within Groups	,054	973	,000		
	Total	,056	974			
pasta_EF	Between Groups	,000	1	,000	3,094	,079
	Within Groups	,097	973	,000		
	Total	,097	974			
vegetable_based_EF	Between Groups	,003	1	,003	2,669	,103
	Within Groups	1,051	973	,001		
	Total	1,054	974			
vegetarian_EF	Between Groups	,000	1	,000	11,575	,001
	Within Groups	,037	973	,000		
	Total	,038	974			
fruit_vegetable_EF	Between Groups	,016	1	,016	7,648	,006
	Within Groups	2,072	973	,002		
	Total	2,089	974			
teacoffee_EF	Between Groups	,001	1	,001	5,715	,017
	Within Groups	,099	973	,000		
	Total	,100	974			
total_food_EF	Between Groups	1,419	1	1,419	30,127	,000
	Within Groups	45,814	973	,047		
	Total	47,233	974			

Appendix 12: The ecological footprint according to age groups (gha/person)

	19-30 years	30-60 years	Above 60
Bread and bakery products	,0778	,0747	,0588
Muesli	,0043	,0031	,0022
Cold cuts	,0502	,0389	,0291
Eggs	,0196	,0194	,0184
Milk	,0677	,0601	,0674
Dairy products	,0329	,0338	,0304
Meat	,1597	,1561	,1522
Potato, rice	,0158	,0146	,0134
Pasta	,0176	,0162	,0168
Vegetable-based meals	,0446	,0522	,0609
Vegetarian meals	,0023	,0023	,0020
Fruits and vegetables	,0250	,0281	,0303
Coffee, tea	,0082	,0096	,0089
Total	,5257	,5091	,4908

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
bread_EF	Between Groups	,039	2	,020	4,201	,015
	Within Groups	4,526	972	,005		
	Total	4,565	974			
muesli_EF	Between Groups	,000	2	,000	1,926	,146
	Within Groups	,104	972	,000		
	Total	,104	974			
coldcuts_EF	Between Groups	,041	2	,020	11,597	,000
	Within Groups	1,718	972	,002		
	Total	1,759	974			
eggs_EF	Between Groups	,000	2	,000	,147	,863
	Within Groups	,553	972	,001		
	Total	,554	974			
milk_EF	Between Groups	,013	2	,006	,804	,448
	Within Groups	7,637	972	,008		
	Total	7,650	974			
dairyproducts_EF	Between Groups	,002	2	,001	,309	,734
	Within Groups	2,379	972	,002		
	Total	2,381	974			
meat_EF	Between Groups	,005	2	,003	,598	,550
	Within Groups	4,230	972	,004		
	Total	4,235	974			
potatorice_EF	Between Groups	,001	2	,000	4,517	,011
	Within Groups	,055	972	,000		
	Total	,056	974			
pasta_EF	Between Groups	,000	2	,000	1,483	,227
	Within Groups	,097	972	,000		
	Total	,097	974			
vegetable_ based_EF	Between Groups	,024	2	,012	11,371	,000
	Within Groups	1,030	972	,001		
	Total	1,054	974			
vegetarian_ EF	Between Groups	,000	2	,000	,110	,896
	Within Groups	,038	972	,000		
	Total	,038	974			
fruit_vegetab le_EF	Between Groups	,003	2	,001	,608	,544
	Within Groups	2,086	972	,002		
	Total	2,089	974			
teacoffee_EF	Between Groups	,000	2	,000	1,534	,216
	Within Groups	,099	972	,000		
	Total	,100	974			
total_food_EF	Between Groups	,111	2	,055	1,143	,319
	Within Groups	47,122	972	,048		
	Total	47,233	974			

Appendix 13: The ecological footprint of men according to age groups (gha/person)

	19-30 years	30-60 years	Above 60
Bread and bakery products	0,087	0,088	0,062
Muesli	0,002	0,002	0,001
Cold cuts	0,066	0,052	0,044
Eggs	0,029	0,025	0,025
Milk	0,073	0,065	0,078
Dairy products	0,035	0,036	0,035
Meat	0,173	0,167	0,151
Potato, rice	0,017	0,016	0,014
Pasta	0,018	0,017	0,017
Vegetable-based meals	0,045	0,052	0,051
Vegetarian meals	0,002	0,001	0,002
Fruits and vegetables	0,020	0,023	0,029
Coffee, tea	0,007	0,009	0,008
Total	0,574	0,552	0,518

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
bread_EF	Between Groups	,039	2	,019	3,187	,042
	Within Groups	2,649	438	,006		
	Total	2,688	440			
muesli_EF	Between Groups	,000	2	,000	,269	,764
	Within Groups	,049	438	,000		
	Total	,049	440			
coldcuts_EF	Between Groups	,020	2	,010	4,204	,016
	Within Groups	1,066	438	,002		
	Total	1,086	440			
eggs_EF	Between Groups	,001	2	,000	,517	,597
	Within Groups	,344	438	,001		
	Total	,344	440			
milk_EF	Between Groups	,011	2	,005	,552	,576
	Within Groups	4,194	438	,010		
	Total	4,205	440			
dairyproducts_EF	Between Groups	,000	2	,000	,002	,998
	Within Groups	1,372	438	,003		
	Total	1,372	440			
meat_EF	Between Groups	,019	2	,010	2,157	,117
	Within Groups	1,963	438	,004		
	Total	1,982	440			
potatorice_EF	Between Groups	,000	2	,000	3,771	,024
	Within Groups	,026	438	,000		
	Total	,026	440			
pasta_EF	Between Groups	,000	2	,000	,857	,425
	Within Groups	,046	438	,000		
	Total	,046	440			
vegetable_ based_EF	Between Groups	,003	2	,002	1,521	,220
	Within Groups	,450	438	,001		
	Total	,453	440			
vegetarian_ EF	Between Groups	,000	2	,000	,948	,388
	Within Groups	,013	438	,000		
	Total	,013	440			
fruit_vegetable_EF	Between Groups	,003	2	,001	1,074	,343
	Within Groups	,582	438	,001		
	Total	,585	440			
teacoffee_EF	Between Groups	,000	2	,000	,984	,374
	Within Groups	,035	438	,000		
	Total	,035	440			
total_food_EF	Between Groups	,126	2	,063	1,149	,318
	Within Groups	23,981	438	,055		
	Total	24,107	440			

