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Measuring Garden Footprints

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Photo:Mira Rur

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Measuring Garden Footprints

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Summary

People nowadays consume resources and ecological services from all over the world and have lifestyles that require a vast amount of resources. According to the European Policy Office of World Wild life Fund (WWF), humanity's annual demand for resources is now exceeding the Earth's regenerative capacity by 30 percent, and it keeps on growing.

Calculating the ecological footprint is a way of measuring our impact on the world's resources. An ecological footprint can be defined as the total area of bio productive land and water necessary to sustain the lifestyle of a population as well as to absorb waste and provide space for infrastructure.

Carbon footprinting is another way of measuring our impact on the environment and on climate change. The amount of CO_2 that we produce is closely linked to the amount of energy that we use, e.g. through transport or manufacturing material goods. Because of this, CO_2 production is a good measure of the amount of resources we consume and can be linked to the ecological footprint.

The resource use related to food consumption and production is a big part of the overall footprint. The average ecological footprint of food is about 23 % of the total footprint of humanity. In the UK, the average footprint associated with food and drink is 1.4 global hectares per person and 23 % of this is represented by vegetables.

In Sweden, gardens and allotments together make up an area of about 300 000 hectares, a surface that theoretically could feed 4 million people. This indicates that it would actually be possible for many people to grow a substantial part of their consumption of fruit and vegetables themselves.

The primary aim of this thesis is to investigate the ecological footprint of gardening and home food production in Sweden and to enable a comparison between two groups in Sweden and England who share a gardening interest. Furthermore, the aim is to bring increased awareness to people about the environmental impact of their lifestyle and to inspire them to live and tend to their gardens in a more sustainable way. The thesis is based on a study made by researchers Dr Gareth Davies and Dr Ulrich Schmutz at Garden Organic in England.

Their study, as well as this one, is based on a survey with detailed questions about people's gardening practices. The survey was sent out to members of the two largest gardening organizations in Sweden, the Swedish Allotment Society (Koloniträdgårdsförbundet) and The Swedish Horticultural Society (Riksförbundet Svensk Trädgård). The results from the survey were used to calculate the average ecological footprint of people's gardening activities - the garden footprint.

The results showed that the average person's gardening activities will produce around 5.285 tonnes CO_2 per hectare, equivalent of about 2.114 global hectares (gha) per hectare or about 0.20 global hectares per garden for this survey. This showed that the garden footprint of Swedish respondents by far exceeds the garden footprint of English respondents. The differences can all be related to their gardening practices. The areas with the most impact were car use, type of products used and storage methods. Based on the results, this study presents several ways of limiting resource use in gardens and allotments.

Sammanfattning

Idag konsumerar vi resurser och produkter från hela världen och i många länder har man en livsstil som kräver oerhörda mängder resurser. Enligt Världsnaturfonden (WWF), överstiger numer mänsklighetens årliga resursförbrukning jordens återhämtningsförmåga med 30 procent och fortsätter att öka.

Att räkna ut det ekologiska fotavtrycket är ett sätt att mäta vår inverkan på jordens resurser. Ett ekologiskt fotavtryck är den totala biologiskt aktiva land- och havsytan som krävs för att uppehålla en befolknings livsstil samt för att ta hand om avfall och ge plats för infrastruktur.

Att mäta koldioxidfotavtrycket är ett annat sätt att uppskatta vår inverkan på miljön och på klimatet. Mängden koldioxid som vi producerar är sammanlänkat med mängden energi som vi använder t.ex. genom transport och tillverkning av varor. På grund av detta är koldioxidproduktionen ett bra mått på resursförbrukningen och kan i sin tur sammanlänkas med det ekologiska fotavtrycket.

Resursförbrukningen inom livsmedelskonsumtion och produktion utgör en stor del av det totala fotavtrycket. Det genomsnittliga ekologiska fotavtrycket av mat är ungefär 23 % av mänsklighetens totala fotavtryck. I England är det genomsnittliga fotavtrycket av mat och dryck 1,4 globala hektar per person och 23 % utgörs av grönsaker.

I Sverige utgör den totala ytan av alla trädgårdar och odlingslotter 300 000 hektar, en yta som teoretiskt sett skulle kunna ge mat åt 4 miljoner människor. Detta visar att det faktiskt skulle vara möjligt för många människor att odla en stor del av sin konsumtion av frukt och grönsaker själva.

Det främsta målet med den här uppsatsen är att undersöka det ekologiska fotavtrycket av fritidsodling i Sverige och att göra en jämförelse mellan svenska och engelska fritidsodlare. Utöver detta är målet att ge ökad medvetenhet om hur ens livsstil påverkar miljön samt att inspirera till att leva och att odla på ett mer hållbart sätt.

Uppsatsen är baserad på en studie gjord av forskarna Gareth Davies och Ulrich Schmutz på Garden Organic i England. Deras studie liksom den här är baserad på en enkät med detaljerade frågor om folks trädgårdar och om hur de odlar. Enkäten skickades ut till medlemmar i de två största organisationerna för trädgårdsintresserade i Sverige, Koloniträdgårdsförbundet och Riksförbundet Svensk Trädgård. Informationen från enkäten om medlemmarnas trädgårdsaktiviteter användes för att räkna ut det genomsnittliga ekologiska fotavtrycket av deras trädgårdar. Resultaten visade att den genomsnittliga personens trädgårdsaktiviteter i den här studien producerar runt 5,3 ton CO_2 per hektar vilket motsvarar 1,2 globala hektar (gha) per hektar eller 0,20 globala hektar per trädgård. Detta visar att fotavtrycket av fritidsodlingen i den här studien är mycket större än fotavtrycket av fritidsodlingen England. Denna skillnad är direkt relaterad till hur de odlar i sina trädgårdar.

De områden som mest påverkade fotavtrycket var bilanvändning, vilka produkter som användes och förvaringsmetoder. Utifrån resultaten kan studien presentera flera sätt att minska på resursanvändningen i trädgårdar och på odlingslotter.

Aim and background

The primary aim of this thesis is to investigate the ecological footprint of gardening and home food production in Sweden and to enable a comparison between groups of people in Sweden and in England with a shared interest in gardening. The aim is also to try to bring increased awareness to people about the environmental impact of their lifestyle and to inspire them to live and tend to their gardens in a more sustainable way.

The thesis is based on a study made by researchers Dr Gareth Davies and Dr Ulrich Schmutz at Garden Organic in England. Garden Organic is the leading organic growing charity in the UK and is dedicated to researching and promoting organic gardening, farming and food. Their study, as well as this one, is based on a survey with detailed questions about people's gardening practices.

The survey was sent out to members of the two largest gardening organizations in Sweden, the Swedish Allotment Society (Koloniträdgårdsförbundet) and The Swedish Horticultural Society (Riksförbundet Svensk Trädgård). In the text, they are referred to as SAS and SHS. The original survey was translated into Swedish before it was sent out but no other changes were made in order to enable a comparison between English and Swedish results. The results from the survey were used to calculate the average ecological footprint of people's gardening activities - the garden footprint. The actual calculations were made using a model in Microsoft Office Excel developed by Ulrich Schmutz, Garden Organic.

Introduction

There are no longer any doubts that climate change and its consequences is one the biggest challenges of our time and it has become increasingly clear that the Earth's ecosystems are not infinite (WWF, 2008; Davies & Schmutz, 2007).

Increasing trade, globalisation and improved living standards have all contributed to unsustainable consumption patterns. People nowadays consume resources and ecological services from all over the world and have lifestyles that require a vast amount of resources. Furthermore, the use of resources is very unequal across the world. To exemplify, it would take up to 3 or 4 planets if everyone would adopt the consumption and lifestyle of people in developed countries. According to the European Policy Office of WWF, humanity's annual demand for resources is now exceeding the Earth's regenerative capacity by 30 percent, and it keeps on growing (Wackernagel *et al*., 2005). They name the biggest challenge that we are facing now: "how we can improve the quality of human life but at the same time live within the carrying capacity of our supporting ecosystems" (Hails *et al*., 2008; Wackernagel *et al*., 2005).

Calculating the ecological footprint is a way of measuring our impact on the world's resources. An ecological footprint can be defined as the total area of bio productive land and water necessary to sustain the lifestyle of a population as well as to absorb waste and provide space for infrastructure (Göteborgs Stad Miljöförvaltningen, 2005; Wackernagel *et al*., 2005).

Carbon footprinting is another way of measuring our impact on the environment and on climate change which has gained popularity in recent times. The amount of CO_2 that we produce is closely linked to the amount of energy that we use, either directly (e.g. transport) or indirectly (e.g. manufacturing material goods). Because of this, CO_2 production is a good measure of the amount of resources we consume and can be linked to the ecological footprint. (Davies & Schmutz, 2007).

Previous studies have shown that it is in fact possible to reduce the impact on the environment by making conscious choices of food as well as limiting spoilage. The smaller amounts of produce that is wasted the smaller agricultural area is needed (Johansson, 2005). Because what and how much we eat can determine how natural resources are used, it is neither logical nor sustainable for a country to depend on products that can only be produced in a completely different part of the world (Carlsson-Kanyama, 2000).

In Sweden, two thirds of the population theoretically has the possibility to engage in gardening and growing food in areas connected to houses, holiday houses or in allotments. Furthermore, there are more than 2.5 million gardens. 1 780 000 belongs to permanent dwellings, 680 000 belongs to holiday houses and at least 40 000 are allotments. Together, they make up an area of about 300 000 hectares, a surface that could feed 4 million people. This indicates that it would actually be possible for many people to grow a substantial part of their consumption of fruit and vegetables themselves (Svanfeldt, 2008; Bill, 2008; Edman, 2005).

Trials at an experimental farm in Sweden have shown that you need approximately 800 m^2 to produce enough food for a year for one person with a vegan diet. If you have a regular diet including meat, you need approximately 2500 m^2 and an additional 600 m^2 of pasture land (Ahnström, 2002).

Urban agriculture is common in developing countries but also in USA and England. Producing food within the city has many benefits. Except for the environmental benefits including increased biodiversity it gives increased understanding of how food is actually produced and how it ends up on the table. Furthermore, when food is produced and consumed within the city, transport is minimised and waste management is reduced (Carlsson-Kanyama, 2000).

In the UK, activities relating to food acquisition, consumption and waste disposal account for around 25-33% of an average person's ecological footprint (Davies & Schmutz, 2007). Together with housing, which accounts for a third (33%) of the average footprint in the UK, it makes up over half of the resource needs (Davies & Schmutz, 2007).

At Garden Organic, these facts became the starting point for an experiment among their members. The aim was to investigate the ecological footprint of gardening and what part of the total ecological footprint that it comprises as well as bringing awareness and allowing people to evaluate their impact on the planet when producing their own food. The hope was that this in turn would lead to people taking practical steps to reduce their impact and producing food in a more sustainable way.

The Ecological Footprint

The founders of the concept of ecological footprinting are researchers William Rees, British Columbia, Canada and Mathis Wackernagel, Schwitzerland. In 1996, they published the book "*Our ecological foorprint: Reducing human impact on the earth*". In it they defined the ecological foortprint as "the amount of biologically productive land and sea area an individual, a region, all of humanity or a human activity requires producing the resources it consumes and absorbing the waste it generate". This information can further be used to compare to how much biologically productive land is available. Biologically productive areas include cropland, forests and fishing grounds (Footprint Network, 2009).

To calculate the ecological footprint of a person, all of the biological materials consumed and all of the wastes generated in a year are translated by yield and equivalence factors into global hectares. A global hectare is expressed as "a hectare with the average global bio productivity within the quarter of the earth's surface considered biologically productive".

Using a common unit facilitates comparisons of different types of land. The sum of these global hectares makes up the ecological footprint needed to support the resource use and waste generation of this person (Footprint Network, 2009; Göteborgs Stad Miljöförvaltningen, 2005).

The calculated footprint of a population is based on its yearly consumption. This type of information can be found in national production, consumption and export data from which it is possible to calculate the area necessary to sustain the consumption level (Moberg *et al*., 1999; Lewan, 2000).

To calculate the ecological footprint of a country, all bio productive areas are multiplied by the equivalence factor for that specific type of area (Table 1). The productive areas together make up the ecological footprint. Alternatively, the ecological footprint of a country can be the sum of the ecological footprints of all the residents (Göteborgs Stad Miljöförvaltningen, 2005; Lewan; Footprint Network, 2009).

When calculating footprints, biodiversity is dealt with by setting aside 12 % of the bio productive area for its preservation. This is however most likely an underestimation of the percentage that really is necessary to set aside (Moberg *et al*., 1999).

In 2005, the global footprint per person was 2.7 global hectares of productive area. However, the total bio productive area is 2.1 global hectares per person. This overshoot will only be possible for a short while and it is slowly depleting the natural resources of the planet (Hails *et al*., 2008; Wackernagel *et al*., 2005).

Europe today has a footprint of more than double its own bio capacity. The reason why this is possible is because Europe nowadays is dependent on the ecological capacity from other parts of the world (Wackernagel *et al*., 2005).

In 2005, the footprint of an average Swedish person was 5.1 global hectares. If everybody lived that way it would take approximately 3 planets. Sweden has an ecological carrying capacity of 9.6 global hectares per capita. This is our ecological reserve. However, this does not mean that Swedish people have a sustainable lifestyle. Instead, it is a result of our country being sparsely populated and large parts being bio capacity rich forests or woodlands, as compared to desert or arid areas in other thinly populated countries. The ecological footprint is calculated in relation to the whole world compared to carrying capacity which only relates to Sweden's surface area (Global Footprint Network, 2008; Göteborgs Stad Miljöförvaltningen, 2005; Lewan, 2000).

