LiveWell for Life

A balance of healthy and sustainable food choices for
France, Spain, and Sweden

Final Report

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Foreword

> for WWF/Duncan?

Executive Summary

There is increasing recognition of the environmental impact of food and drink. This leads to proposals that that food policy and dietary advice need to go beyond their traditional focus on nutrient contents of food and include consideration of environmental impacts. Balancing environmental, economic and social aspects with those of nutrition and diet adds complexity to the establishment of nutritional guidelines.

This report builds on the work done in the UK that led to the LiveWell diet recommendations, representing a balance between healthy and sustainable food choices, with sustainability defined only in terms of greenhouse gas emissions (GHGe). It was agreed to extend this approach to a further three countries – France, Spain, and Sweden – to determine whether it is possible to develop corresponding diet recommendations in these three countries, and to analyse the difficulties of integrating data from multiple sources to see whether these countries can be used as pilots for work elsewhere.

The key question addressed in this report is whether it is possible, in each of the countries, to develop a "LiveWell" diet which decreases greenhouse gas emissions by 25% from the current average[1], costs no more, meets national nutritional guidelines, and still resembles current diets sufficiently to be widely and easily accepted.

To answer this question we used a similar approach to that adopted for LiveWell UK – collating data on current consumption patterns, nutritional recommendations, public dietary guidance, greenhouse gas emissions of particular foods, and general price information. The quality and completeness of the data varied between the countries and we have had to make appropriate assumptions in order to come to a response. Nonetheless, through modelling we have sought to demonstrate that, for all three countries

- Moves towards healthier eating can align with environmental objectives.
- A healthy and sustainable diet does not necessarily cost more than the existing diet
- A healthy diet which costs no more than current amounts and reduces greenhouse gas emissions by 25% is possible and can be developed in a way which would be acceptable to a large proportion of the population (i.e. not too far from current consumption patterns).

Our analysis substantiates all these points and we can state, specifically:

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1 Livewell UK based its reduction on 25% taking into account projected growth in population. Owing to lack of clarity in projections, in this report the 25% does not take population changes into account i.e. it is per capita rather than for the country as a whole

1. For all three countries it is possible to produce a healthy and sustainable diet[2]. In all cases it was possible to produce a diet which reduced GHG emissions by more than 25%, although there has to be compromise regarding acceptability. Whilst recognising the limitations of the methodology, the wide reductions possible demonstrate that food choices can have a real effect.
2. A healthy sustainable diet does not have to be an expensive one. Indeed, in all the general analysis, cost was not a binding constraint and only came into play in terms of choosing "acceptable" foods for the consumer. This is important because cost is often seen as a factor in consumers not adopting healthy and sustainable eating.
3. At the extreme, the modelling shows that GHG emissions could probably be reduced by more than 50% through choice of foods, whilst still complying with nutritional recommendations. However, such a reduction would be at the expense of acceptability – a diet with 50% GHG reductions would be relatively unrecognisable to most consumers.
4. We have demonstrated that for all three countries a LiveWell diet is possible - one where nutritional recommendations are complied with, GHG emissions are reduced by 25%, and the choice of foodstuffs is as acceptable as possible. We have made our research concrete by illustrating the LiveWell diet with a weekly shopping list and sample menu. This shows that with such a diet the majority of meals and the general meal patterns can still be recognisable, even though the composition has changed.

Examination of the three sample menus (and the corresponding work for Livewell UK) shows that there is considerable scope for variation and for adapting the diet for reasons of acceptability to consumers. The samples we have produced are just that: samples. They should not be taken as recommendations for a strict diet but rather give guidance on what direction dietary changes have to take in order to reduce GHG. Comparison between the three countries can be invidious and can easily become a comparison of cuisine and eating habits rather than balancing health, cost and sustainability. Nonetheless, a number of overall similarities between these nutritious low GHGe diets can be observed:

1. All diets show a reduction in the total amount consumed of foods in the meat group. This is inevitable since these are the foods with the highest GHG emissions. On the other hand, we demonstrate that for a 25% reduction it is still possible to have a certain amount of meat and/or fish in the diet, sufficient to comply with nutritional recommendations and to ensure that there are some traditional dishes and meal patterns.
2. As sources of protein all diets show an increase in the consumption of legumes. This again is inevitable owing to the lower GHG emissions of legumes relative to most other sources of protein, even if they are imported long distances. In addition, this may help to keep the food budget constant or even to decrease it because legumes are not costly.
3. All diets show an increase in cereals and starchy foods, typically represented by increases in bread, pasta and potatoes.