Appendix 14: The ecological footprint of women according to age groups (gha/person)

	19-30 years	30-60 years	Above 60
Bread and bakery products	0,070	0,063	0,057
Muesli	0,006	0,004	0,003
Cold cuts	0,037	0,028	0,018
Eggs	0,012	0,014	0,013
Milk	0,064	0,056	0,060
Dairy products	0,031	0,032	0,027
Meat	0,149	0,147	0,153
Potato, rice	0,014	0,014	0,013
Pasta	0,017	0,016	0,017
Vegetable-based meals	0,044	0,053	0,068
Vegetarian meals	0,003	0,003	0,002
Fruits and vegetables	0,029	0,032	0,031
Coffee, tea	0,009	0,010	0,010
Total	0,485	0,472	0,472

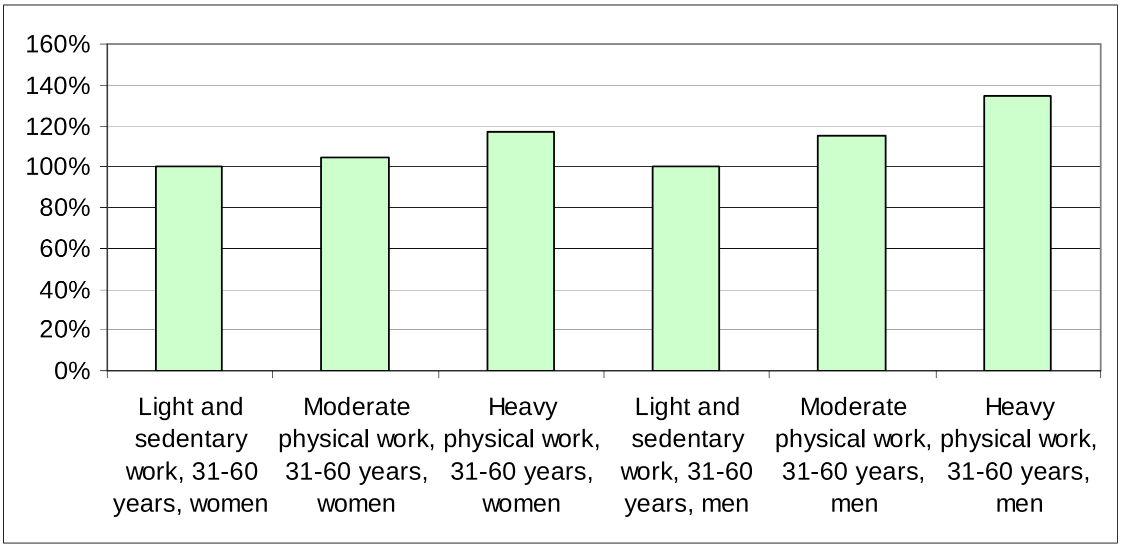
ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
bread_EF	Between Groups	,010	2	,005	1,432	,240
	Within Groups	1,774	531	,003		
	Total	1,783	533			
muesli_EF	Between Groups	,001	2	,000	2,776	,063
	Within Groups	,053	531	,000		
	Total	,054	533			
coldcuts_EF	Between Groups	,018	2	,009	9,612	,000
	Within Groups	,499	531	,001		
	Total	,517	533			
eggs_EF	Between Groups	,000	2	,000	,640	,528
	Within Groups	,171	531	,000		
	Total	,171	533			
milk_EF	Between Groups	,006	2	,003	,429	,651
	Within Groups	3,412	531	,006		
	Total	3,418	533			
dairyproducts_EF	Between Groups	,002	2	,001	,557	,573
	Within Groups	1,002	531	,002		
	Total	1,004	533			
meat_EF	Between Groups	,002	2	,001	,293	,746
	Within Groups	2,180	531	,004		
	Total	2,182	533			
potatorice_EF	Between Groups	,000	2	,000	1,087	,338
	Within Groups	,028	531	,000		
	Total	,028	533			
pasta_EF	Between Groups	,000	2	,000	1,210	,299
	Within Groups	,051	531	,000		
	Total	,051	533			
vegetable_ based_EF	Between Groups	,029	2	,014	13,376	,000
	Within Groups	,569	531	,001		
	Total	,598	533			
vegetarian_ EF	Between Groups	,000	2	,000	1,244	,289
	Within Groups	,024	531	,000		
	Total	,024	533			
fruit_vegetab le_EF	Between Groups	,001	2	,001	,190	,827
	Within Groups	1,486	531	,003		
	Total	1,487	533			
teacoffee_EF	Between Groups	,000	2	,000	,704	,495
	Within Groups	,064	531	,000		
	Total	,064	533			
total_food_EF	Between Groups	,015	2	,007	,181	,835
	Within Groups	21,693	531	,041		
	Total	21,708	533			

Appendix 15: The ecological footprint according to occupational activity (gha/person)

	Physical worker	Sedentary worker	Skilled worker	Pensioner	Woman on maternity leave	Student	Total
Bread and bakery products	0,082	0,065	0,089	0,061	0,072	0,080	0,073
Muesli	0,001	0,007	0,002	0,002	0,004	0,005	0,003
Cold cuts	0,047	0,028	0,053	0,031	0,045	0,046	0,040
Eggs	0,025	0,014	0,018	0,021	0,017	0,022	0,019
Milk	0,068	0,056	0,072	0,063	0,069	0,072	0,063
Dairy products	0,029	0,029	0,035	0,034	0,035	0,038	0,033
Meat	0,166	0,148	0,153	0,155	0,176	0,180	0,156
Potato, rice	0,016	0,014	0,015	0,014	0,017	0,018	0,015
Pasta	0,017	0,014	0,016	0,017	0,018	0,019	0,017
Vegetable-based meals	0,051	0,048	0,047	0,062	0,053	0,045	0,052
Vegetarian meals	0,002	0,004	0,002	0,002	0,003	0,003	0,002
Fruits and vegetables	0,020	0,031	0,024	0,031	0,020	0,030	0,028
Coffee, tea	0,011	0,009	0,009	0,009	0,008	0,007	0,009
Total	0,533	0,467	0,536	0,502	0,537	0,565	0,509