A carbon footprint measures the total greenhouse gas emissions caused directly and indirectly by a person, organisation, event or product. Carbon footprints are included in the ecological footprint because ecological footprints measure the amount of biological capacity demanded by human emissions of fossil carbon dioxide. It is either measured in tonnes of CO_2 produced per year or in some cases, the amount that we produce each year per hectare, or tonnes of CO_2 equivalent gases (e.g. methane and nitrous oxide-N_2O) produced per hectare per year (Footprint Network, 2008; Davies & Schmutz, 2007).

The advantages and disadvantages of ecological footprinting can and should be discussed. Nevertheless it is considered to be a valuable tool which can be used as an indicator of sustainable development and as a pedagogical tool to influence both decision-makers and the public to take a more sustainable direction (Göteborgs Stad Miljöförvaltningen, 2005).

Table 1: Equivalence factors for converting different productive areas to global hectares.

	Equivalence factors 2003 [gha/ha]
Primary cropland	2.21
Marginal cropland	1.79
Forest	1.34
Permanent pasture	0.49
Marine	0.36
Inland water	0.36
Built-up land	2.21

Source: Living Planet Report, 2006.

Resource use linked to consumption of fruit and vegetables

The resource use related to food consumption and production is a big part of the overall footprint. The average ecological footprint of food is about 23 % of the total footprint of humanity. In the UK, the average footprint associated with food and drink is 1.4 global hectares per person and 23 % of this is represented by vegetables (Bond, 2009; Davies & Schmutz, 2007).

In Sweden, it has been estimated that the input of energy into the grocery chain is 100 TWh. This can be compared to the total supply of energy in Sweden which is 600 TWh (Carlsson-Kanyama, 2000). Studies in the Netherlands have shown that food represents 17% of the total indirect energy use of a household and in Canada; it was found that food represents 30% of the total ecological footprint (Carlsson-Kanyama, 2000). Furthermore, it is estimated that 25-30 % of the total climatic influence is related to food production (Eriksson, 2009).

The food industry in Sweden is responsible for a quarter of our total release of greenhouse gases. This is equal to around 2 tonnes of CO_2 equivalents per year. Most of this release happens before the consumer buys the product. However, a lot of CO_2 offsets when food is transported home from the shop by car. 80 % of the greenhouse gas released by the food industry originates from the actual production phase (90-95 % for dairy and meat products) but a substantial part is also released through waste management and transportation (Mobjörk & Jonsson, 2009).

Sweden, as well as many of the countries of the western world, can economically afford to rely on imported food rather than locally produced. Today Sweden relies on agricultural area abroad for one third of its food. The current tendency in Sweden is an increased import of meat, dairy products, and protein feed. This is negative in the sense that it that the increased import leads to increased emissions of e.g. nitrogen and ammoniac in other parts of the world which means that we export environmental effects (Larsson, 2004).

The term “foodprint” was introduced by Susanne Johansson in her doctoral thesis “The Swedish foodprint – An agroecological study of food consumption”. It was part of an attempt to visualize our dependency on resources for our food consumption. In the thesis, the foodshed approach is used together with footprinting methodology and emergy analysis. Emergy is defined as “the available energy of one kind previously required directly and indirectly to make a product or service. It includes the energy of the complete lifecycle of the product (units: emjoules, emkilocalories, etc.)” (Odum, 1998).

The thesis addresses the fact that improved living standards change consumption patterns which become more demanding on resources. An emergy calculation showed that the emergy support area needed to support Swedish food consumption was 40 times the agricultural area, or 3.6 times the land area of Sweden. The calculated Swedish foodprint was about 2 to 4 times larger than the average agricultural area used for food consumption in Sweden 1997-2000. Furthermore, 65 % of the direct land area appropriated for food consumption was estimated to be in Sweden and 35% abroad. This clearly states that if we wanted to produce the same agricultural products using only local renewable resources, we would need a substantially larger area (Johansson, 2005).

Food availability in the world today

The term “food security” was defined at the World Food Summit in 1996: “Physical and economic access to sufficient, safe and nutritious food to meet dietary needs and food preferences for an active and healthy life”. Today, there are many challenges related to food production and availability in the world. The human population is growing and is expected to reach 8 billion in 2050 at the same time as climate change is expected to decrease productivity in many areas. There is also a rise in food prices linked to increased energy costs and a demand for food crops to be used for bio fuel production. This coupled with rising demand for animal protein and income growth, e.g. in Asia, increases the need for high yielding production systems (Pond *et al.*, 2009; Chapin *et al*., 2009).

In the words of Rosamond L. Naylor, co-author of the book “Principles of Ecosystem Stewardship”, food production systems of today need to be redesigned. They need to be developed to support rural incomes, enhance yields, increase input efficiency, minimize environmental impacts and provide healthy diets for the population. She also points out that efforts should be directed both towards creating small scale farming systems that meet local and regional demand and large-scale surplus systems that meet national and global demands (Chapin *et al*., 2009).

The authors of the publication “Vision for an Organic Food and Farming Research Agenda to 2025”, seem to agree with this when they mention what the three priority fields of research should be: “Eco functional intensification of food production, Empowerment of rural areas and economies and production of food for health and human well-being” (Niggli *et al*., 2008). Clearly, science and technology will play an important role in the process of redesigning our agricultural systems to cope with the effects of climate change and obtaining food security for humanity (Kitzes *et al*., 2008).

History of allotment gardening

Allotment gardening today has the purpose of consumption, recreation, leisure and social good-fellowship. The early history of allotment gardening is not completely known. In Europe, Germany was one of the precursors along with France, Denmark, the Netherlands, Schweiz and England (Ek, 1979; Björkman, 2002).

In Denmark, allotment gardening was first established in the area around Copenhagen. As early as in 1655, a precursor to our modern allotment society was mentioned by the Danish king Frederik III. He wanted to set up allotments in an area called Fredericia. Moreover, in 1750 there were large areas of allotments used by workfolk and craft workers around the centres of the early industrial revolution like Birmingham, Nottingham, Sheffield and Southampton (Ek, 1979).

The foundation of the Swedish allotment society was inspired by Denmark. The practise of allotment gardening came from Denmark to Sweden in the late nineteenth century. The first planned allotment area in Sweden was established in an area of Malmö, called Pildammarna in 1895 (Ek, 1979; Björkman, 2002).

Two people who were very much involved in the spread of the allotment practise in Sweden were Anna Lindhagen and F. A. Wingborg. They both contributed to the establishment of the Swedish allotment society (Ek, 1979).

In the beginning, the driving force and base of the allotment movement was social awareness with the goal of improving health conditions for workers and giving them the possibility of recreation after the working day. The movement was further fuelled by the lack of food during the First World War (Björkman, 2002).

Since the early days, the allotment movement has evolved in different ways throughout Europe. Today, 3 million people are part of the international allotment garden movement (Björkman, 2002).

Methods

The Survey

The choice of sending the surveys to members of SHS and SAS was due to the fact that these are the largest organisations for people with a gardening interest in Sweden with 31 000 and 25 000 members respectively. It was also central that they had the possibility to give out addresses to their members.

The members of these organisations and the members of Garden Organic are of course very different. Therefore, the comparison was very interesting. Supposedly, the members of SHS and SAS can be seen as representing an average Swedish person with an interest in gardening whereas the members of GO can be considered a more environmentally conscious group of people. Garden Organic has 40 000 members, considerably more than SAS and SHS.

The aim was to a get a minimum of a hundred returned surveys. Since it was not considered realistic to expect the same return rate as in England (85%), a decision to send out 200 surveys was made. Garden Organic has done membership experiments for many years and therefore this high return rate is not unusual. It was also decided that equal numbers of surveys were to be sent out to each organisation, which meant a hundred each.

To prepare members for the survey, a written notice was published in both members' magazines before the surveys were sent out.

SHS delivered the names and addresses of 100 randomly chosen members spread throughout the country. SAS used a different system and instead sent lists of members of 14 local groups from 14 cities. From those lists a random selection of 100 names was made using Microsoft Office Excel and the random numbers tool.

The survey was developed by researchers Ulrich Schmutz and Gareth Davies in order to provide the basis for an estimate and an overview of the carbon footprint and ecological footprint attributable to gardening and home production. It consists of four sections.

In the first section people are asked to provide the type of information necessary to fill in a typical on-line calculator in order to get a rough carbon footprint as well as an ecological footprint. They were also encouraged to go on-line themselves and do the calculation if they had the possibility. Two on-line calculators were used. The Best Foot Forward calculator (http://www.ecolgicalfootprint.com) which was the only one used at GO. For people who could go on-line themselves, a Swedish on-line calculator by WWF (www.klimatsmartcommunity.net) was suggested in order to facilitate for the Swedish respondents. At GO, the reason for choosing the Best Foot Forward calculator was due to their previous research co-operation with Best Foot Forward and that they considered it as a tested and useful tool.

In the second section people were asked about the scale and commitment to their gardens and/or allotments. Except for questions about garden/allotment size there are also questions about attitudes towards gardening.

The third section consists of questions about the inputs and resources used in gardening activities. Examples of inputs are seeds, fertilisers, pest management products and tools. All of these inputs have an inbuilt "energy" or resource cost which have an impact on the carbon footprint. Protective structures such as glasshouses have an inbuilt energy cost and also take energy to heat. In a subsection, questions about composting are asked e.g. what and how much they composted (Davies & Schmutz, 2007). In the final and fourth section, questions were asked about gardening practices, outputs as well at consumption of fruit and vegetables.

To facilitate the analysis, the results of the survey was entered into a database and then transferred to spreadsheet programme for further analysis.

Calculating the garden footprint

The model for calculating the ecological footprint was developed in a spreadsheet programme, by Ulrich Schmutz at Garden Organic. It is based on embedded energy data from previous study at Garden Organic where the energy use of organic farms was investigated. However, it was adapted to suit a garden or allotment situation.

All inputs and resources used for gardening listed by the respondents were entered into the model. The inputs were given an embedded energy factor based on manufacture, life span and weight or of the input e.g. the tool or product. The result is average energy consumption per year per input (e.g. tool, product or protected cropping method). These figures are summarised into the total energy consumption per year per input for average garden/allotment and added to the final calculation of the ecological footprint. The carbon footprint for each section of the survey is added to the ecological footprint by the use of accepted conversion factors. The factor used to arrive from CO_2 t/ha to the CO_2 component of the ecological footprint in global hectares/ha is 0.4. This factor is based on Best Foot Forward's publicly available ecological footprint calculator[1].

During the process of entering data into the calculation some difficulties emerged. In some cases people did not answer all questions or gave incomplete answers. Therefore some assumptions had to be made. In the first section of the questionnaire, when respondents left out what their main energy source was, it was assumed to be from a fossil (non renewable) source. This assumption was made throughout the whole calculation of the general footprint. When they did not specify how much they used their car it was assumed that they were average car users. When no information was given about holiday habits, it was assumed that they spent their holiday close to home since that was the most common answer people gave. Furthermore, when adding tools and products which had not been used by English respondents to the calculation, the data from the most similar tools and products in the original survey were reused. Tools or products which were not used by Swedish groups were simply removed from the list.

In some cases the respondents did not specify hours of use, replacement rate or average quantity. Without this data the calculation cannot be completed. Instead of deleting the whole dataset for a tool, an average from all the other datasets was created to fill in the empty cells. When information about quantity was missing for a product, a standard quantity from the manufacturer was used.

[1] Ulrich Schmutz, Garden Organic, e-mail 8 December 2009.

Results

The results of each part of the survey is described and compared with the result from Garden Organic. In the footprint analysis section, results from the different areas are analysed briefly. A more extensive analysis of the results follows in the discussion

The Survey

Many differences between the respondents in England and Sweden emerged from the survey. To begin with, the difference in return rate was quite high. The return rates were much higher in the study at Garden Organic, 85% (116/136) compared to 45% (90/200) in this study.

Another difference was the age. Most of the people who took part in this survey were older than 60. The second largest age group was 40-60. The members of Garden Organic are generally younger. Even though the largest age group is 40-60, there are many more between the ages of 19-39 than among the Swedish respondents. They are also part of an organisation with a clear organic profile which of course shows in their way of gardening and cultivating. Even though SHS and SAS encourage organic gardening, they do not have an organic profile in the same way that Garden Organic does.

General Ecological Footprint

In the first part of the survey people answered questions that enabled a rough calculation of their carbon footprint and ecological footprint using an online calculator. People who had access to the internet were also asked to estimate their footprint by themselves. Possibly as a result of the average age of members of these organisations, not many have chosen to calculate their household footprint on the suggested website (www.klimatsmartcommunity.net). Therefore, there was unfortunately no possibility to compare this result to the footprints calculated in this thesis.

The average calculated carbon footprint was **7.7 tonnes CO_2 per person** with a range from **5.1** to **12.8**. This is actually below the national average of 8.4 tonnes per person and, as mentioned by Davies & Schmutz (2007), could be seen as an example of what increased awareness could achieve. Compared to GO, where the average was 7.4 tonnes per person, it is slightly higher.