2 sustainability here relating to reducing GHG emissions only

4. Levels of consumption of dairy products remain relatively similar to current consumption.

We emphasise that the sample diets are based on a view related to the acceptability of a diet which can be created from the list of ingredients produced as the result of a mathematical model. Different assumptions about an acceptable diet could have produced different diets - for example it would be possible to run the model excluding meat altogether for vegetarians.

This first piece of research demonstrates that healthy sustainable food choices are possible in a variety of different countries, and can be adapted to make them acceptable in a variety of different contexts. But it also points to further research and analysis which should be done to make this work more precise and assist in guidance to stakeholders. In particular we suggest:

- Better GHG and LCA data would assist in modelling and giving precise guidance
- Research into other factors which can affect the degree to which GHG emissions can be reduced – for example, eating seasonal foods, and different ways of preparing food (including, for example, the effect of this on bio-availability of nutrients). These are complex factors which our modelling could not take into account
- Further research on the effect of such diets on supply and pricing, including how this should affect subsidy systems for farmers. We note that there are connections between supply of different items (e.g. connection between meat and diary production) which would need to be taken into account.
- Consideration of minority and regional diets, or even individual diets, rather than looking at a single sample diet for each country.
- Research into the consequences of taking wider sustainability criteria (water, biodiversity) into account and into possible technological approaches to reducing GHG not based on current consumption patterns (i.e. in production and distribution of food).

Glossary

ANSES	French agency for food, environmental and occupational health safety
BEDCA	Database of Spanish Food Composition
CAP	Common Agricultural Policy
CPI	Consumer Price Index
ENIDE	National Survey of Dietary Intake [Spain]
EU	European Union
FAO	Food and Agriculture Organisation
FBDG	Food-based dietary guidelines
GHG	Greenhouse Gases
GHGe	Greenhouse Gas emissions
HBS	Household Budget Survey
HLCWG	“How Low Can We Go” report
INCA	Individual and National Survey on Food Consumption [France]
LCA	Life Cycle Analysis
PNNS	National Health and Nutrition Programme [France]
RDA	Recommended Daily Allowance
RDC	Regional Distribution Centre
SIK	Swedish Institute for Food and Biotechnology
SNO	Swedish Nutritional Recommendations Objectified
SNR	Swedish Nutritional Recommendations
WWF	World Wildlife Fund

Introduction

We realise that this report has a number of different audiences. On the one hand, this is a research project and we wish to give full details of the methodology and assumptions made, but on the other hand many people will just want to look at the diet for a particular country and compare it with what they or others eat now. To cater for both audiences, the report is divided into the following sections:

1. Background and research questions. This explains the background to the project, including the Livewell UK project, and the key questions which we have sought to answer.
2. Methodology. This explains the general approach we used and the ways in which we adapted data for the purposes of dietary modelling.
3. The Livewell Diet. This gives a diet for each country based on a 25% reduction in GHG emissions. For each diet we show the list of ingredients (compared against current consumption), a sample menu, nutritional data against average consumption and national nutritional recommendations, and comparison of consumption of different food groups between current consumption, the Livewell diet, and the maximum possible through choice of foods. For ease of reading, sample shopping lists and details of ingredients for individual dishes are put in Annexes.
4. Analysis. This section gives greater detail in the assumptions made and the ways we approached data in different countries, including some specific national issues.
5. Conclusions from this work, both in terms of the answers to the key research questions and with regard to potential further research work.