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
bread_EF	Between Groups	,156	10	,016	3,418	,000
	Within Groups	4,409	964	,005		
	Total	4,565	974			
muesli_EF	Between Groups	,005	10	,000	4,419	,000
	Within Groups	,100	964	,000		
	Total	,104	974			
coldcuts_EF	Between Groups	,109	10	,011	6,370	,000
	Within Groups	1,650	964	,002		
	Total	1,759	974			
eggs_EF	Between Groups	,015	10	,002	2,738	,003
	Within Groups	,538	964	,001		
	Total	,554	974			
milk_EF	Between Groups	,093	10	,009	1,183	,299
	Within Groups	7,557	964	,008		
	Total	7,650	974			
dairyproducts_EF	Between Groups	,020	10	,002	,806	,623
	Within Groups	2,361	964	,002		
	Total	2,381	974			
meat_EF	Between Groups	,085	10	,009	1,975	,033
	Within Groups	4,150	964	,004		
	Total	4,235	974			
potatorice_EF	Between Groups	,002	10	,000	2,745	,002
	Within Groups	,054	964	,000		
	Total	,056	974			
pasta_EF	Between Groups	,004	10	,000	3,833	,000
	Within Groups	,094	964	,000		
	Total	,097	974			
vegetable_ based_EF	Between Groups	,039	10	,004	3,662	,000
	Within Groups	1,015	964	,001		
	Total	1,054	974			
vegetarian_ EF	Between Groups	,001	10	,000	2,530	,005
	Within Groups	,037	964	,000		
	Total	,038	974			
fruit_vegetab le_EF	Between Groups	,030	10	,003	1,387	,181
	Within Groups	2,059	964	,002		
	Total	2,089	974			
teacoffee_EF	Between Groups	,001	10	,000	,974	,464
	Within Groups	,099	964	,000		
	Total	,100	974			
total_food_EF	Between Groups	1,067	10	,107	2,228	,015
	Within Groups	46,166	964	,048		
	Total	47,233	974			

Appendix 16: Hypothetical ecological footprint of the occupational groups, based on recommended energy intake, supposing identical consumption structure



Source: Author's own compilation based on the Nutritional tables of Bíró and Lindner (1999)

Appendix 17: The ecological footprint of people with active occupations (30-60 years, both genders) (gha/person)

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
total_food_EF	Between Groups	,407	2	,204	4,048	,018
	Within Groups	19,913	396	,050		
	Total	20,320	398			

Appendix 18: The ecological footprint of people with active occupations (30-60 years), men and women are analysed separately

The ecological footprint of men (gha/person)

	Physical worker	Sedentary worker	Skilled worker	Average
Bread and bakery products	0,098	0,080	0,105	0,099
Muesli	0,000	0,010	0,001	0,003
Cold cuts	0,046	0,038	0,065	0,057
Eggs	0,037	0,024	0,022	0,024
Milk	0,052	0,074	0,079	0,075
Dairy products	0,024	0,035	0,036	0,035
Meat	0,191	0,174	0,160	0,167
Potato, rice	0,019	0,018	0,015	0,016
Pasta	0,015	0,014	0,017	0,016
Vegetable-based meals	0,051	0,043	0,050	0,049
Vegetarian meals	0,000	0,004	0,001	0,001
Fruits and vegetables	0,012	0,027	0,020	0,021
Coffee, tea	0,012	0,009	0,009	0,009
Total	0,557	0,548	0,581	0,571

The ecological footprint of women (gha/person)

	Physical worker	Sedentary worker	Skilled worker	Average
Bread and bakery products	0,073	0,061	0,070	0,065
Muesli	0,004	0,006	0,003	0,005
Cold cuts	0,037	0,023	0,032	0,028
Eggs	0,014	0,009	0,015	0,012
Milk	0,062	0,055	0,065	0,060
Dairy products	0,033	0,028	0,033	0,031
Meat	0,136	0,140	0,147	0,143
Potato, rice	0,013	0,013	0,014	0,013
Pasta	0,018	0,013	0,016	0,014
Vegetable-based meals	0,047	0,052	0,047	0,050
Vegetarian meals	0,004	0,004	0,003	0,004
Fruits and vegetables	0,031	0,031	0,032	0,032
Coffee, tea	0,010	0,010	0,010	0,010
Total	0,480893	0,446068	0,486988	0,465598

The ecological footprint of men, ANOVA table (30-60 years)

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
bread_EF	Between Groups	,019	2	,010	1,153	,318
	Within Groups	1,518	181	,008		
	Total	1,538	183			
muesli_EF	Between Groups	,002	2	,001	5,463	,005
	Within Groups	,038	181	,000		
	Total	,041	183			
coldcuts_EF	Between Groups	,026	2	,013	5,580	,004
	Within Groups	,427	181	,002		
	Total	,453	183			
eggs_EF	Between Groups	,004	2	,002	3,066	,049
	Within Groups	,110	181	,001		
	Total	,114	183			
milk_EF	Between Groups	,013	2	,006	,505	,604
	Within Groups	2,252	181	,012		
	Total	2,264	183			
dairyproducts_EF	Between Groups	,002	2	,001	,662	,517
	Within Groups	,335	181	,002		
	Total	,338	183			
meat_EF	Between Groups	,019	2	,010	2,571	,079
	Within Groups	,676	181	,004		
	Total	,696	183			
potatorice_EF	Between Groups	,000	2	,000	3,658	,028
	Within Groups	,008	181	,000		
	Total	,009	183			
pasta_EF	Between Groups	,000	2	,000	,951	,388
	Within Groups	,020	181	,000		
	Total	,020	183			
vegetable_ based_EF	Between Groups	,002	2	,001	1,235	,293
	Within Groups	,139	181	,001		
	Total	,141	183			
vegetarian_ EF	Between Groups	,000	2	,000	7,945	,000
	Within Groups	,004	181	,000		
	Total	,005	183			
fruit_vegetab le_EF	Between Groups	,003	2	,001	2,403	,093
	Within Groups	,111	181	,001		
	Total	,113	183			
teacoffee_EF	Between Groups	,000	2	,000	,587	,557
	Within Groups	,022	181	,000		
	Total	,022	183			
total_food_EF	Between Groups	,037	2	,018	,375	,688
	Within Groups	8,898	181	,049		
	Total	8,935	183			