The average ecological footprint was **4.4 global hectares (gha) per person** which is also below the national average of 5.1 global hectares per person. This is higher than the average for members of GO where it was 3.8 global hectares per person. The range in the Swedish group was from **2.9** to **6.0** global hectares per person. These results show that the members of SHS and SAS on average would need **2.7 planets** to sustain their current lifestyle. However, it is still below the national average of 3.0 planets but slightly higher than members of GO who needed 2.5 planets to sustain their current lifestyle. For both countries, the ecological footprint well exceeds the footprint available if we would share all resources equally over the world, which is 2.1 global hectares per person (Hails *et al*., 2008).

Table 1: Footprints from survey compared with national averages.

	Carbon footprint (t/person)	Ecological footprint (gha/person)	No. planets
Sweden (survey)	7.7	4.4	2.7
UK (survey)	7.4	3.8	2.5
Sweden (national)	8.4	5.1	3
UK (national)	10.92	5.3	3.4

From the answers that people gave, it seems that this is a very mixed group. However, the majority is aware of the benefits of saving energy in their household. 91% say that they try to conserve energy. Weather this is for economic or environmental reasons or both is however not clear. Many people in the Swedish (55%) group compared to the English group (31%) used renewable energy sources.

A majority of the respondents were also meat-eaters (98%), mostly eat fresh fruit and vegetables (51%), produced a medium amount of waste (64%), had compost (63%), spent their holiday close to their home (71%), recycled most of their domestic waste, used the car rather than going by bicycle, foot or public transport (60%), and had moderate heating bills (57%).

The most noticeable differences between the English and the Swedish group were in areas diet, waste and compost. There were no vegans at all in the Swedish group compared to 3% in the English group and only 2% vegetarians compared to 25%.

More people in the English group consumed fresh vegetables and fruit (83% compared to 51%). However, they also consumed more processed food than the Swedish group (17% compared to 1%). In the English group, small amounts of waste were produced (85% compared to 36%). But most astonishingly, even though a majority of the Swedish group (63%) were composting, they could not compete with the English group where the same number was 100%.

Table 2: The general footprint, figures from calculation.

Heating bills	Sweden	England
low	40%	41%
moderate	57%	50%
high	4%	9%
Electricity	**Sweden**	**England**
renewable	55%	31%
non-renewable	45%	69%
Conserve energy	**Sweden**	**England**
yes	91%	97%
no	9%	3%
Transport	**Sweden**	**England**
bicycle or foot	24%	25%
train or bus	17%	15%
car	60%	58%
Car use	**Sweden**	**England**
light	41%	57%
moderate	47%	31%
heavy	11%	2%
Holiday	**Sweden**	**England**
close to home	71%	61%
a short flight away	21%	27%
a long flight away	8%	10%
Diet	**Sweden**	**England**
vegan	0%	3%
vegetarian	2%	25%
light meat eater	23%	44%
moderate meat eater	64%	28%
heavy meat eater	11%	0%
Freshness diet	**Sweden**	**England**
fresh veg and fruit	51%	83%
mix of two	48%	0%
processed foods	1%	17%
Amount of waste	**Sweden**	**England**
small	36%	85%
medium	64%	15%
Compost	**Sweden**	**England**
do	63%	100%
do not	37%	0%

Production area, aims & attitudes

To investigate what the effect that gardening has on the footprint of the members of SHS and SAS, the survey also had question about production aims and methods, types of inputs used and the outputs produced.

82 members answered the question about the size of their gardens and/or allotments. The average total land area was **959 m^2** with a range from 2 m^2 to 5700 m^2 (Table 4). In comparison, the median value was 515 m^2. The average total land area reported by members of GO was much bigger (1955 m^2) than in Sweden. This was also true for garden and allotment area, both of these areas were bigger that in Sweden (Table 4 and 5).

Most of the respondents (63%) produced fruit and vegetables in their gardens or in an allotment (28%). Only a few (4%) had both an allotment and a garden. This differed a lot from the English results where only 4% produced exclusively in allotments and as many as 36% produced in both a garden and allotment.

The question about the size was no. 8 in the survey. Further on in the survey, in question no.29, people could answer a question about growing location and choose between allotment, home, both or somewhere else. These answers differed a little from the ones in question no. 8. This is most likely due to that people with summerhouses chose garden in the first question whereas in the second question they could specify their growing location. The results are shown in Table 3, where the answers from question 29 are in brackets.

Table 3: Growing location, comparison Sweden and England

Location	Sweden	England
Garden only	63% (61%)	58%
Allotment only	28% (34%)	4%
Garden and Allotment	9% (5%)	36%

Table 4: Area of gardens and/or allotments reported by members in Sweden

		Sweden		
Location	No. replies	Average area m^2	Min Area	Max area
Garden only	52	1444	30	5700
Garden + Allotment	7	573	2	1000
Allotment only	23	300	50	700
Total	82	**959**	2	5700

Table 5: Area of gardens and/or allotments reported by members in England

		England		
Location	No. replies	Average area m^2	Min Area	Max area
Garden only	67	2859	25	25000
Garden + Allotment	42	562	78	2003
Allotment only	5	1531	248	3556
Total	114	**1955**	25	25000

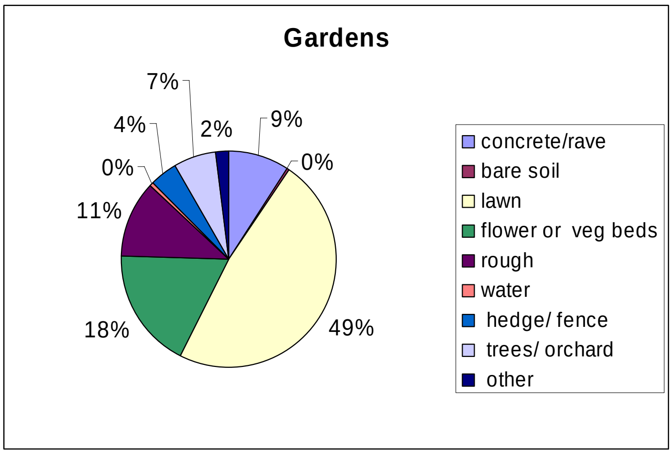
Furthermore, the members were asked to estimate what proportion of the garden/allotment that was devoted to different uses. This is shown in Figure 1 and Figure 2. It should be stated that this estimation is rather subjective but it can at least give a give a hint of the proportions in people's gardens and allotments.

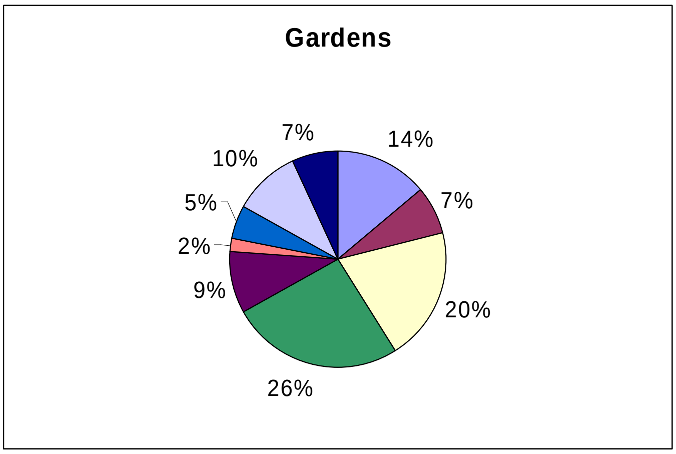
The results for gardens show that much more land in the English gardens is used for flowers and vegetables than in the Swedish gardens. Interestingly enough, nearly half of the Swedish gardens are devoted to lawns. But on the other hand they have almost no bare soil compared to 7% in the English gardens. All other areas are quite alike in terms of proportions.

The allotment areas in both countries are quite similar in proportion between areas. The exceptions are proportions of lawn, bare soil and rough. Again, more area is devoted to lawn in the Swedish gardens (31%) compared to the English (11%). As in the gardens, Swedish allotments contain a smaller proportion of bare soil (6%) than the English allotments (13%). The proportion of rough areas are larger in the English allotments (8%) compared to the Swedish (2%).

The comparison made at GO between the English allotments and gardens showed that almost twice as much land on allotments is devoted to flower and vegetable beds than in gardens. The gardens, on the other hand, had three times as much area of unproductive concrete or gravel and twice as much lawn as allotments. The relationship is similar in the Swedish group. Allotments also have nearly twice as much area for flowers and vegetables than gardens. There were also less rough areas, less lawn areas and more bare soil.

Figure 1: Proportion of gardens/allotments used for different purposes - Gardens



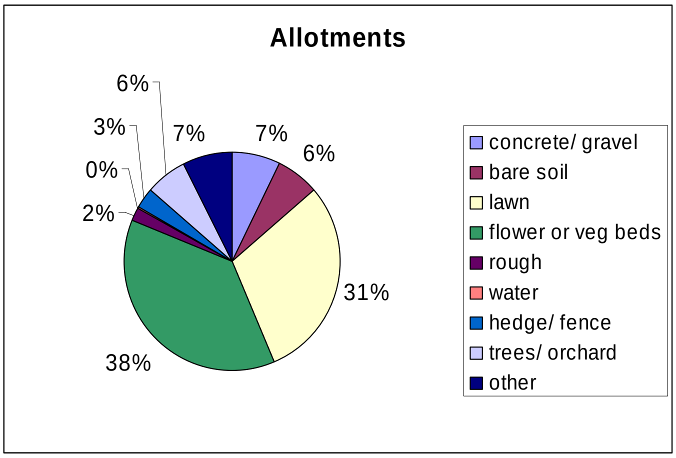


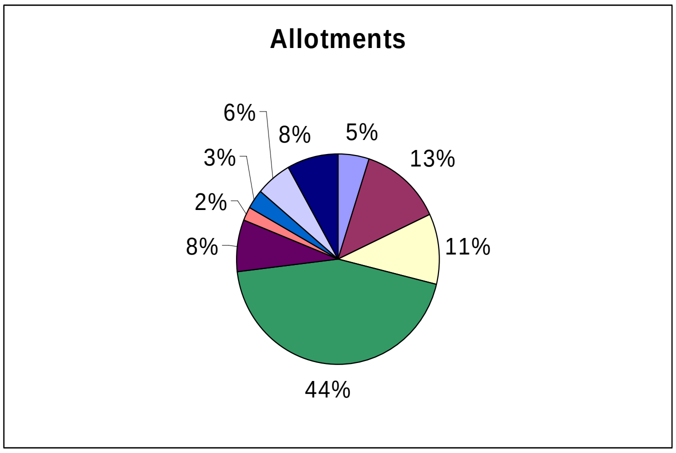
Sweden

England

(Source: Garden Organic. Used by permission)

Figure 2: Proportion of gardens/allotments used for different purposes –Allotments





Sweden

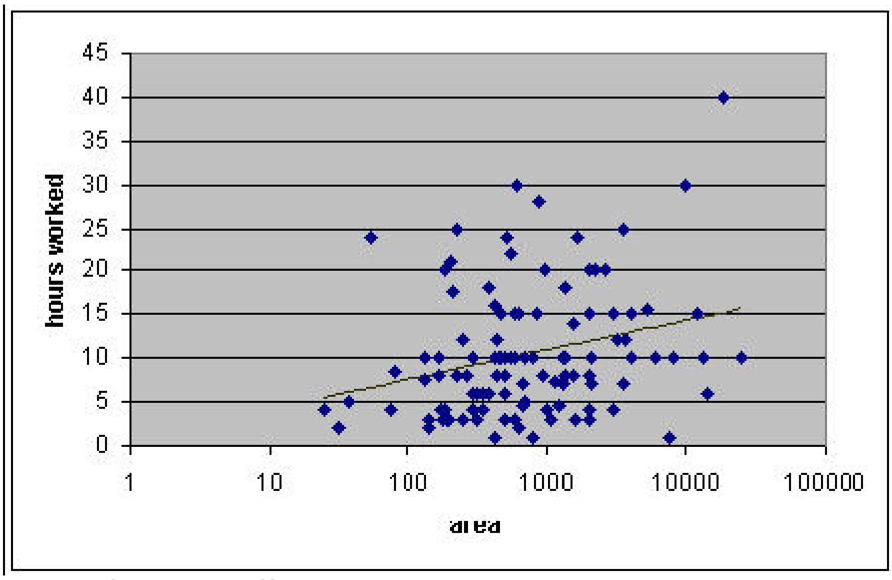
England

(Source: Garden Organic. Used by permission

Concerning input of work, 55 members in Sweden estimated that they spent an average of **9.3 hours per week** in their garden and/or allotment averaged over the whole year. As expected, mostly in spring, summer and autumn. This was quite similar to members in England who spent 10.4 hours per week on average over the year.