The report has the following annexes for reference:

1. Shopping lists for the Livewell diets
2. Detailed ingredients for the Livewell menus
3. Extreme diets – maximum possible GHG reductions
4. Detailed methodology for collating data
5. Sensitivity analysis
6. National nutritional recommendations (from Task 1)
7. Project brief
8. References

1. Background and Research Questions

1.1 WWF's One Planet Food Programme and the Livewell Diet for the UK

WWF UK's One Planet Food Programme is a programme of work running from 2009-2015 which supports environmental and social justice by safeguarding the natural world, tackling climate change, and changing the way we live. The 2050 goals of the One Planet Food Programme are to:

- reduce greenhouse gas (GHG) emissions resulting from the production and consumption of food destined for the UK by 70% based on 1990 levels
- ensure that water usage in the production and consumption of food destined for the UK has no unacceptable socio-economic or environmental impacts and
- change trading patterns and governance structures so that UK food is making a net positive contribution to WWF's priority biodiversity places, such as the Amazon.

The concept of a "Sustainable Diet" has stimulated debate about how changes in the UK diet may go some way towards achieving these goals. It is clear that any work on diet needs to look beyond the environment and include the potential benefits to health, society, the economy and developing countries.

Between 2010 and 2011 WWF UK commissioned the Rowett Institute of Nutrition and Health at Aberdeen University to define a more carbon-sustainable diet and produce the Livewell Plate. This work was framed by the following 3 questions:

1. What does the average UK consumer eat and what would change if we were to follow the recommendations of the Eatwell plate[3]?
2. What would be the sustainability benefits of following the Eatwell plate guidance and how can sustainability criteria be integrated into this and would the plate need to be modified?
3. What would be the key principles of a sustainable diet?

The overall objective of the UK Livewell project was to construct a 7-day diet with significantly lower greenhouse gas emissions (GHGE) than the average current UK diet, while also meeting dietary requirements for health.

Linear programming was used to construct a sample diet that minimised GHGE while still meeting food, energy and nutrient requirements for an adult woman in the UK. Nutrient composition and GHGE data for 82 different food items were used, and to ensure a realistic variety and balance of food items consumer acceptability

3 The Eatwell plate embodies the UK government's food-based dietary guidelines in the form of a plate where the size of sectors represents the recommended consumption of different food groups.

constraints were placed on the model to limit the amount of each food group included in the diet.

A 7-day sample diet was created that met dietary requirements and achieved a significant reduction in GHGE. It was possible to incorporate a wide variety of food without eliminating any food groups (e.g. meat, dairy products) but the quantities of some foods were reduced compared to the current diet. The retail cost of the diet was comparable to the average UK expenditure on food.

The Livewell study for the UK illustrated that many of the principles of a healthy diet are consistent with the dietary changes needed to reduce GHGE to tackle climate change. Individual food groups do not need to be eliminated, but the range and quantities of food need to be rebalanced to benefit health and the environment.

1.2 LiveWell for Low Impact Food in Europe (LIFE)

The LiveWell for LIFE project seeks to demonstrate the LiveWell Plate as a tool to define country-specific sustainable diets across the EU. Recognising the contribution of the food system to GHG emissions, the project regards moves towards sustainable diets across the EU as an important contribution towards stabilising GHG concentration at a level that prevents global warming above 2°C. The project examines the feasibility of EU-wide introduction of the LiveWell Plate by testing and evaluating the tool in three pilot EU Member States – Sweden, Spain and France. These countries have been chosen due to the range of dietary contexts they represent and the different levels of policy readiness for adopting the sustainable diets concept. Monitoring and evaluation (M&E) of the LiveWell Plate and of the methodology used for its application will be embedded in all demonstration actions. The establishment and capacity building of the European network of food stakeholders is a key component of the project, essential to the project's longer term impact. The ultimate aim of the LiveWell for LIFE programme is to facilitate a conducive policy environment and influence European legislation by the development of policy pathways and disseminating this widely across the EU.