The ecological footprint of women, ANOVA table (30-60 years)

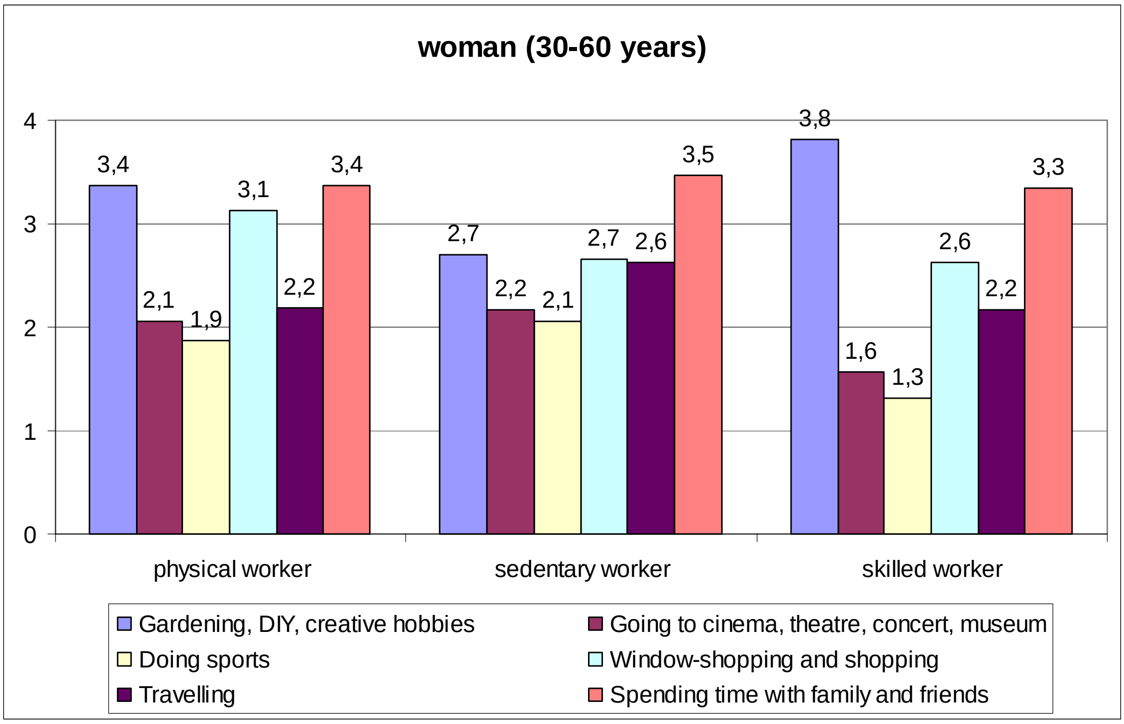
ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
bread_EF	Between Groups	,005	2	,002	,572	,565
	Within Groups	,891	212	,004		
	Total	,896	214			
muesli_EF	Between Groups	,001	2	,000	2,964	,054
	Within Groups	,025	212	,000		
	Total	,025	214			
coldcuts_EF	Between Groups	,006	2	,003	3,059	,049
	Within Groups	,199	212	,001		
	Total	,205	214			
eggs_EF	Between Groups	,002	2	,001	4,851	,009
	Within Groups	,039	212	,000		
	Total	,041	214			
milk_EF	Between Groups	,005	2	,002	,258	,773
	Within Groups	1,969	212	,009		
	Total	1,974	214			
dairyproducts_EF	Between Groups	,002	2	,001	,306	,737
	Within Groups	,540	212	,003		
	Total	,542	214			
meat_EF	Between Groups	,003	2	,001	,378	,686
	Within Groups	,810	212	,004		
	Total	,813	214			
potatorice_EF	Between Groups	,000	2	,000	,843	,432
	Within Groups	,010	212	,000		
	Total	,010	214			
pasta_EF	Between Groups	,001	2	,000	4,169	,017
	Within Groups	,015	212	,000		
	Total	,016	214			
vegetable_ based_EF	Between Groups	,001	2	,001	,754	,472
	Within Groups	,206	212	,001		
	Total	,208	214			
vegetarian_ EF	Between Groups	,000	2	,000	,887	,413
	Within Groups	,011	212	,000		
	Total	,011	214			
fruit_vegetab le_EF	Between Groups	,000	2	,000	,006	,994
	Within Groups	,570	212	,003		
	Total	,570	214			
teacoffee_EF	Between Groups	,000	2	,000	,047	,954
	Within Groups	,023	212	,000		
	Total	,023	214			
total_food_EF	Between Groups	,086	2	,043	,899	,409
	Within Groups	10,194	212	,048		
	Total	10,280	214			

Appendix 19: Leisure time activities of men (30-60 years), according to occupational activities

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Gardening, DIY, creative hobbies	Between Groups	25,725	2	12,863	6,617	,002
	Within Groups	351,835	181	1,944		
	Total	377,560	183			
Going to cinema, theatre, concert, museum	Between Groups	11,136	2	5,568	6,306	,002
	Within Groups	159,815	181	,883		
	Total	170,951	183			
Doing sports	Between Groups	33,022	2	16,511	14,278	,000
	Within Groups	209,304	181	1,156		
	Total	242,326	183			
Window-shopping and shopping	Between Groups	4,563	2	2,281	2,137	,121
	Within Groups	193,263	181	1,068		
	Total	197,826	183			
Travelling	Between Groups	12,875	2	6,437	6,841	,001
	Within Groups	168,428	179	,941		
	Total	181,302	181			
Spending time with family and friends	Between Groups	,371	2	,186	,227	,797
	Within Groups	147,377	180	,819		
	Total	147,749	182			