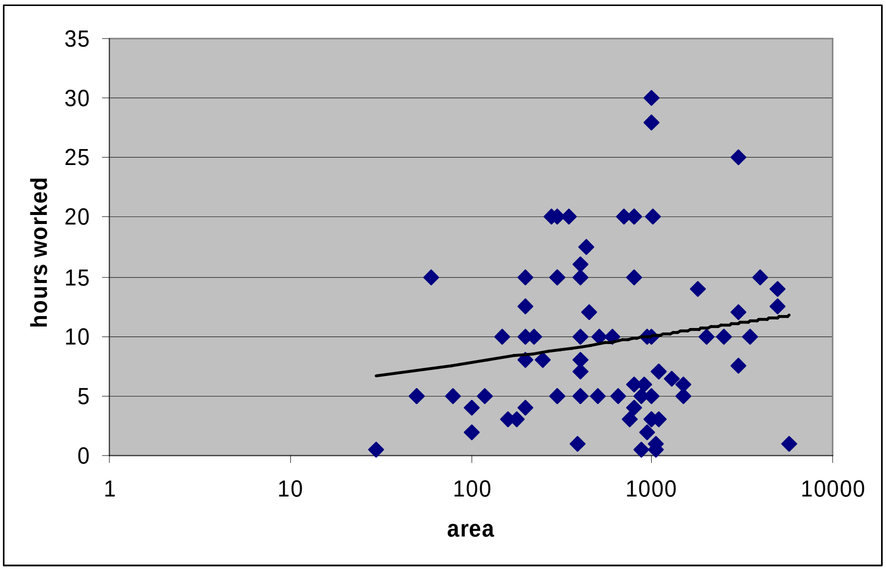
In the study at GO, there was a relationship between the area and the hours worked; (Figure 3). The relationship was exponential which meant that people with larger areas worked proportionally less time. The relationship was somewhat similar in the in the Swedish group. However, the result was not univocal. Some people with large areas worked many hours and some not. For example, a few large gardens of around 1000 m^2 where people worked maximum 20-30 hours per week

Figure 3: relationship between garden/allotment area and time worked, England



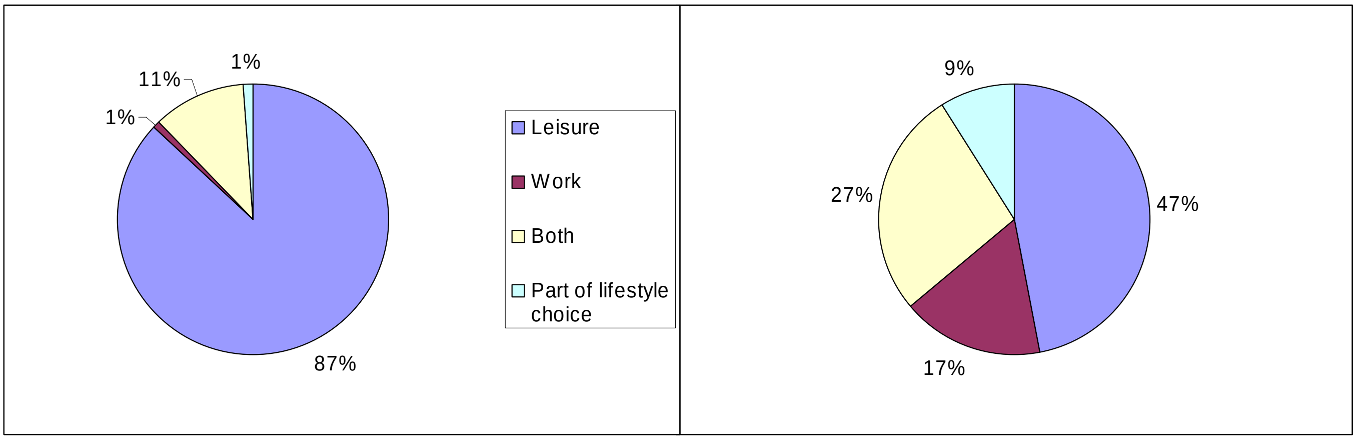
Source: Garden Organic. Used by permission.

Figure 4: relationship between garden/allotment area and time worked, Sweden



In another question, people were asked about their attitude towards gardening and producing food. As in England, many respondents thought that it was very difficult to differentiate between leisure and work. In this study however, an overwhelming majority chose leisure (86%) over work (1%) (Figure 5) Although some of the respondents who chose leisure specified that some gardening activities felt like work, e.g. mowing the lawn, and others did not. 11% considered gardening to be both work and leisure and 1% thought of it as simply part of their lifestyle choice. This was quite different compared to results from England were 17% thought of gardening as work, 47% thought of gardening as leisure and 27% thought of gardening as both.

Figure 5: Attitude towards gardening and production



Sweden

England

(Source: Garden Organic. Used by permission

Inputs

This part of the study deals with the physical inputs that respondents used in their gardens and allotments. Some were produced within the gardens/allotments but many, in this study, came from external sources.

The first question in this part of the survey was weather people grew organically or not. A majority, 63%, stated that they grew organically. As expected, this was not as many as in the English group were the same number was 95%. It is unclear whether all of the 63% grew organically completely according to the principles because some of the respondents said yes in the first question and later on listed that they used pesticides or artificial fertilisers. As the survey showed in England, people often grow their food organically but are less particular in other areas of the garden (e.g. paths and lawns).

Seed

Seed is a primary resource for any grower. 24% of the respondents in this study did not use any home saved seed at all which probably meant that they bought all of it. 7% used a lot of home saved seed and as many as 69% used some. In England, even more people (84%) responded that they used some home saved seed.

Products

Many products were used by people in their gardens and allotments. However, the range of products used was wider in the English group. The products used by people in this study are shown in Table 6 where they are listed in categories. The source of the product is abbreviated in the table. H stands for produced at home, C stands for close to home and D stands for from a distance.

The most common homemade input in this study was compost. Generally, people in the English study used more homemade products, such as liquid fertilisers and insecticidal mixtures.

Table 6: Inputs used by members by category

Product category	Product	No. using product	Average quantity used	Measure	Source
Pest/Disease Control	ant poison (Cypermetrin)	1			C
	ant poison (Myrr)	1	0,25	kg	C
	fungicide (unspecified)	1			C
	insecticide (homemade) methylated spirit	1			H
	pesticides (unspecified)	1	25	kg	C
	soap	5	1,5	kg	C/H
	soap water	1	10	kg	H
Weed control	herbicide (Round-up)	5	4	kg	C
	herbicide (unspecified)	3	10	kg	C
	weeding vinegar (ättika)	1	8	kg	C
Mulch	mulch (bark)	1	30	kg	H
	mulch (wood chip)	1	500	kg	C
Amendments	compost	51	11035	kg	H/C
	grass clippings	2			H/C
	multipurpose compost	6	860	kg	C
	nettle liquid	4	50	kg	H
	peat	3	22,4	kg	C
Fertility	artificial fertiliser	5	685	kg	C
	artificial fertiliser (Blå Korn)	4	13	kg	C/D
	artificial granule fertiliser (Blå Korn)	3	22	kg	C
	artificial liquid fertiliser (Blå Korn)	2	5,5	kg	C
	bone meal	6	67	kg	C/D
	chicken manure	1	10	kg	C
	cow manure	9	1690	kg	C/D
	cow manure (composted)	7	1200	kg	C/D
	farm yard manure	8	1350	kg	H/C
	farm yard manure (composted)	1	100	kg	C
	fertile soil compost	1			C
	general fertiliser	1	1	kg	C
	general fertiliser (Binadan)	1	5	kg	C
	general liquid fertiliser (Biobact)	2	10	kg	C
	horse manure	5	1115	kg	C
	human manure	1	300	kg	H
	lawn fertiliser (artificial)	1	3	kg	C
	lawn fertiliser (Stroller kombi)	1	8,75	kg	C
	lime	2	10	kg	C

	manure	7	2650	kg	C/H
	manure (composted)	10	2502	kg	C/H
	NPK 11-5-18	1	100	kg	C
	NPK fertiliser (unspecified)	2	25	kg	C
	organic fertiliser	1	20	kg	C
	organic fertiliser (Chrysan)	1	1	kg	C
	organic fertiliser (liquid)	1			H
	organic pesticide (pyretrum)	1			D
	poultry manure	6	60	kg	C/D
	rhododendron fertiliser (solid)	1	1	kg	C
	rose fertiliser (solid)	1	1	kg	C
	sea weed meal (Algomin)	12	91,5	kg	C
	urine	2	250	kg	H
Propagation	seed compost	2			C
	vermiculite	1	5	kg	C
Misc	silage	1			C

Tools

When answering this question, people had to list which tools they used along with how many hours per year they used them and how often they were replaced. How often a tool is replaced and what material it is made of will affect its footprint.

The tools used are listed in Table 7. Again, a wider range of tools was listed by the English respondents. However, many tools which can be assumed to be fairly common in a garden were not listed by the respondents (e.g. watering cans, hoes and buckets). The most common tools that people used were spades, rakes and lawn mowers (unspecified).

For the most part, people estimated that they would be able to use both their basic manual tools and their mechanical equipment for more than 10 years.

Table 7: Most popular tools used by members

Tool	Count of tools	Avg of Replacement	Min of Replacement	Max of Replacement	Avg of hours use per year	Min of hours use per year	Max of hours use per year
cultivator	2	17,7			14		
dandelion weeder	4	10	10	10	10	10	10
fork	27	17	5	40	27	5	100
fork(s) (small)	2	18	15	20	30	30	30
hand fork	3	9	8	10	20	15	25
hedge trimmer	6	15	10	20	14	1	48
hedge trimmer (electric)	2	4	4	4	6,5	3	10
hoe(s)	6	9	5	10	32	5	75
lawn mower	38	12	4	20	34	1	375
lawn mower (electric)	9	13	10	15	19	6	40
lawn mower (manual)	9	13	7	25	19	5	50
lawn mower (petrol)	10	14	9	20	36	1,5	100
lawn rake	22	14	3	30	15	5	50
loppers	5	8	5	10	6	6	6
mattock	15	18	5	30	11	2	20
pruning saw	2	8	5	10	6	6	6
rake	44	12	3	25	23	1	100
rotovator	2	13,3			6	6	6
saw	6	5	5	5	17,4		
scythe	4	23	10	50	3	3	3
secateurs	31	9	1	30	27	5	100
shears	14	9	2	20	5	1	20
shovel	4	23	15	30	8	6	10
shredder	3	23	15	30	6	5	6
spade	57	14	2	30	19	2	100
spade (small)	11	7	4	10	22	10	75
strimmer	5	8	5	10	24	5	40
strimmer (electric)	2	9	2	15	5	5	5
trimmer	6	9	5	15	5	3	10
trimmer (electric)	2	4	4	4	12	10	13
watering can	5	10	10	10	50	50	50
weeding fork	2	15	10	20	12,5	10	20
weeding tool	4	20	20	20	15	10	20
wheelbarrow	5	8	8	8	9	8	10

Protected cropping

Protected cropping is widely used in England to prolong the season. This was evident among the members of Garden Organic. 61% reported that they had a glasshouse, 19% had a polytunnel and a wide range of other methods were used. However, it was not very common among the members of SAS and SHS. Only 18 people (20%) had a glasshouse and no one used polytunnels. Instead, the most common protected cropping method was fleece.

Not many heated their glasshouses, only 5 people out of 18. These people kept their glasshouses heated for only about 5 days and 8 hours a day.

All alternative protected cropping methods used by people in this study are listed in Table 8. As mentioned, fleece was the most popular here. This was also one of the most popular protected cropping methods in England, together with plastic cloches and cold frames.

The footprint associated with protected cropping is discussed further in the footprint analysis section.

Table 8: Other protected cropping methods.

Protected cropping	Count of protected cropping
black plastic	1
cold frame(s)	4
fleece	16
glass-enclosed veranda	1
heated propagator	1
mini plastic greenhouse	2
netting	1
plastic greenhouse	1

Compost

Generally, composting was much more common among the members of Garden Organic. In Sweden, a majority of the respondents composted garden waste (74%) although not to the extent of the members of Garden Organic where the same number was 99%. Furthermore, in Sweden only 40% composted kitchen waste and 16% composted other biodegradable waste compared to 100% and 87% respectively in England.

People were also asked to estimate the size of their compost heaps. The average volume of the composts was 4.42 m^3 (from 56 replies). A few people had 2 or 3 heaps. This was actually very close to the volume in England which was 4.64 m^3.

Water use

In this part of the survey people were asked to answer what they watered in their garden/allotment, with what they watered and how much mains water they used. Most people found it very difficult to estimate their water use.

To begin with, 64 people (71%) watered their vegetables. Of these, 35 people (39%) also watered their flower beds and 18 (20%) people watered their lawn as well. The biggest difference was that only 4% in the English group watered their lawn and 97% watered their vegetables.

53% of the respondents also collected rainwater. This was however far from the overwhelming majority (97%) who collected rainwater in England.

In the next question, if they watered, people could estimate how much mains water they used. They could choose to indicate in hours per year or in m^3. When people answered in hours per year, the volume was calculated based on figures from England (Ofwat, 2007) assuming that a hosepipe uses 540 litres of water per hour. Understandably, many thought this was difficult to estimate and presumably some people may have skipped this question. Many commented by saying that it depends on the weather, as well as mentioning that they use water from their own well or lake water. In any case, 31 people did estimate their use of mains water and the average volume was **14.1 m^3 per year** (min 0.25 to max 108). This was quite a bit more than in the English group where the average volume was 9.8 m^3.

15 (17%) of the respondents used bath or grey water compared to 30 (26%) in England. Grey water is water which is only lightly tainted, e.g. from soap.

Food storage

Most people (64%) answered that they both used a fridge and a freezer (big or small). In the English study, more people (80%) used a fridge with or without a number of freezers.

Most respondents used various types of cool dry storage. This was also the preferred method among the English respondents. However, they used a much wider range of storage methods which is probably a result of that they grew more vegetables and fruit in general. The figures on vegetable and fruit production are found in the output section.