The Livewell 2020 Plate produced for the UK sets out a diet that will reduce GHG emissions from the UK food supply chain by 25% (based on 1990 levels) by 2020. At present, the LiveWell plates developed for the pilot countries (France, Spain and Sweden) would provide for the same 25% reduction in GHG emissions from the pilot countries' food chains by 2020. As the pilot countries are large food producers this will contribute significantly towards the EC's overall target of a 20% reduction in overall GHG's by 2020.

The project brief is shown in Annex 7

1.3 Key Research Questions

In using this report it is important to keep in mind that:

- The work addresses all three countries separately.
- *Sustainable* refers only to greenhouse gases (GHG): specifically reduction from present levels of emission from the average diet unless a figure is given.
- *Economic* refers to estimated costs of the diet, specifically reduction from the estimated costs of the average diet unless a figure is given,
- *Minimising change* means that the diet is as close to the current average diet as is possible (we consider how to define this later)
- *Viable change of diet* means that the change in diet is one which is acceptable to most consumers (we consider how to define this later)

In order to make the research specific, we sought to define a set of research questions which we should be able to answer. These are as follows:

A. Can a healthy diet be environmentally sustainable?
Is it possible to comply with national health guidelines while reducing GHG?
Most health guidelines include a reduction in meat consumption which is the major cause of source of GHG (e.g. UK figures show meat, dairy and eggs account for around one third of the diet in terms of energy and two thirds of production GHG emissions). However, not all dietary guidelines explicitly advise reductions in meat consumption. In particular, the French dietary guidelines advise the consumption of 1 to 2 (at least 1, max 2) portion sizes per day of meat or fish or poultry or egg. Also to note that unlike in the UK and US guidelines, nuts and legumes are not included in this group of "protein-rich" foods. In addition, we hypothesize that it is possible to conceive healthy diets with high GHG emissions (e.g. living on exotic fruit and vegetables, higher quantities of white meat and fish) and therefore our model needs to demonstrate that it is not the case with the proposed diet.

B. Can a diet be healthy, economic and respect the environment?
Previous studies have shown that it is difficult to eat healthily on a low budget but that it is possible by selecting specifically foods with the high nutritional quality to price ratio (see reference 3). In this study, we identify food choices that reconcile healthily eating with cost-conscience household budgeting, while reducing environmental impacts from the food system. In making this static analysis we do not consider the effects of supply and demand of the whole population adopting a different diet (e.g. changing prices of foodstuffs due to demand and availability of subsidies). Pricing and the market for food is a complex subject which is beyond the scope of this report.

C. What is the lowest level of GHG emissions that may be reached while fulfilling nutritional recommendations and not increasing diet cost?
What diet would reduce GHG emissions while following health guidelines? What would be the diet following health guidelines which minimises GHG and does not increase costs?
Such a diet will almost certainly have a limited variety of specific foods and at the same time be relatively cheap. On the other hand, it will at the same time be almost certainly unappetising and a long distance from current diets. Nonetheless, we will

seek to identify this as a benchmark to show the limits of minimising GHG through food choices in the current environment.

D. What would be a healthy sustainable diet which reduces GHG by 25% and minimises change from the current diet?
This is a major part of the work and results in a recommended distribution of foods as the LiveWell plate for each country.

E. How can we show consumers that this is a viable change in diet?
This is done by producing sample menus based on the current typical diet but fulfilling the restrictions created by D.

F. What are the general implications?
In view of the fact that this is a first piece of research, we also review briefly some of the issues as noted in the terms of reference and indicate trends and need for further research.

Defining *minimising change*
This clearly caused some difficulties for the original LiveWell plate and their experience suggested that the creation of a function representing objective change from the current diet is not simple and some degree of iteration and testing was necessary. Therefore in addition we created upper and lower bounds based on factors including: popularity of foodstuffs (i.e. not excluding the most popular items), portion sizes (avoiding small amounts of items which can only be bought as units), cultural preferences (potatoes vs pasta vs rice as a source of carbohydrate), avoiding introducing large amounts of currently unpopular foods, and ensuring that there is an appropriate degree of variety.