Leisure time activities of women (30-60 years), according to occupational activities



ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Gardening, DIY, creative hobbies	Between Groups	60,979	2	30,489	13,973	,000
	Within Groups	462,603	212	2,182		
	Total	523,581	214			
Going to cinema, theatre, concert, museum	Between Groups	18,062	2	9,031	10,852	,000
	Within Groups	176,431	212	,832		
	Total	194,493	214			
Doing sports	Between Groups	27,275	2	13,637	12,646	,000
	Within Groups	228,614	212	1,078		
	Total	255,888	214			
Window-shopping and shopping	Between Groups	3,486	2	1,743	1,590	,206
	Within Groups	231,266	211	1,096		
	Total	234,752	213			
Travelling	Between Groups	11,032	2	5,516	6,374	,002
	Within Groups	182,599	211	,865		
	Total	193,631	213			
Spending time with family and friends	Between Groups	,788	2	,394	,524	,593
	Within Groups	159,370	212	,752		
	Total	160,158	214			

Appendix 20: The ecological footprint of food consumption according to income deciles (gha/person)

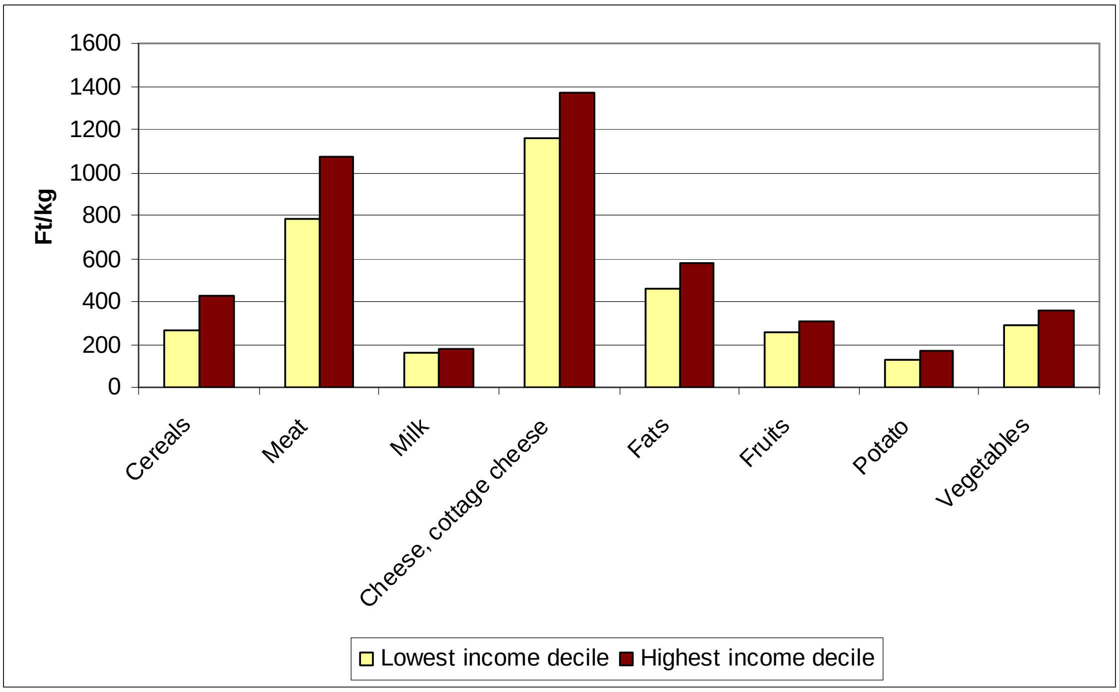
	Ecological footprint (gha)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Cereals	0.091	0.088	0.088	0.089	0.097	0.102	0.102	0.101	0.093	0.090
Cold cuts, ham	0.036	0.039	0.039	0.042	0.045	0.050	0.053	0.056	0.058	0.059
Meat	0.085	0.101	0.110	0.114	0.128	0.137	0.145	0.156	0.145	0.147
Milk	0.034	0.036	0.042	0.045	0.050	0.055	0.056	0.055	0.057	0.058
Dairy products	0.042	0.050	0.063	0.065	0.076	0.088	0.097	0.105	0.113	0.133
Egg	0.008	0.010	0.011	0.011	0.013	0.014	0.014	0.014	0.013	0.012
Fruits	0.006	0.007	0.010	0.011	0.013	0.016	0.018	0.018	0.020	0.022
Potato	0.006	0.006	0.006	0.006	0.007	0.007	0.008	0.008	0.007	0.007
Vegetables	0.018	0.021	0.025	0.026	0.030	0.035	0.036	0.037	0.039	0.038
Total	0.326	0.359	0.393	0.410	0.459	0.504	0.529	0.549	0.546	0.565

Appendix 21: Fat and sugar consumption of income deciles (kg/person)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Fats	11.8	14.3	15.3	15.3	17.5	19.1	19	19.9	19.1	18
Sugar	9.5	11.2	12	13.3	13.9	15.9	15.4	16.4	13.6	13.7

Source: KSH (2012e)

Appendix 22: Expenditures on one kilogram of food for the lowest and highest income deciles



Source: Author’s own calculations based on KSH (2012e-f)