Table 9: Reported alternative storage methods

Storage method: produce	No. using method
Drying	4
Fruit syrup	5
Cool dry storage (pantry, attic, butlery, earth cellar, cellar)	25
Jam	6
Leavening (lactic acid)	1
Immediate use	4

Outputs

Vegetables and fruit

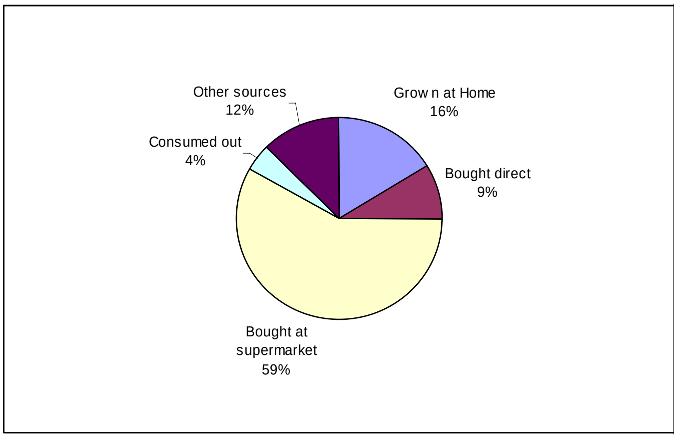
Of the 90 replies, 9 people (10%) only grew vegetables, 19 people (21%) only grew fruit. As in the English group, the majority grew both vegetables and fruit 56 (61%) even if it was not to the same extent (93%). As for the growing location, a majority of 46 people (51%) grew these at home in their garden, 26 people (29%) grew on an allotment and 4 people (4%) grew both in their garden and their allotment. A big difference compared to the English group is that 9 people (10 %) grew fruit and vegetables in their holiday home. No one in the English group mentioned that they had a holiday home. The holiday homes were also sometimes quite far away.

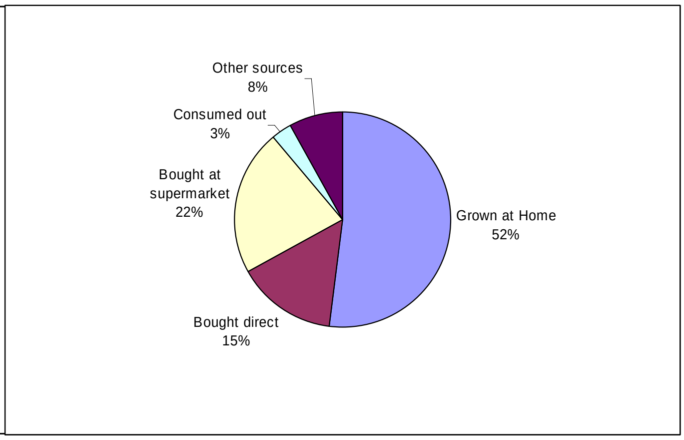
The average distance that people travelled to their holiday homes was **72 km** (from 0.4 km to 110 km) as reported by 9 people who went, on average, **3 times per month** (3.4). The average distance that people travelled to their allotment was **3.7 km**. This was reported by 30 people who went, on average, **13 times per month** (12.7). On average, the distance travelled to both allotments and holiday homes was **23 km**. Most people went to their allotment or holiday house by car **(18 (46%))** or by bike **(14 (36%))**. Many also went by foot **(10 (26%))**. Only 2 people used public transport. The average distance travelled by car was **27 km**.

Since most people in the English group grew in allotments close to their home, these results differed a lot. The number of visits per month was nearly the same (12) but the average distance was only 1.4 km. Most people travelled this distance by foot or by bike (40 (93%) but as many as 16 (37%) occasionally used the car.

People could also answer a question about how often they eat their own produce. From 66 replies, **16 (24%)** reported that they eat their own produce daily, **29 (44%)** weekly and **21 (32%)** monthly. These results differed from England where most people eat their own produce daily (60%) and very few eat their own produce monthly (6%). In both countries, these results correspond to the average proportion of fruit and vegetables that people estimated that they obtained from various sources (Figure 6). As mentioned, in Sweden, 24% eat their own produce daily and they also estimated that the average proportion of fruit and vegetables obtained from their own garden was 16%. Furthermore, 59% was obtained from supermarkets. This can be compared to England where 60% eat their own produce daily and as much as 52% was from their own produce. Only 22 % was from supermarkets. In Sweden, people also estimated that 9% of the fruit and vegetables consumed was bought direct (e.g. from farm shops or box schemes) from other sources, 4% was consumed out and 12% was from other sources. The reported other sources were family, friends, neighbours, and workplaces. Not many specified these sources. In England, more people answered this question and some the most common other sources were local green grocers and local markets as well as friends.

Figure 6: Proportion of fruit and vegetables obtained from various sources.





Sweden

England

(Source: Garden Organic. Used by permission)

As mentioned, people in the Swedish group estimated that they only produce on average 16% of the staple fruit and vegetables that they consumed. In Table 10 and 11, the vegetables and fruit grown are listed along with average and maximum and minimum proportion of total consumption.

The most common vegetables that people grew were potatoes, salads, tomatoes and peas/beans and the proportion of consumption that the production of these crops met ranged between 17 to 36%. The most common crops grown were almost the same in England, although people there produced a higher proportion of their consumption. The English respondents also grew a wider variety of vegetables and vegetables such as squashes, sweet corn and pepper was much more common.

As in the results from England, the proportion of vegetable consumption met by the production varies between different types of vegetables and fruit. The estimated proportion of total consumption was higher when it came to less common crops. For example, the few people who grew spinach, borecole and beetroots all estimated that they produced between 90 to 100% of their consumption.

Table 10: Vegetables grown. Average, minimum and maximum produced proportion of total consumption.

Crop Category	Percentage of total consumption (%)	Min of consumption (%)	Max of consumption (%)	No. of producers
Green leafy vegetables	27	-	100	36
Onions	37	-	100	35
Other alliums	43	-	100	21
Peas/ beans	36	-	100	37
Potatoes	31	-	100	40
Root vegetables	23	-	100	33
Salads	19	-	100	39
Tomatoes	17	-	80	39
Other crops	**Percentage of total consumption (%)**	**Min of consumption (%)**	**Max of consumption (%)**	**No. of producers**
Beetroots	100	100	100	1
Borecole	100	100	100	1
Cabbage	55	15	90	3
Carrots	50	50	50	1
Cauliflower	1	1	1	1
Chives	50	50	50	1
Coriander	85	70	100	2
Cucumbers	34	1	100	5
Dill	90	80	100	6
Fennel	100	100	100	1
Garlic	100	100	100	1
Herbs	67	25	100	5
Oregano	50	50	50	1
Parsley	83	70	90	6
Pepper	5	5	5	1
Rosemary	50	50	50	1
Spinach	70	70	70	1
Squash	90	90	90	3
Zucchini	80	80	80	1

As for fruit, the results were quite similar in both countries. The most common fruit grown in Sweden as in England was apples. It seems that most people have one or more apple trees in their garden. Other common top and soft fruit crops were plums, currants, raspberries, strawberries and rhubarb. It is also apparent that, compared to vegetables, people often produce most of their consumption of fruit and berries. However, the proportion of consumption met by production in the English group was slightly higher for many fruit crops (<90%).

As with the vegetables, the variety of crops grown differed a little. In England, more fruits suitable for a warmer climate were grown such as citrus, figs, apricots, peaches and grapes. In southern England all these Mediterranean crops can be grown outside or in unheated glasshouses.

Table 11: Fruit grown. Average, minimum and maximum produced proportion of total consumption.

Crop category	Crops	Percentage of total consumption (%)	Min of consumption (%)	Max of consumption (%)	No of producers
Elder		100	100	100	2
Grapes		10	10	10	2
Rhubarb		91	1	100	12
Soft fruit	Berries	66	10	98	3
	Black currants	100	100	100	6
	Blackberries	100	100	100	3
	Blueberries				2
	Currants	84	5	100	17
	Gooseberries	89	2	100	11
	Raspberries	72	1	100	17
	Strawberries	42	0,5	100	12
	Wild strawberries	60	5	100	3
Top fruit	Apples	33	0,1	100	43
	Cherries	74	5	100	8
	Peaches				1
	Pears	62	30	100	9
	Plums	57	0,01	100	18

Savings

The last question was about estimated savings by home production. The original intention was to further investigate what proportion of consumption was met by home production. People had the choice to answer in kronor per month or per year. However, since very few answered this question and most people did not specify if they meant per month or per year, these results are not very reliable and are therefore not included in the results.

Footprint Analysis

The purpose of this footprint analysis is to gain knowledge about what proportion of a person's ecological footprint that is represented by gardening and also what effect home food production has on the footprint.

The calculation model used was developed by Dr Ulrich Schmutz and Dr Gareth Davies, researchers at Garden Organic. With the help of figures from a previous study at Garden Organic on energy use of organic farms, it calculates the carbon footprint of the garden inputs. The carbon footprint is then used to calculate an overall average ecological footprint for home food production. For each input, an average carbon footprint is calculated per year. The carbon footprint depends on factors such as material, quantity used, how long it will last before being replaced, all maintenance resources, and the energy use (fossil fuels or electricity). In the final analysis, an ecological footprint value is substituted for this carbon footprint using conversion factors (Davies & Schmutz, 2007).

The footprint analysis is based on four main areas; production, storage, transport and waste and recycling. The result of the analysis in each of those areas is presented here.

Tools

The analysis showed that tools are responsible for around 9% of the gardening footprint in total (Table 17). This can be compared to 12% in England. The most common tools used by Swedish respondents are listed in Table 12 together with their embedded energy costs. The amount and type of tools used were very different between English and Swedish groups.

Table 12: Tools. Energy use per year

Tool	% Users	Average replacement time	Average hours use (per year)	Mass (kg)	Energy manufacture & delivery (MJ/year)	Repairs ratio	Energy maintenance (MJ/year)	Fuel (l/hour)	Energy fuel (MJ/year)	Total energy per tool (MJ/year)	Average garden footprint (MJ/year)
brush cutter	1	10	10	3,7	35	0,39	13	0,5	190	238	3
cultivator	2	18	14	1,1	6	0,10	1			6	0
fork(s)	31	24	15	1,9	8	0,10	1			8	3
fork(s) (small)	6	14	25	1,0	7	0,10	1			8	0
hacksaw (electric)	1	9	6	3,0	32	0,39	11	0,5	114	157	2
hand tools	12	15	13	0,3	2	0,10	0			2	0
hedge trimmer (electric)	9	15	10	3,0	19	0,39	7	0,5	195	221	20
hedge trimmer (petrol)	1	8	13	3,7	44	0,39	16	0,5	253	313	3
hoe(s)	7	9	32	1,9	20	0,39	7			27	2
iron-bar lever	1	30	1	2,4	8	0,10	1			8	0
lawn mower (solarcharged)	1	12	3	10,0	80	0,39	28			108	1
lawn mower (unspecified)	34	12	34	25,0	199	0,39	71	0,5	646	916	309
lawn rake	24	14	15	2,0	14	0,10	1			15	4
lawnmower (electric)	10	13	19	20,0	147	0,39	52	0,5	361	560	56
lawnmower (manual)	10	13	19	10,0	74	0,39	26			100	10
lawnmower (petrol)	11	14	36	25,0	171	0,39	60	0,5	684	915	102
loppers	6	8	6	2,0	24	0,10	2			26	1
mattock	17	18	11	1,1	6	0,10	1			6	1
potato ridging tool	1	30	10	1,9	6	0,10	1			7	0
pressure washer	1	10	10	20,0	191	0,39	68	0,5	190	449	5
pruning saw	2	8	6	0,5	6	0,20	1			7	0
rake(s)	49	12	23	1,1	9	0,10	1			10	5
rotovator (petrol)	2	13	6	25,0	180	0,39	64	0,5	114	357	8
saw (petrol)	1	13	5	6,0	43	0,39	15	0,5	95	153	2
saw(s)	7	5	17	0,4	8	0,20	1			9	1
scarifier	1	20	40	1,9	9	0,10	1			10	0
scythe	4	23	3	2,0	8	0,10	1			9	0
secateurs	34	9	27	0,3	3	0,10	0			3	1
shears	16	9	5	0,8	8	0,10	1			9	1
shovel	4	23	8	1,1	5	0,10	0			5	0
shredder (petrol)	3	13	6	20,0	144	0,39	51	0,5	114	309	10
spade(s)	63	14	19	2,4	16	0,10	1			18	11
strimmer	6	8	24	3,7	44	0,39	16	0,5	456	516	29
strimmer (electric)	2	9	5	2,0	21	0,39	8	0,5	95	124	3
tractor mower	1	10	100	250,0	2389	0,39	846	2,0	7600	10835	120
trimmer	7	9	5	3,0	32	0,39	11	0,5	95	138	9
trimmer (electric)	2	4	12	2,0	48	0,39	17	0,5	228	293	7
trimmer (petrol)	1	6	6	3,7	59	0,39	21	0,5	114	194	2
trowel(s)	12	7	22	0,3	4	0,10	0			5	1
watering can(s)	6	10	50	0,4	4	0,10	0			4	0
wheelbarrow(s)	6	8	9	13,5	161	0,10	15			176	10

Products

Many different products are used in the garden for fertility, nutrition and crop protection. The products used by the Swedish respondents are responsible for 26% of the gardening footprint. This is twice as much as in the English group, where the same number was 13%. The tools used by Swedish respondents are listed in Table 13 together with their embedded energy costs. The number of products used is fewer in the Swedish group but there are more people using pesticides, herbicides and composted manure.