We used two different approaches for balancing acceptability with other factors. For France, minimisation of the change from current food intake patterns was conducted following a previously described methodology (see references 7 and 12). and only limited additional bounds were then imposed. For Spain and Sweden, we used more general bounds based on popularity and minimum portion sizes and then imposed additional constraints based on discussion with dieticians in order to produce an acceptable menu.

Defining *viable change of diet*
The purpose here is to examine if a healthy economic diet with GHG emissions reduced by 25% can be produced using largely menus which are currently part of a typical diet (albeit with changed recipes, e.g. less meat). We have produced a sample weekly menu for each country based on these constraints. The sample menu is designed to be an example of how the diet can be made objective and is to be seen as a demonstration rather than a recommendation or guideline.

2. Methodology

2.1 General Approach

Our general approach followed the methodology developed by Livewell UK. This had three stages, as follows:

1. Collation of relevant data
2. Production of a model, including creation of appropriate constraints
3. Derivation of a shopping list and sample menu

The sources for data and detailed approaches differ for each country and are explained in the analysis section. However, we used a basic approach described below.

2.1.1 Collation of data

The following data was gathered:

1. Dietary data – showing an average diet for the country and, if possible indications of popularity of particular items (percentage of the population eating a particular food item, standard deviation of consumptions as well as just the average). The data was produced by a separate contract ("Task 1") and we did not need to supplement this.
2. Information on national nutritional recommendations – again this was provided by Task 1 and we did not need to supplement it. However, we note that for some trace elements (e.g. iodine) nutritional data can be unreliable so we considered carefully which items should be part of the model. National nutritional recommendations (provided by Task 1) are presented in annex 6
3. National nutritional data – again provided by Task 1. This required a certain amount of processing because there was not data for all items and therefore substituted data from other countries had to be used, or in some cases there was missing data on particular nutrients. In addition, estimates had to be made for wider categories (for example "fish" in the Swedish dietary survey) based on other information regarding composition or derivation. Additional processing and merging databases was a particular issue for Spain owing to the wide range of specific foods identified in the dietary survey.
4. GHGe data. For this we tried where possible to use GHGe/LCA data from studies conducted for the particular country. Where this was not possible we used data from countries with the most similar GHGe patterns where possible (for example, UK in preference to France for Sweden, France in preference to UK for Spain). When using UK data (specifically HLCWG data) consideration was given to different trading patterns in estimating GHG emissions. Where there were several studies showing data to different stages of the life cycle (RDC, retail, final consumer), multiplications were made to ensure consistency between the figures. The result is a set of GHGe figures where the *relative* values are more reliable than the absolute values. For Sweden the figures estimate the GHG emission for the full cycle to the consumer, whereas for

France and Spain figures are to retail. It seemed pointless to estimate an additional multiplication factor which would not affect the relative values. Finally, for highly processed items where there was no national data, we used data presented by Eat England, based on UK experience, since in a global market place such goods are likely to have a similar profile across Europe, certainly in terms of relative values.

5. Price data. For France we were able to access detailed price data, but for Sweden and Spain a more general approach was used. For these two countries we did not have comprehensive price data, even though there was some detailed data on a limited range of products (generally from official statistics used to calculate consumer price inflation). We therefore used a combination of methods, making an overall estimation from the statistics from the Household Budget Survey (HBS) for each country, which shows the amount households spent on different groups of foods. We then fine-tuned this to make sure that relative prices had some validity by taking absolute figures from official statistics and also making comparisons to check validity from online supermarket websites. This may create some averaging effects, but in other respects avoids problems, for example through examining figures at a particular time of seasonal foods.
6. Information on food based dietary guidelines, provided by Task 1. Since in general these categorisations are very broad and not completely quantified (for example, the Swedish recommendation is to have at least one item from each group in the Food Circle each day). This data was therefore used for reporting rather than modelling.