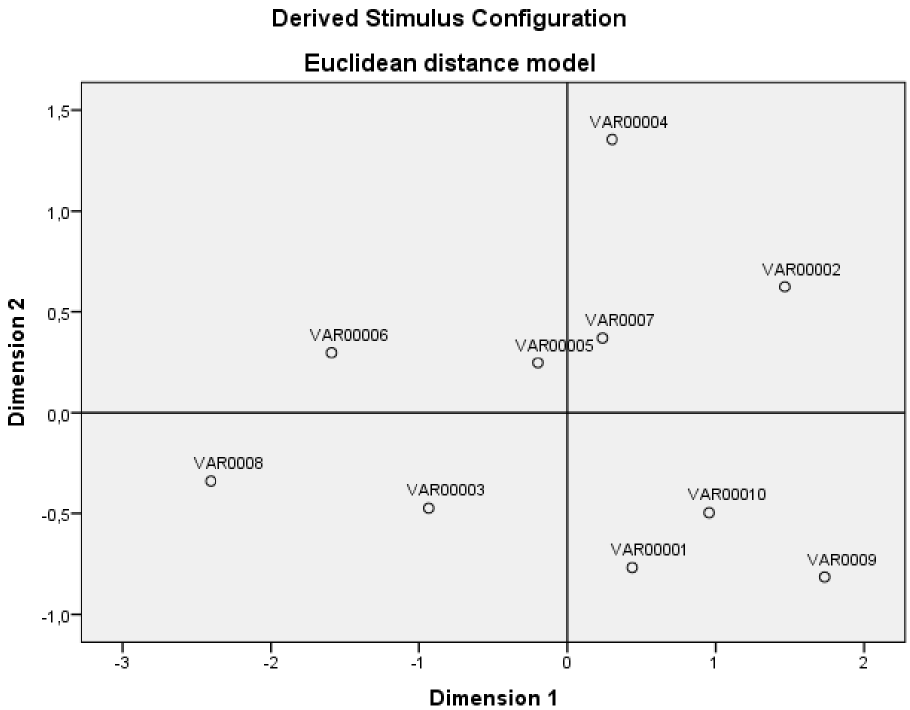
Appendix 23: Cluster analysis

Initial ten clusters

Final Cluster Centers

	Cluster									
	1	2	3	4	5	6	7	8	9	10
bread_kcal_pc	,23	,12	,39	,24	,30	,46	,23	,56	,09	,17
coldcuts_kcal_pc	,04	,01	,03	,04	,04	,03	,03	,03	,02	,04
egg_kcal_ pc	,04	,03	,03	,04	,04	,03	,03	,03	,07	,06
milk_kcal_ pc	,03	,21	,03	,25	,13	,12	,10	,03	,05	,06
dairyproducts_kcal_ pc	,04	,04	,04	,08	,04	,04	,11	,03	,02	,02
meat_kcal_ pc	,23	,19	,17	,10	,15	,11	,13	,11	,27	,18
pasta_kcal_ pc	,08	,09	,08	,09	,08	,05	,07	,05	,10	,19
veget_based_kcal_ pc	,12	,14	,09	,06	,09	,05	,09	,06	,18	,10
fruits_vegetables_kcal_ pc	,03	,04	,02	,03	,03	,03	,09	,02	,03	,04

Plotting the ten clusters in multidimensional space, the result of the Alscal method



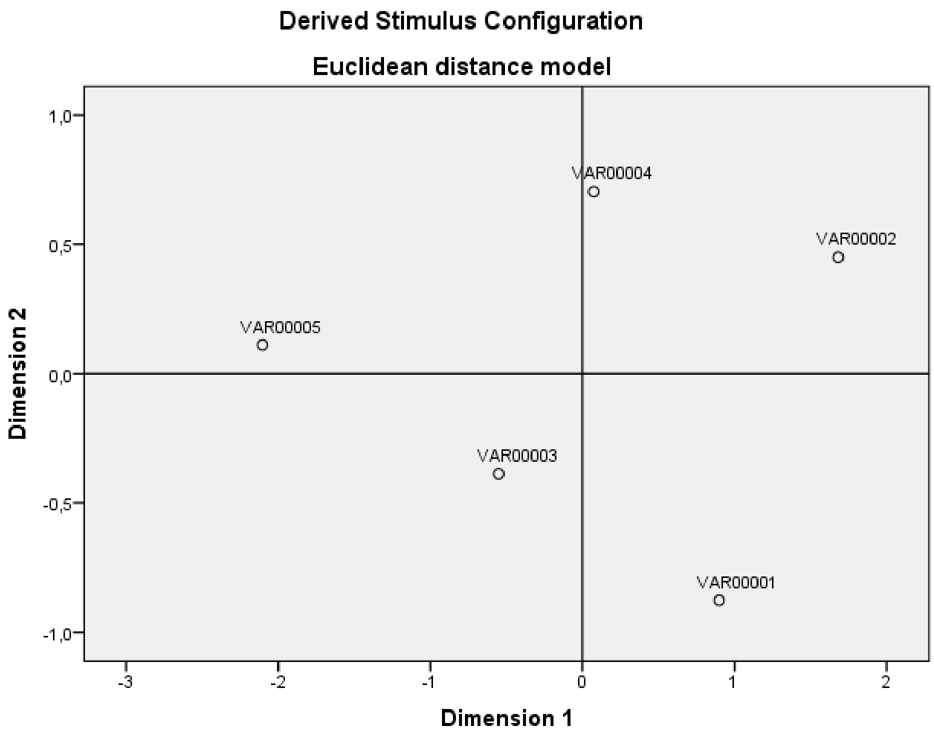
Final five clusters

Final Cluster Centers					
	Cluster				
	1	2	3	4	5
bread_kcal_pc	0,18	0,11	0,33	0,27	0,50
coldcuts_kcal_pc	0,03	0,01	0,04	0,03	0,03
egg_kcal_ pc	0,05	0,04	0,03	0,03	0,03
milk_kcal_ pc	0,04	0,19	0,05	0,17	0,07
dairyproducts_kcal_ pc	0,04	0,04	0,04	0,07	0,04
meat_kcal_ pc	0,24	0,19	0,17	0,14	0,12
pasta_kcal_ pc	0,11	0,12	0,08	0,07	0,06
veget_based_kcal_ pc	0,13	0,13	0,10	0,08	0,06
fruits_vegetables_kcal_ pc	0,03	0,04	0,03	0,04	0,02

ANOVA						
	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
bread_kcal_pc	3,103	4	,003	757	949,186	,000
coldcuts_kcal_pc	,008	4	,001	757	9,864	,000
egg_kcal_ pc	,010	4	,001	757	7,245	,000
milk_kcal_ pc	,643	4	,003	757	242,500	,000
dairyproducts_kcal_ pc	,027	4	,002	757	17,912	,000
meat_kcal_ pc	,353	4	,002	757	184,586	,000
pasta_kcal_ pc	,086	4	,002	757	34,517	,000
veget_based_kcal_ pc	,152	4	,003	757	58,102	,000
fruits_vegetables_kcal_ pc	,010	4	,001	757	8,411	,000

The F tests should be used only for descriptive purposes because the clusters have been chosen to maximize the differences among cases in different clusters. The observed significance levels are not corrected for this and thus cannot be interpreted as tests of the hypothesis that the cluster means are equal.