Table 13: Products. Energy use per year

Product	% Users	Average quantity	Measure	Energy embedded (MJ/kg)	Energy embedded (MJ/year)	Avergae garden footprint (MJ/year)
compost (commercial)	16	1412	kg	1	**1610**	**250,5**
compost (home made)	57	11035	kg	0	**0**	**0,0**
cow manure	10	1690	kg	324	**324**	**32,4**
cow manure (composted)	8	1200	kg	230	**230**	**17,9**
farm yard manure	9	1350	kg	259	**259**	**23,0**
farm yard manure (composted)	1	100	kg	19	**19**	**0,2**
fertiliser general (non organic)	23	865	kg	1	**986**	**230,1**
fertiliser liquid	4	16	kg	50	**775**	**34,4**
fertiliser organic	3	21	kg	1	**24**	**0,8**
fungicide spray	1	0	kg	92	**37**	**0,4**
herbicide pathclear (glyphosate)	9	14	kg	454	**6356**	**565,0**
humanure	2	550	l	1	**627**	**13,9**
insecticidal soap	7	12	kg	199	**2289**	**152,6**
insecticides	3	25	kg	199	**5025**	**167,5**
lime (dolomite)	2	10	kg	1	**11**	**0,2**
manure	1	300	kg	57	**57**	**0,6**
manure (composted)	11	2502	kg	479	**479**	**53,3**
manure chicken pellets	8	70	kg	1	**80**	**6,2**
manure horse	6	1115	kg	175	**175**	**9,7**
organic pest control spray	2	2	kg	90	**180**	**4,0**
seaweed extract	13	92	kg	1	**110**	**14,6**
seeds	100				**29**	**28,8**
vermiculite	1	5	kg	11	**53**	**0,6**

Protected cropping

The protected cropping methods used by the respondents are listed in Table 14 along with their embedded energy costs. As seen in the inputs section, protected cropping methods was a much more common practice among the English respondents than among the Swedish. Probably in relation to that they grow more of their own produce. Polytunnels were very common in England but were not used at all by the Swedish group.

Because very few in the Swedish group used protected cropping, it only represents 2% of the gardening footprint, including heating costs. In the English group the same number was 18%.

Table 14: Protected cropping. Energy use per year

Protected cropping	% Users	Average quantity	Measure	Average replacement time (years)	Mass (kg)	Energy embedded (MJ/kg)	Energy embedded (MJ/year)	Average garden footprint (MJ/year)
black plastic	1	2	sq m	1,5	2,0	87	**116**	**1**
cold frame(s)	4	1	sq m	5,0	10,0	87	**174**	**8**
fleece	18	15	sq m	1,5	2,0	87	**116**	**21**
heated propagators	1			5,0	10,0	95,57	**191**	**2**
mini plastic greenhouse/ polytunnel	3	1	sq m	10,0	20,0	87	**174**	**6**
netting (over fruit and/or cabbages)	1			1,5	2,0	87	**116**	**1**
wire mesh cages	6			5,0	5,0	95,57	**96**	**5**
Glasshouses		% heated						
Glasshouse large	0	0%		20,0	150,0	95,57	**717**	**0**
Glasshouse medium	6	20%		20,0	100,0	95,57	**478**	**27**
Glasshouse small	14	31%		20,0	50,0	95,57	**239**	**35**
Heating		Average use (hours)			kW		Energy MJ/year	
Glasshouse large	0	184			0,3		**199**	**0**
Glasshouse medium	1	184			0,2		**132**	**1**
Glasshouse small	4	184			0,1		**66**	**3**

Storage

Storage is a very important when growing your own food in order to keep the quality of the produce and avoid spoilage. The storage methods used by Swedish respondents are listed in Table 15 along with their energy costs.

In the study at Garden Organic, storage represented 55 % of the gardening footprint and as a result had the most influence on the total gardening footprint (Attachment 2). This can be compared to this study where it only represents 22 % (Attachment 1).

In the calculation it was assumed that people also used the fridges and freezers to store other things than own produce and that bulk items such as apples, potatoes and carrots were stored somewhere else. Therefore, between 10 and 70% of the footprint costs were allocated to fridges and freezers used for home production (Table 15) (Davies & Schmutz, 2007).

Table 15: Storage. Energy use per year

Storage method	% Users	Average replacement time	Average hours use (per year)	Mass (kg)	Energy manufacture & delivery (MJ/year)	Repairs ratio	Energy maintenance (MJ/year)	kWh per year	Energy fuel (MJ/year)	Total enegy per tool (MJ/year)	Average garden footprint (MJ/year)
cool dry storage	28										
drying	4										
jam	7	20		10,0	48				0	**48**	**3**
fruit syrup	6	20		10,0	48				0	**48**	**3**
fridges*	4	15	8760	8,0	51	0,10	5	263	946	**1002**	**2**
small freezers**	21	15	8760	8,0	51	0,10	5	350	1261	**1317**	**11**
large freezers***	23	15	8760	16,0	102	0,10	9	526	1892	**2003**	**26**

*assuming 10% use for gardening **assuming 50% use ***assuming 70% use

Transport

The distance that people travelled by car to and from the site of their garden or allotment was significantly larger in this study, 856 km/ year compared to 33 km/year in the English group. As a result, transport is responsible for around 42 % of the total gardening footprint in this study. This can be compared to 2 % among the members of Garden Organic who mostly grew on site or very close to home. The main reason for the difference, which will be discussed later, is the number of Swedish respondents (10 %) who have a summer or holiday house. The figures are listed in Table 16 although more detailed figures can be seen in Attachment 1 and 2.

In the calculation, it was assumed that only 20% of the bicycle use was for the purpose of gardening. The calculation is based on embedded energy (like garden tools) instead of average distance because no fuel is used. Concerning car use, people had to estimate the distance that they drove to the site of their garden or an allotment. In the calculation, only the distance driven to and from the garden/allotment is accounted for. The reason for that is that the emissions from manufacture and maintenance are proportionally very small compared to the direct emissions and therefore can be considered as included in the average per km emission.[2]

[2] Ulrich Schmutz, Garden Organic, e-mail 17 July 2009

Table 16: Other inputs. Energy use per year

Activity	% Use	Average replacement time	Average hours use (per year)	Mass (kg)	Energy manufacture & delivery	Repairs ratio	Energy maintenance (MJ/year)	Use for gardening	Energy fuel (MJ/year)	Total energy per tool (MJ/year)	Average garden footprint (MJ/year)
Transport											
bicycle	3	10	514	15,0	143	0,39	51	20%		**194**	**6**
car	18	-									
Waste & Recycling											
Rainwater use	53	-									
Grey water use	17	-									
Composting											
Garden waste	74	-									
Kitchen waste	40	-									
Other Household waste	16	-									

Waste and Recycling

This area was never completed in the original study at GO because it is rather complex and in need of further investigation. In lack of more detailed data, the assumption was made that garden composting is carbon neutral. It is therefore included as zero in the total gardening footprint.

Overview of footprint analysis

The overview of the garden footprint for each country can be viewed in Attachment 1 and 2. In this study, the average person's gardening activities will produce around **5.285 tonnes CO_2 per hectare**. This is equivalent to about **2.114 global hectares (gha) per hectare** or about **0.20 global hectares per garden** for this survey. The carbon footprint for gardening is about **0.23 tonnes CO_2 per person**.

These results show that the garden footprint of Swedish respondents by far exceeds the garden footprint of the English if 100% of car use is allocated to gardening, (Table 17). In the study made at Garden Organic, the average person's garden activities produced 1.71 tonnes CO_2 per hectare (0.15 t/CO_2 per person) equivalent to 0.68 global hectares per hectare and 0.13 global hectares per garden.

The results from the surveys in both countries are analysed and compared in the discussion which follows in the next section.

Table 17: Comparison of garden footprint – England and Sweden

Country	CO_2 Component of Ecological Footprint		Ecological Footprint	
	CO2 t/ha	CO2 t/person	gha/ha	gha/garden
England	1,71	0,15	0,68	0,13
Sweden	5,29	0,23	2,11	0,20

Discussion

The survey

The return rate in this study was only 45 % compared to 85 % at Garden Organic. The most likely explanation for this is that the members of GO were more actively agreeing to take part in the survey compared to the members of SHS and SAS. GO has a history of member participation whereas the members of SHS and SAS were randomly chosen and only prepared for the survey by a written notice in the members' magazines. The questionnaire was also very detailed and probably took a while to fill in. Therefore, it was not very surprising that some were returned blank with comments expressing irritation. Nevertheless, 45% can still be considered as a good response rate in view of the circumstances. It also does not differ that much from the 116 replies received at GO.

Very few people also calculated their footprint on the suggested website and as mentioned, this could have been due to the high average age of the respondents, but also that the process of both filling in the questionnaire and going online felt too time consuming.

Furthermore, because of the less satisfactory geographical spread of members of SAS compared to members of SHS, the results can perhaps not be considered as representative of all members of SAS.

General Footprint – online calculator

The average household footprint of members of GO was overall smaller than the household footprint of the people participating in this study (Table 1). However, it did not differ much.

Compared to the national average of Sweden, the Swedish respondents had a considerably smaller household footprint. However, Sweden does have a smaller national average footprint compared to the UK. Nevertheless, respondents in both countries have a footprint that well exceeds the footprint available if we would share all resources equally over the world, which is 2.1 global hectares per person (Hails *et al.*, 2008), and further lifestyle changes are necessary to reach a more sustainable level.

Many facts about the lifestyles of the respondents arose from this section of the questionnaire. The most noticeable differences between the English and the Swedish group were in diet, waste and compost. There were no vegans at all in the Swedish group compared to 3% in the English group and only 2% vegetarians compared to 25%. This can perhaps be explained by the age of the respondents. Most people who took part in this survey were over 60 and more people in the English group were 19-39 years old. It is probably not wrong to assume that fewer people over 60 are vegan or vegetarian.

There is no exact information on how many people in Sweden are vegetarian or vegan. However, a few investigations have been made, for example by SIFO Research international and the national food administration. There was also a national investigation of eating habits in 1997-1998. These investigations have shown that about 2-5% of the Swedish population is estimated to be vegetarian and 0.1-1% is vegan. It was also shown that these numbers were higher among younger people (15-24 years) (Terneborg, 2006). This indicates that the number of vegetarians and vegans in among the respondents correspond rather well with the national average.

Another noticeable difference was the main energy source that people used. Many people in the Swedish (55%) group compared to the English group (31%) used renewable energy sources. This is not surprising since Sweden has the highest use of renewable energy sources in relation to the total energy consumption in the EU. In 2007, it amounted to 43.9 % of the total energy consumption. District heating also seems to be much more developed in Sweden compared to England (Energimyndigheten, 2008).

The on-line calculator is a very crude measure because it requires that you make a lot of generalisations about your behaviour. It is not always easy to answer questions about your heating bills and to define the size of your house small, medium or large. Sometimes more than one alternative is correct. Many people found it difficult to only choose one alternative when it came to where they spend their holiday. Perhaps it differed between years or maybe they usually spent their holiday in different places.

As mentioned by Davies & Schmutz (2007), another disadvantage with these types of calculators is that they do not allow for alternative lifestyle choices. If you are using solar hot water or electricity you can only incorporate this in the calculation by indicating low heating bills. However, the calculators can still be useful for broader questions because they can easily visualize what happens with your footprint if you spend your holiday close to home or stop using your car. If you spend your holiday a long flight away, the calculator clearly shows that it gives you a large footprint regardless of how you change your other lifestyle choices. It also shows that when more people share the resources in a household, the footprint becomes smaller per person (Davies & Schmutz, 2007).

The reasons that this calculator was chosen for the study at Garden Organic were several. Partly because they thought that it made it clear that a portion of our footprint has to do with the way we live. Some people participating in the study in England pointed out that, except for our personal responsibility; there is also a collective and political responsibility for reducing our collective environmental footprint. They are both important. They also chose this calculator because of the connection that it makes between our carbon footprint and our ecological footprint. The carbon footprint has to do with the amount of CO_2 emissions that we are responsible for and the ecological footprint is the area from which we draw our resources. They are equally important because they help in bringing awareness by visualising the current situation and indicating if we are on the right course to sustainability or not. Because we only have one planet it is obvious that having a lifestyle that requires resources from 2.7 planets is not possible if there is going to be anything left for future generations (Davies & Schmutz, 2007).

Production area, aims & attitudes

The average total land area as well as the average area of gardens and allotments reported by members of GO was much bigger than reported by Swedish respondents. It was also much more common in the English group to both grow in a garden and an allotment. The explanation may partly be due to the fact that the members taking part in this study are part of different organisations. Equal parts of the survey were sent to SHS and SAS. People who are members of SAS presumably only produce in an allotment whereas most people in SHS produce in a garden. There may of course be exceptions but it seems likely that this would influence the results.

Much more land in the English gardens is used for flowers and vegetables and nearly half of the Swedish gardens are devoted to lawns. This corresponds well to the fact that there is a much smaller production of vegetables and fruit by the Swedish respondents.

In both groups, twice as much land in allotments is devoted to flower and vegetable beds as in gardens. This was not surprising since allotments traditionally mostly are used for growing fruit, flowers and vegetables. Furthermore, the gardens had three times as much area of unproductive concrete or gravel and twice as much lawn as allotments.

Regarding hours worked in the garden or allotment, there was a relationship, in both groups, between hours worked and area, which meant that people with larger areas worked proportionally less time per ha. This relationship seems odd but as suggested by Ulrich Schmutz, this could be explained by economics of scale or that people used external help which they did not include when they estimated the hours spent on gardening. It is more likely that large gardens are managed more extensively.