2.1.2 Modelling

The task of optimisation can be formulated as a simple linear programming model which we then processed electronically, either through the Rglpk package (Sweden and Spain) or by using Solver in Excel (France). Rglpk is faster and more versatile regarding data manipulation, whereas Solver allows more flexibility in developing constraints.

The problem can be articulated as being to find the values of a set of variables (amounts consumed of individual foodstuffs) which optimises an output (minimum GHG emissions) subject to a number of constraints (minimum nutrient requirements, and others) and bounds on particular variables (due to acceptability, portion sizes etc).

Owing to the availability and quality of data, modelling worked slightly differently in France, compared to the other two countries.

For France, we imposed the current French dietary guidelines strictly. These are expressed as consumption frequencies of defined portion sizes of some categories and therefore can be readily translated into daily quantities. This is not the case for Spain and Sweden.

For the purpose of making a clear model for Sweden and Spain, where dietary guidelines are more qualitative, we used the following approach

1. The definition of different foodstuffs used was the same as that used in the national dietary survey, in order to maintain comparability with current consumption.
2. Nutritional constraints were defined for key nutrients in the national nutritional recommendations where there was adequate data. For France, we used the nutrients used as constraints in the LiveWell UK report and then checked for other nutrients in the final diet. For Sweden and Spain, different selections of nutrients were used based on availability of data, though ensuring that ones which were expected to be key binding constraints (for example iron and zinc) were included.
3. Overall acceptability constraints were defined by requiring that amounts consumed in particular food groups should be at least 60-80% of the current average consumption. Food groups were defined differently for different countries – for Sweden we used the Food Circle recommendations, for Spain, the wider categories used in the dietary survey were used as a guideline.
4. Bounds were set for a number of reasons, in order to produce an acceptable model (see further discussion on acceptability below). Setting of bounds is discussed in more detail for individual countries.

We ran the model to produce two outputs:

1. Optimising GHG emissions based only on nutritional recommendations and currently consumed foodstuffs
2. Ensuring a target of 25% reduction in GHG emissions subject to constraints and bounds being set to ensure maximum acceptability

For the second outputs, for Spain and Sweden we ran the model to optimise for GHG emissions and imposed successively tighter "acceptability" bounds until the reduction was only 25%. For France, we minimized total departure from the mean observed consumption of food in the French population, subject to nutritional constraints (both nutrient-based and food-based) and to 25% GHGe reduction, as previously described (reference 12). However, this method requires getting precise data on the food intakes observed in the target population. In addition, such an objective function does not fully guarantee that the modelled diet will be acceptable, particularly because:

1. It is difficult to encapsulate how different foodstuffs go together in a particular national diet (need for milk with breakfast cereal, butter/margarine with bread etc)
2. Different sources of particular nutrients can make small differences to GHG emissions but the result is one that is not culturally acceptable. The trade-offs here are difficult to work through. For example, the basic model would suggest that in Sweden the diet could be more sustainable by eating pasta rather than potatoes. What is more important for acceptability: to eat potatoes rather than pasta, or to be able to eat slightly more meat?

3. Inevitably any model will produce strange amounts of some minority foodstuffs which are difficult to integrate into a "normal" weekly menu – for example more than 200g strawberry jam.

For France, only one modelled diet was designed that fulfilled the nutritional constraints subject to 25% GHGe, acceptability constraints (on particular maximal portion-sizes for each food) and minimal departure from the average diet. For Spain and Sweden, we used linear programming to examine a variety of scenarios and to make some analysis of the effect of different assumptions not only on GHG emissions, but also on variety and composition of the diet.