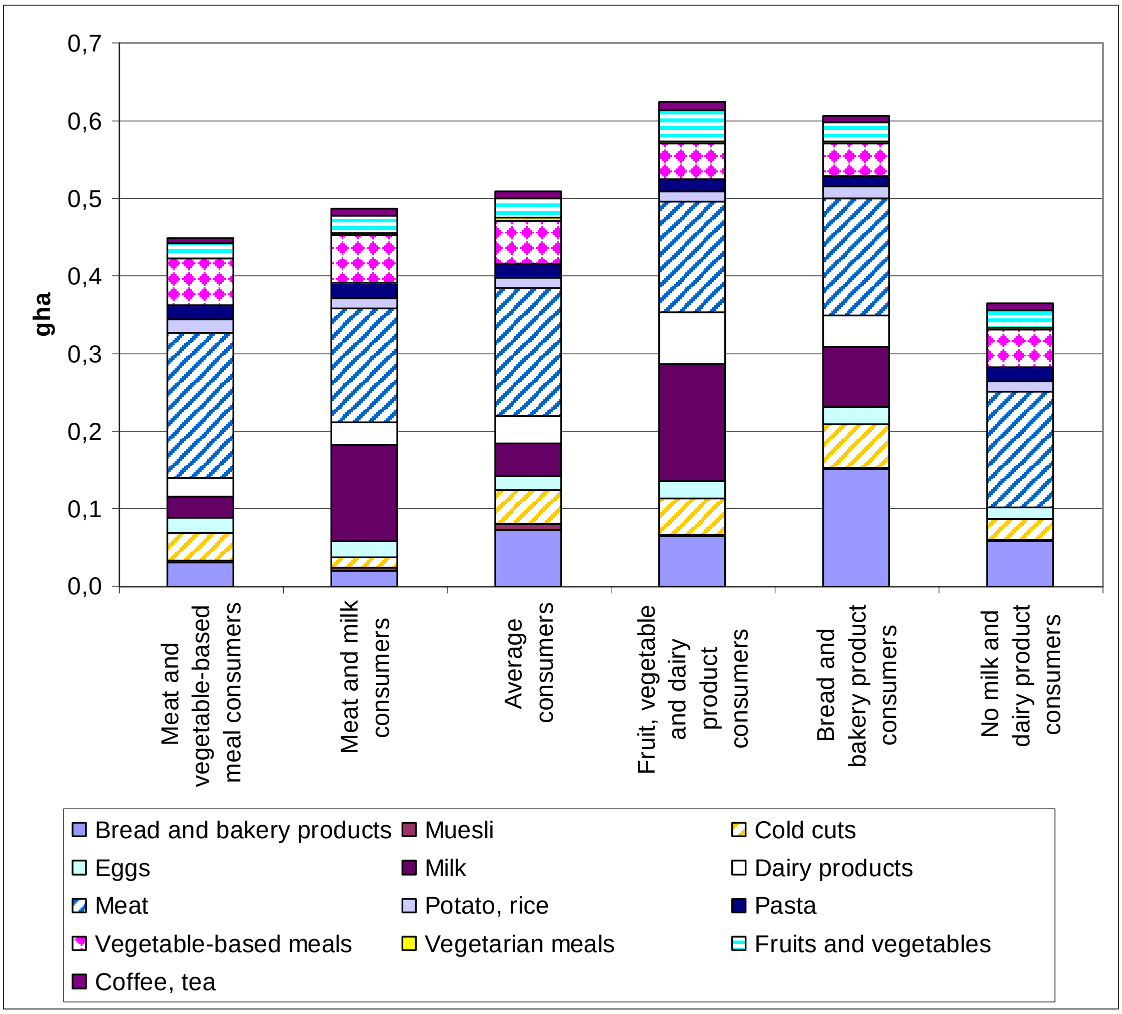
Plotting the final clusters in multidimensional space, the result of the Alscal method



Appendix 24: The ecological footprint of the clusters (gha)

Mean	Meat and vegetable-based dish consumers	Meat and milk consumers	Average consumers	Fruit, vegetable and dairy product consumers	Bread and bakery product consumers	Consuming no milk and dairy products
Bread and bakery products	0,032	0,020	0,074	0,064	0,151	0,057
Muesli	0,002	0,005	0,005	0,004	0,002	0,002
Cold cuts	0,034	0,014	0,046	0,047	0,055	0,029
Eggs	0,021	0,019	0,018	0,021	0,023	0,015
Milk	0,027	0,126	0,042	0,153	0,078	0,000
Dairy products	0,024	0,029	0,035	0,065	0,041	0,000
Meat	0,187	0,146	0,164	0,142	0,151	0,148
Potato, rice	0,018	0,012	0,015	0,013	0,015	0,014
Pasta	0,017	0,020	0,016	0,016	0,015	0,017
Vegetable-based meals	0,059	0,063	0,057	0,048	0,042	0,050
Vegetarian meals	0,002	0,001	0,002	0,003	0,002	0,002
Fruits and vegetables	0,019	0,023	0,026	0,040	0,025	0,022
Coffee, tea	0,008	0,009	0,009	0,011	0,009	0,008
Total	0,450	0,486	0,510	0,625	0,607	0,364