Concerning respondents attitude towards gardening and producing food, much more people in the Swedish group thought of it as leisure rather than work. A probable explanation for this is that English respondents actually have more areas dedicated to fruit and vegetables than people in Sweden and also produce a large proportion of their consumption. Taking care of this presumably requires more work, e.g. weeding and watering.

Self sufficiency

It is difficult to estimate what area is necessary for self sufficiency. However, it is clear that it very much depends on if you eat meat or not and what climate zone you live in. A calculation of the area necessary to be self-sufficient in vegetables and fruit should also include the area necessary to produce biomass for fertility building, storage and tool production. As mentioned previously, trials in Sweden have shown that the estimated area necessary for self-sufficiency is 0.8 ha with a vegan diet and 2.5 ha if you eat meat. It is however not clear weather this includes areas for production of biomass (green manure) and storage. In the UK it has been estimated there is about 0.1 hectare of arable farmland per person for food production (5.3 million ha arable land and 60 million people. (Davies & Schmutz, 2007; Ahnström, 2002), however the UK import a very large percentage of food and feed.

The average garden and allotment area is 1955 m^2 in the study at GO and 959 m^2 in Sweden. These are quite large areas to maintain even if the calculated average productive area in gardens and allotments are smaller, 1036 m^2 (53 %) and 350 m^2 (37 %) of this, respectively. These figures are based on what proportion of the garden/allotment likely to be devoted to vegetables and fruit, trees/orchard and bare soil (Figure 1 and 2).

By dividing the average garden and allotment area (1955 m^2) with the average household size (2.2 persons) the theoretical area available per person is 422 m^2. The same theoretical area for members at GO is 880 m^2 per person. This is closer to the estimated area needed to be self sufficient on a vegan diet (800 m^2). However, self sufficiency is of course not only dependent on the land area, it is also a lot work as well as time consuming. In the English group, people spent an average of 10 hours per week (averaged over the whole year) and grew an estimated half of their consumption. In this study, people spent an average of 9 hours per week but only produced 16 % of their consumption. In that sense it seems quite inefficient but it is hardly surprising because all of this time is not only spent growing food crops.

Considering the statistics on available garden area in Sweden (300 000 ha) there is no doubt that many people could grow at least some part of their consumption of fruit and vegetables (Edman, 2005). As is evident from the results on people's attitude towards gardening, it is seldom considered to be a work activity but rather gives people sense of well being. The health aspects of being outdoors and the exercise involved in gardening should also not be underestimated.

Inputs and outputs

The results from the ecological footprint analysis were different in many ways between the groups in England and Sweden. These differences are directly linked to their different gardening practices.

A majority (63%) of the Swedish respondents stated that they grew organically. As expected, this was not as many as in the English group were the same number was 95%. It is unlikely that all of the 63% grew organically completely according to the principles because some of the respondents said yes in the first question and later on listed that they used pesticides or artificial fertilisers. As mentioned in the English survey, people often grow their food organically but are less particular in other areas of the garden (e.g. paths and lawns) which is probably also the case in this group of people.

Tools

The amount and type of tools used were very different between English and Swedish groups. The English groups listed more types of tools that the Swedish. However, it is not certain that people actually listed all of their tools. It could be that they only listed the ones that they thought of first or the most commonly used tools. For example, none of the Swedish respondents listed that they used a bucket which can be assumed to be a fairly common tool used in a garden. Some presumably common tools were missing in the survey at GO as well which led to the conclusion that the survey should have more specifically asked for common tools (often with dual uses in the house or car like washing buckets hose pipes) and which ones of these were used for gardening only. Furthermore, people's estimation of the use of their tools and products may not be completely accurate. People who commented on this said that it was very difficult to appreciate the use and replacement time of the tools.

The analysis showed that tools are responsible for around 9 % of the gardening footprint in total (Attachment 1) compared to 12% in England. Again, it seems that the English respondents used more tools but perhaps they took more time to go through and list everything that they used. The English group also produced a lot more vegetables and fruit than the Swedish group which calls for a greater variety of tools.

In most cases, the more complex the tool is the more energy is used per year. Petrol tools use more energy than corresponding electric tools and both of them use more energy compared to manual tools. Many manual tools of good quality can last 20 or more years. This and the low maintenance requirements results in low energy costs and a small footprint. The more complex tools require less labour but have higher energy usage and have to be maintained and replaced more often (a higher repairs ratio) resulting in a bigger footprint. Fuel adds to the footprint. Bio fuels are not carbon neutral and they also have a footprint from production and processing (Davies & Schmutz, 2007).

Products

Many different products are used in the garden for fertility, nutrition and crop protection. The products used by the Swedish respondents are responsible for 26 % of the gardening footprint. This is twice as much as in the English group, where the same number was 13 %. The explanation can be found in the table of products in Table 13, where they are listed with their embedded energy costs. The number of products used is fewer in the Swedish group but there are more people using pesticides, herbicides and composted manure. This was not unexpected since the Swedish respondents did not grow organically to the same extent as the members of GO. Pesticides and herbicides are highly processed products with a large footprint.

The most common product used was compost, presumably bought in garden centres. This suggests that the transport energy cost associated with inputs are larger in this study then at GO where people used much more homemade products. Going to the garden centre to buy manure and compost results in a substantially larger footprint than if you make your own compost. Homemade compost has low transport costs and very low processing costs. However, composts do offset some greenhouse gases during the degrading process (Davies & Schmutz, 2007).

Seed is essential when growing food crops. Because seed production has an associated environmental footprint from production and transport it is a good idea to use home saved seed as much as possible. The exact energy costs associated with seed production and transport are not known but presumably not insignificant. If you are growing a lot of your food, seed is also one of the big expenses.

As the result showed, 69 % at least used some home saved seed. If members of SAS and SHS in Sweden would save even more seed, it would probably have an effect on their footprint.

Protected cropping

Protected cropping methods were a much more common among the English respondents than among the Swedish. Probably in relation to that they grow more of their own produce. They also used many different types of protected cropping.

Because very few in the Swedish group used protected cropping, it only represents 2 % of the gardening footprint, including heating costs. In the English group the same number was 18 %.

Protective structures such as polytunnels and glasshouses have high embedded energy costs and adding to that are running costs when they are heated. The high energy costs are due to the long supply chains of the materials. However, glass structures have a longer lifespan than plastic structures which have to be replaced more often. Larger amounts of waste generate increased transport and destruction costs. Plastic as a material also has a large footprint because it consumes non-renewable resources. Even recycled plastics have an embedded energy cost which should be accounted for (Davies & Schmutz, 2007).

Storage

Storage is very important when growing your own food. Most people (64%) answered that they both used a fridge and a freezer (big or small).

In this study storage represents 22 % of the gardening footprint which is a substantial part (Attachment 1). However, at GO it represented as much as 55 % of the gardening footprint and as a result had the most influence on the total gardening footprint (Attachment 2). Presumably, this is a consequence of the fact that Swedish respondents did not grow as much food as the English and therefore did not have the same need for storage.

In the calculation it was assumed that people also used the fridges and freezers to store other things than their own produce and that bulk items such as apples, potatoes and carrots were stored somewhere else. Therefore, only between 10 and 70% of the footprint costs were allocated to fridges and freezers used for home production (Davies & Schmutz, 2007).

The way you choose to store your produce is of utmost importance when trying to reduce your footprint. Freezers and fridges, especially older ones, consume a lot of energy. They have high running cost as well as high manufacturing costs. Therefore replacing your old fridge or freezer with the latest high insulated A++ rated model can make a big difference.

According to findings made by Davies & Schmutz (2007) fridges typically consume 3.5% of the total household energy in the UK but are getting better. In Sweden, they consume 4% of electricity in a house and 8% in a flat. These numbers are based on percentage of total electricity consumption including heating, hot water and household electricity. When looking strictly at the percentage of household electricity, freezers and fridges consume 20% in a house and 40% in a flat (EON [online], 2009).

Having a big freezer, in e.g. a holiday house, which runs all year round, is something that should be avoided. Even if you do have a newer model there is a footprint attached to it from production and manufacturing due to the embedded energy and resources that goes in to that process.

The best way to decrease the footprint associated with storage seems to be to use alternative cold storage methods, when possible.
Cooking does have an ecological footprint attached to it. However, it is unclear how big it really is.

Transport

When going through the different areas of the calculation (Attachment 1 and 2) it is clear that the most noticeable difference between the groups is in transport. The distance that Swedish respondents travelled by car to the site of their garden or allotment was 25 times larger (856 km/year) compared to England (33 km/year). As a result, transport is responsible for around 42% of the total gardening footprint in this study compared to 2% among the members of Garden Organic who mostly grew on site or very close to home.

The main reason for the difference is the number of Swedish respondents (10%) who have a summer or holiday house. None of the English respondents mentioned that they had a summer house compared to 9 of the Swedish. A few of the houses were as far as 100-110 km away from their permanent home. Transport costs of going to garden centres to buy the inputs are not included in the energy cost.

Adding to the footprint was also probably a slight overestimation of the number of times people went to the site of production. When people were asked to estimate how many times per month they went, they often seemed to think about how often they went during spring and summertime. Therefore, the number of times people went per year may have been exaggerated and should in fact be lower. The question should perhaps have been rephrased to get a more accurate answer.

Transport in this case represents the cost of getting to and from the site of production. Costs of going to garden centres to buy the inputs are not included in the energy cost. They were assumed to be small, but are included in the manufacture and delivery costs (based on weight and postage of tool) in the original study in at Garden Organic. However, by looking at the large amounts of composted manure and compost used by Swedish respondents and the fact that fewer people in the Swedish group use home made products, it may be assumed that this cost would be higher in this study (Davies & Schmutz, 2007).

Because of the fact that some of the respondents in Sweden had holiday houses contributing to increased car use compared to the respondents in England, two versions of the footprint analysis in Sweden is included. One is based on that the distance travelled by car is solely (100%) for the purpose of gardening, as in the calculation made at GO. The other one is based on that the distance travelled by car is only partly (20%) for the purpose of gardening (Attachment 3). It can be argued that 20% of the distance travelled would be a more realistic assumption because the car is not only used for the sole purpose of gardening when driven to a holiday house. Including both versions also visualises the large effect that car use has on the garden footprint. Nevertheless, even if the footprint generated from of going by car to your holiday house, is much bigger compared to a cycling holiday it is a better option than a long-distance flight or even a long-distance car holiday.

Compost

Most people (74 %) in this study as well as in England (99 %) composted garden waste. However, when it came to composting kitchen waste and other biodegradable waste, the Swedish respondents were far behind. 40 % compared to 100 % composted kitchen waste and only 12 % compared to 87 % stated that they composted other biodegradable household waste. This difference may partly be explained by the fact that 95 % of members of garden grow organically and composting is an important part of that.

When it comes to the ecological footprint of composting, it is not completely known and opinions on the matter differ. All material that comes from other sources than the garden basically has an associated footprint. The question is if composting can in fact increase or decrease the footprint, or if it is simply neutral.

The aerobic degrading process of composting does produce CO_2, but if the plant material was produced without inputs it could be argued that is carbon neutral.

Scientists agree on that composting emits much less green house gas (GHG) than landfilling. By composting at home, the organic material is not transported and does not risk ending up in landfill where it would be degraded anaerobically to produce methane. Even municipal composting from a green bin collection scheme requires fossil fuel energy for transport, processing and redistribution (Lou & Nair, 2008; Davies & Schmutz, 2007).

The GHG emissions from the composting process are highly dependent on the feedstock and higher dissolved organic carbon rates result in higher GHG emissions. On the other hand, waste with lower rates of dissolved organic carbon take longer to decompose.

In municipal waste management, fuel consuming machinery is used when managing composts which contribute to the emission of GHG. Some argue that this is the only significant source of GHG emissions and that the GHG emissions from the actual decomposition process are negligible (Lou & Nair, 2008).

Indirectly, the production of compost can actually help to decrease GHG. For example by reducing the need of inorganic fertilisers and thereby the GHG emissions from the fossil fuel used in production and application; by allowing more rapid growth in plants which increase carbon uptake and remove it from the atmosphere and by improving soil structure and thereby reducing emissions from fossil fuel from tillage machinery. However, although all of these processes have been recognised, they have not been quantified (AESA, 2001; Lou & Nair, 2008).

In, England, this is an area of ongoing government funded research and at Garden Organic, the aim is to investigate it further. Indisputably, there are many very important benefits with composting your garden and household waste. Composting it is invaluable for improving soil conditions, increasing soil organic matter and biological activity and by composting at home, unnecessary waste transport is avoided.

At GO, it is concluded that research is needed on how this diversion of general and kitchen waste in the municipal collection compares home composting in how it affects the gardening footprint. They suggest that the assumption could be that increased home composting is positive for the general footprint even if municipal waste is processed into biogas.

Water use

The average water volume was 14.1 m^3 per year which was quite a bit more than in the English group where the average volume was 9.8 m^3 per year but perhaps not surprising considering that they also used rainwater to a much greater extent and refrained from watering their lawns. On the other hand, the results on average volume from this study may not be as reliable as the in English study considering that many more people (82) answered this question. In the Swedish group more than half of the respondents (53%) used rainwater. Using rainwater is good because it has no carbon footprint except for the storage and collecting devices. However, from a hygiene point of view, grey water should not be stored but used immediately and it is important to make sure that it cannot backflow into the mains water (Davies & Schmutz, 2007).

71% of respondents in Sweden watered their vegetables compared to 97 % at GO. One of the reasons that fewer people watered their vegetables in the Swedish group could naturally be that not as many grow vegetables. The other reason possibly is climate difference. Despite common belief, the average rainfall in the English growing season can be low (500-600 mm) and commercial and home gardeners have to use irrigation routinely for successful cropping. Cleaning and distribution of water is not yet considered in the ecological footprint, but as mentioned by Davies & Schmutz (2007), the water use in gardening is probably negligible compared to the use in agriculture, industries and other personal uses, especially with the high use of rain and grey-water collection in the GO sample. The use of grey-water and rainwater should be encouraged because it can reduce the use of this important resource.

Production and consumption

The proportion of the ecological footprint associated with production is lower (36%) in this study than at Garden Organic (43%). This can be linked to the fact that only 61% grew fruit and vegetables compared to 93% in the English group. Because they grow more food than Swedish respondents they also use more tools, products and protected cropping methods.

However, while the amount of tools and products used by Swedish respondents is smaller, the proportion of the footprint associated with products is twice as high as in the study at Garden Organic (Attachments 1 and 2). The explanation for this could possibly be found in that 63 % of the Swedish respondents reported that they grew organically compared to 90% of the English. This shows in the footprint analysis because the use of pesticides, herbicides, artificial fertilisers and other highly processed and transported products has high energy costs and thus increases the footprint of products used. An example of this is that 36% of energy use in U.S. agriculture is related to manufacture of inorganic fertilisers and pesticides. Because of this organic farms use comparatively less energy (Niggli *et al.*, 2008).

These results show that by adopting more organic methods like the English sample, Swedish gardeners could potentially cut their product input footprint in half.

Furthermore, 24 % of the Swedish respondents reported that they eat their own produce daily, 44 % weekly and 32 % monthly which differed from England where most people eat their own produce daily (60%) and very few eat their own produce monthly (6%). However, the results may perhaps be a bit misleading considering that many people may have had their consumption in summertime and not per year in mind when answering this question.

The most common vegetables that people grew (potatoes, salads, tomatoes and peas/bean) met between 17 to 36% of their consumption. The most common crops grown were almost the same in England. Although growing squashes, sweet corn and pepper was much more common, because of the milder climate in England. Respondents in Sweden were from many places in the country.

The Swedish respondents only estimated that they produced around 16% of their consumption of fruit and vegetables compared to members of Garden Organic who estimated that they produced around 52 % of their consumption of fruit and vegetables. At Garden Organic, these results were compared with the footprint of buying the equivalent quantity of fruit and vegetables in the supermarket. This comparison showed that growing your own fruit and vegetables results in a 13 % reduction of your footprint. Unfortunately, corresponding information on the footprint buying your consumption of fruit and vegetables in Sweden was difficult to find (Davies & Schmutz, 2007).

Savings

Due to lack of data the estimated savings could not be included in the results of this thesis. However, as in England, many people remarked that this was very difficult to estimate and that saving money was not the reason why they grew their own fruit and vegetables. 8 people also did not think that they saved any money at all. People were clear on that the real motivation was that it made them feel good.

The methodology

Ecological footprinting

Starting with the disadvantages, the process of ecological footprinting where environmental effects and resources use are transformed into area units is often complicated. The lack of conversion factors makes recalculation of resources difficult. However, the basic limitation of the method, which is still somewhat incomplete, is that it only shows *part* of a person's, city's or a process' total claim on the bio productive area and that a footprint only gives a momentary measure of the situation, a snapshot in time. There may also be different interpretations of the definitions of sustainable land use. Another disadvantage is that the emission outputs are mostly represented by CO_2 emissions, leaving out all other greenhouse gases. Furthermore, nature's services are not included. Altogether, this indicates that the footprints often are an underestimation of reality and that it can be argued to be inaccurate (Moberg *et al*., 1999).

Wackernagel and Rees suggest that the losses of bio productivity and land due to the thinning of the ozone layer and contamination caused by waste should be included in foot printing. They name the biggest shortages; "lack of accurate data for sustainable production, shortages in managing of waste and emissions, effects of recycling".(Moberg *et al*., 1999).

There are several methods available for investigating sustainable development and environmental aspects and it is always a good idea to use a combination of methods. No concept or tool has the ability to cover everything. If only one single method is used, it is important to bring awareness of the possible shortages, disadvantages and of assumptions that have been made.

The Global Footprint Network takes a similar approach as they point out that the ecological footprint measure does not cover all aspects of sustainability and should therefore always be complemented by other measures (Moberg *et al*., 1999; Global Footprint Network, 2008).

On the positive side is that footprint calculations provide valuable information about how human activities fit within the regenerative capacity of the planet and help us to reflect on how dependent humanity is of the surrounding ecosystems. Furthermore, the ecological footprint methodology does produce pedagogic and comprehensible results, which are useful in education and to bring awareness of our impact (Global Footprint Network, 2008; Moberg *et al.,* 1999; Baumann & Cowell, 1998).

In this study, the ecological footprinting method has been used with the objective of bringing awareness of one's lifestyle and to inspire people to live and tend to their gardens in a more sustainable way. The most important thing is not how perfect and accurate the method is but how it can assist in the process of making better choices. A lot can still be achieved without a perfect manual.

The study has shown the relative magnitude of inputs like car use, organic versus non-organic methods, mechanical versus fossil-fuel tools, home composting versus shopping for bulk materials and of various storage options. Consequently, it is possible to show which input to change first as well as the likely magnitude, not 100%-accuracy, of the effect on the carbon and ecological footprint.

The Garden Organic calculation model

The calculation model developed at Garden Organic works well considering that it presumably is the first attempt to investigate the ecological footprint solely of gardening and home food production. For this reason the focus was mainly on developing thinking and methodology. However, as the calculation is based on figures from one previous study on energy use of organic farms, it would be possible to argue that the basis is somewhat insufficient. Preferably, the calculation should be based on figures from multiple sources in order to increase the reliability of the results. It would also have been interesting to include corresponding data on carbon footprints from conventional farms.

It should be mentioned that in 2006-07, when Garden Organic conducted the study, less information was available. For example, when B&Q (the UK's largest retailer for garden products) was approached by GO researchers asking for information on the carbon footprint of their tools. The answer they got was "we don't know, but we would be interested if you could tell us". Full carbon labelling on tools would help consumers to make better choices.

Conclusion

This study is based on a survey with people's personal estimates and exploits a new practice for calculating garden footprints. Therefore these results are indicative and should be interpreted as such. However, the study does provide valuable information about how it is possible to reduce your gardening footprint and what areas to focus on. Furthermore, it offers insight into the gardening habits of two very different groups of people in Sweden and in England with gardening as a common interest. One group consists of members of an organisation with a very clear organic profile in England and the other group consists of members of the two largest organisations for gardening in Sweden. This of course showed in the results.

To conclude, the main strategies to reduce your garden footprint seem to be:

- Reduce car use to go to and from the place where you grow.
- Use homemade fertilizers and pesticides (e.g. comfrey, nettle liquid, soap) and manual weed control tools.
- Try to eat your produce fresh or store it in alternative cool dry storages or a less energy consuming fridge/freezer.
- Compost and recycle instead of buying compost at a garden centre.
- Use rain and grey water instead of tap water.
- Save seeds.
- Use mechanical tools instead of fossil-fuel driven.
- Use quality tools with last very long and need little repair, buy used tools if possible.

The ecological footprint presented here is the calculated average footprint for all replies from the survey in Sweden. It would in principle be possible to also calculate a footprint for each individual reply. However, during the process of working with this project at Garden Organic it became clear that more time, resources and funding was needed which was not available at the time. Because of this it was decided that the focus should be on developing thinking and methodology. As the work performed at Garden Organic serves as a basis for this study and because of the time limit, the same approach is chosen here. Nevertheless, the results from this study will be able to give the members of SHS and SAS, who participated, a rough idea of the footprint generated by their gardening and an understanding of which areas that mainly affect the footprint. As in the original aim at Garden Organic, these results could provide the necessary tools to help people limit their garden footprint as well as their overall ecological footprint. Furthermore, it hopefully can promote further funding to investigate the environmental effects of gardening and growing your own food.

The conclusion made from the study in England was that growing your own fruit and vegetables could potentially be a valuable part of the solution to the ecological problems that we face. In addition, they found that as a group, organic gardeners tend to be more environmentally aware and often take other footprint reducing measures. Because of this, their savings often reach further than the ones directly related to production (Davies & Schmutz, 2008).

As for suggestions for further research, it would be interesting to be able to include detailed figures for composting and water use into the calculation. It would also be interesting to further develop the calculation model as well as studying the environmental effects of gardening and home food production using life cycle analysis.

It seems that the interest for gardening is increasing in Sweden today. If more people were aware of the environmental benefits that come with gardening and growing your own food there is a possibility that it would increase even more. As of today, not much of the actual garden area is used for growing food but perhaps this could change with increased information and encouragement from policy makers. This thesis has tried to show how to produce food in your garden without an increased use of resources.

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Attachments

Attachment 1: Overview Sweden. Members gardening footprint with 100 % car use

Activity	Energy use		CO_2 Component of Ecological Footprint		Ecological Footprint	Proportion Footprint	
Production	MJ/year	MJ/ha	CO2 t/ha	CO2 t/person	gha/ha		36%
Tools	562	5860	0,457	0,020	0,183	9%	
Products (seed, fertiliser, pest control)	1671	17428	1,359	0,059	0,544	26%	
Protected cropping manufacture	105	1097	0,086	0,004	0,034	2%	
Protected cropping heating	4	46	0,007	0,000	0,003	0%	
Storage							22%
Jam, bottling, pickling jars	6	61	0,005	0,000	0,002	0%	
Freezer & fridges	40	414	0,032	0,001	0,013	1%	
(manufacture)	741	7724	1,128	0,049	0,451	21%	
Freezer & fridges (electricity)							
Transport							42%
Average bicycle	6	63	0,005	0,000	0,002	0,1%	
Average car	856 km/year	*0,2116**	2,206	0,095	0,883	42%	
Waste and Recycling	0	0	0	0	0	0%	
Rain and grey water use	0	0	0	0	0	0%	
Composting garden waste	0	0	0	0	0	0%	
Composting kitchen waste	0	0	0	0	0	0%	
Composting house waste	0	0	0	0	0	0%	
		Sum	5,285	**0,228**	2,114		
Average area	*959 m^2*						
Average household size	*2,22 persons*						

* t/CO2 per year

Attachment 2: Overview England. Members gardening footprint with 100 % car use

Activity	Energy use		CO_2 Component of Ecological Footprint		Ecological Footprint	Proportion Footprint	
Production	MJ/year	MJ/ha	CO2 t/ha	CO2 t/person	gha/ha		43%
Tools	511	2614	0,204	0,018	0,082	12%	
Products (seed, fertiliser, pest control)	564	2886	0,225	0,019	0,09	13%	
Protected cropping manufacture	561	2873	0,224	0,019	0,09	13%	
Protected cropping heating	117	600	0,088	0,008	0,035	5%	
Storage							55%
Jam, bottling, pickling jars	73	375	0,029	0,003	0.012	2%	
Freezer & fridges (manufacture)	64	325	0,025	0,002	0.010	1%	
Freezer & fridges (electricity)	1178	6028	0,88	0,076	0.352	51%	
Transport							2%
Average bicycle	3	14	0,001	0	0,0004	0,1%	
Average car	33 km/year	*0,0065**	0,033	0,003	13	2%	
Waste and Recycling							0%
Rain and grey water use	0	0	0	0	0	0%	
Composting garden waste	0	0	0	0	0	0%	
Composting kitchen waste	0	0	0	0	0	0%	
Composting house waste	0	0	0	0	0	0%	
		Sum	1.71	**0.147**	0.684		
Average area	*1955 m^2*						
Average household size	*2.27 persons*						

* t/CO2 per year

Attachment 3: Overview Sweden. Members gardening footprint with 20 % car use

Activity	Energy use		CO_2 Component of Ecological Footprint		Ecological Footprint	Proportion Footprint	
Production	MJ/year	MJ/ha	CO2 t/ha	CO2 t/person	gha/ha		54%
Tools	562	5860	0,457	0,020	0,183	13%	
Products (seed, fertiliser, pest control)	1671	17428	1,359	0,059	0,544	39%	
Protected cropping manufacture	105	1097	0,086	0,004	0,034	2%	
Protected cropping heating	4	46	0,007	0,000	0,003	0%	
Storage							33%
Jam, bottling, pickling jars	6	61	0,005	0,000	0,002	0%	
Freezer & fridges (manufacture)	40	414	0,032	0,001	0,013	1%	
Freezer & fridges (electricity)	741	7724	1,128	0,049	0,451	32%	
Transport							13%
Average bicycle	6	63	0,005	0,000	0,002	0,1%	
Average car	171 km/year	*0,0423**	0,441	0,019	0,177	13%	
Waste and Recycling							0%
Rain and grey water use	0	0	0	0	0	0%	
Composting garden waste	0	0	0	0	0	0%	
Composting kitchen waste	0	0	0	0	0	0%	
Composting house waste	0	0	0	0	0	0%	
		Sum	3,520	**0,152**	1,408		
Average area	*959 m^2*						
Average household size	*2,22 persons*						

* t/CO2 per year

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