The ecological footprint of the clusters



Appendix 25: Scenarios for changing the structure of food consumption

A. Decreasing meat consumption once per week

EF =ecological footprint in global hectares

	Meat consumption is reduced by one occasion per week, no replacement		**Meat consumption is reduced by one occasion per week, replacement with fruits and vegetables**		**Meat consumption is reduced by one occasion per week, replacement with dairy products**		**Meat consumption is reduced by one occasion per week, replacement with pasta**	
	kg	**EF**	**kg**	**EF**	**kg**	**EF**	**kg**	**EF**
Bread and bakery products	68.27	0.073	68.27	0.073	68.27	0.073	68.27	0.073
Muesli	2.67	0.003	2.67	0.003	2.67	0.003	2.67	0.003
Cold cuts	12.51	0.040	12.51	0.040	12.51	0.040	12.51	0.040
Eggs	13.49	0.019	13.49	0.019	13.49	0.019	13.49	0.019
Milk	68.36	0.063	68.36	0.063	68.36	0.063	68.36	0.063
Dairy products	6.93	0.033	6.93	0.033	11.58	0.055	6.93	0.033
Meat	40.10	0.131	40.10	0.131	40.10	0.131	40.10	0.131
Potato, rice	44.55	0.015	44.55	0.015	44.55	0.015	44.55	0.015
Pasta	12.45	0.017	12.45	0.017	12.45	0.017	16.61	0.022
Vegetable-based meals	43.17	0.052	43.17	0.052	43.17	0.052	43.17	0.052
Vegetarian meals	3.49	0.002	3.49	0.002	3.49	0.002	3.49	0.002
Fruits and vegetables	50.52	0.028	88.43	0.049	50.52	0.028	50.52	0.028
Coffee, tea	2.44	0.009	2.44	0.009	2.44	0.009	2.44	0.009
Total	**369**	**0.485**	**407**	**0.506**	**374**	**0.507**	**373**	**0.490**
Change in the ecological footprint		**-5.0%**		**-0.9%**		**-0.6%**		**-3.9%**

B. Reducing meat and egg consumption according to the guidelines of OÉTI (National Institute for Food and Nutrition)

EF= ecological footprint in global hectares

	Meat consumption recommended by OÉTI, no replacement		Meat and egg consumption recommended by OÉTI, no replacement		Meat and egg consumption recommended by OÉTI, replacement with fruits and vegetables		Meat and egg consumption recommended by OÉTI, replacement with dairy products		Meat and egg consumption recommended by OÉTI, replacement with pasta		Meat and egg consumption recommended by OÉTI, replacement with fruits, vegetables and pasta	
	kg	**EF**	**kg**	**EF**	**kg**	**EF**	**kg**	**EF**	**kg**	**EF**	**kg**	**EF**
Bread and bakery products	68.27	0.073	68.27	0.073	68.27	0.073	68.27	0.073	68.27	0.073	68.274	0.073
Muesli	2.67	0.003	2.67	0.003	2.67	0.003	2.67	0.003	2.67	0.003	2.672	0.003
Cold cuts	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.000	0.000
Eggs	13.49	0.019	6.00	0.009	6.00	0.009	6.00	0.009	6.00	0.009	6.000	0.009
Milk	68.36	0.063	68.36	0.063	68.36	0.063	68.36	0.063	68.36	0.063	68.359	0.063
Dairy products	6.93	0.033	6.93	0.033	6.93	0.033	20.38	0.097	6.93	0.033	6.925	0.033
Meat	40.80	0.133	40.80	0.133	40.80	0.133	40.80	0.133	40.80	0.133	40.800	0.133
Potato, rice	44.55	0.015	44.55	0.015	44.55	0.015	44.55	0.015	44.55	0.015	44.555	0.015
Pasta	12.45	0.017	12.45	0.017	12.45	0.017	12.45	0.017	24.47	0.033	24.466	0.033
Vegetable-based meals	43.17	0.052	43.17	0.052	43.17	0.052	43.17	0.052	43.17	0.052	43.168	0.052
Vegetarian meals	3.49	0.002	3.49	0.002	3.49	0.002	3.49	0.002	3.49	0.002	3.493	0.002
Fruits and vegetables	50.52	0.028	50.52	0.028	160.02	0.088	50.52	0.028	50.52	0.028	105.271	0.058
Coffee, tea	2.44	0.009	2.44	0.009	2.44	0.009	2.44	0.009	2.44	0.009	2.435	0.009
Total	**357.14**	**0.44**	**349.65**	**0.436**	**459.15**	**0.497**	**363.11**	**0.50**	**361.67**	**0.453**	**416.42**	**0.483**
Change in the ecological footprint		**-12.3%**		**-14.4%**		**-2.6%**		**-1.8%**		**-11.3%**		**-5.4%**

C. Reducing meat consumption according to McMichael et al. (2007)

EF= ecological footprint in global hectares

	Meat consumption 90g per day, no replacement		Meat consumption 90g per day, replacement with fruits and vegetables		Meat consumption 90g per day, replacement with dairy products		Meat consumption 90g per day, replacement with pasta	
	kg	**EF**	**kg**	**EF**	**kg**	**EF**	**kg**	**EF**
Bread and bakery products	68.274	0.073	68.274	0.073	68.274	0.073	68.274	0.073
Muesli	2.672	0.003	2.672	0.003	2.672	0.003	2.672	0.003
Cold cuts	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eggs	13.489	0.019	13.489	0.019	13.489	0.019	13.489	0.019
Milk	68.359	0.063	68.359	0.063	68.359	0.063	68.359	0.063
Dairy products	6.925	0.033	6.925	0.033	21.542	0.103	6.925	0.033
Meat	32.760	0.107	32.760	0.107	32.760	0.107	32.760	0.107
Potato, rice	44.555	0.015	44.555	0.015	44.555	0.015	44.555	0.015
Pasta	12.454	0.017	12.454	0.017	12.454	0.017	29.507	0.039
Vegetable-based meals	43.168	0.052	43.168	0.052	43.168	0.052	43.168	0.052
Vegetarian meals	3.493	0.002	3.493	0.002	3.493	0.002	3.493	0.002
Fruits and vegetables	50.521	0.028	169.491	0.093	50.521	0.028	50.521	0.028
Coffee, tea	2.435	0.009	2.435	0.009	2.435	0.009	2.435	0.009
Total	**349.106**	**0.421138**	**468.0759**	**0.486635**	**363.7223**	**0.490918**	**366.1584**	**0.443883**
Change in the ecological footprint		**-17.5%**		**-4.6%**		**-3.8%**		**-13.0%**

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