2.1.3 Derivation of the Weekly Shopping List and Sample Menu

As noted, the production of a final recommendation for a "LiveWell" diet required some discussion and adaptation to ensure acceptability. For Spain and Sweden, we achieved it by iteration of the model using different bounds on foodstuffs and other constraints. For France, a dietician was asked to translate the modelled diet into a realistic diet, making assumptions about nutritional equivalences between foods, acceptable portion sizes and the creation of original recipes, As a result of this we have produced suggestions which comply with all the constraints and show:

1. A diet based on foods currently consumed which minimises GHG emissions. This is probably not a realistic diet for many reasons, not least being that no attempt was made to match foodstuffs together. Nonetheless it gives an indication of how low GHG emissions could be.
2. A diet based on foods currently consumed which would result in a 25% GHGe reduction and a weekly shopping list and sample menu to accompany this[4]

4 It should be noted that the shopping list contains items as bought (e.g. dry pasta) while the sample menu contains items as consumed (cooked pasta) – appropriate conversion factors have been used.

3. LiveWell Diet

3.1 General

3.1.1 Introduction

In this section we present a Livewell diet for each country, that is to say, details of a possible diet which is as acceptable as possible, reduces greenhouse gas emissions by 25% from the current average diet, costs no more than now, and complies with national nutritional recommendations.

For each country diet we show
1. the list of ingredients (compared against current consumption[5]);
2. a sample menu;
3. nutritional data against average consumption and national nutritional recommendations;
4. comparison of consumption of different food groups between current consumption, the Livewell diet, and the maximum possible through choice of foods.

For ease of reading, sample shopping lists and details of ingredients for individual dishes are put in Annexes 1 and 2. Discussion of diets which make a maximum reduction in GHG are shown in Annex 3, and sensitivity analysis in Annex 5.

In all analysis we have ignored the effect of alcohol and drinks[6] since it was too difficult to put this in the model.

Presentation against public dietary recommendations proved to be difficult, since many such recommendations are qualitative. Instead, we used these to determine the categories of foods used for reporting and show how the breakdown changes.

3.1.2 Comparing the three countries

There is an inevitable temptation to try to compare the Livewell diets in the three countries and to try to derive conclusions form this – Who has the most sustainable diet? Why does one country eat more fruit than another? Why does the other country have more meat in the diet?

However, comparison between the three countries can be invidious and can easily become a comparison of cuisine and eating habits rather than balancing health, cost and sustainability. We would like to urge caution in terms of comparisons for a number of reasons:

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5 For ease of reading, food items from the dietary survey which are not included in the Livewell menu are excluded from the table

6 except for fruit juices, milk, and a single cola drink

1. We have tried to develop the diets with national acceptability in mind and the cuisine of the three countries is quite different. Therefore we have more potatoes in Sweden and more pasta in Spain – but this is more a matter of preference than a critical difference in the diet and its sustainability or nutritional content. In the same way, whether there is a mixture of different types of meat or just a few but of larger quantities is partly dependent on the ease of manufacturing a menu from the results.
2. The models work with slightly different data. In particular we note that the French model was produced with women only data (as with the original Livewell UK), but because of availability of data, Spain and Sweden are presented for an "average" person. Nutritional recommendations are averaged accordingly where they are different for men and women.
3. We also highlight that nutritional recommendations (see Annex 6) vary considerably between countries. We have sought to strictly comply with nutritional recommendations, and therefore these have an effect on the foods selected. Running a model for Spain with Swedish nutritional recommendations would inevitably produce a different Livewell plate.
4. The degree to which food-based dietary guidelines are used as a constraint varies between countries. For France, we interpreted the principles and used these within the model. For Sweden, the general principle of variety within the Food Circle was used, keeping variety similar to that of the current diet. For Spain, food-based dietary guidelines were found to be too difficult to quantify and therefore constraints were chiefly based on acceptability criteria.
5. Absolute figures are not comparable. We spent time in adjusting the data (particularly the carbon data, but also for cost) for Sweden and Spain so that the figures are consistent (i.e. that relative values are defensible) since the selection of foods and quantities in the model is based on relative values, not absolute ones. Hence the overall figures e.g. for overall GHGe are less reliable than the results of the model. In any case for GHGe figures, for Sweden we used an estimate of the figure for the life cycle to the consumer whereas for France and Spain the figure used is only to retail.
6. Owing to the detail coming from dietary surveys, the number of different foods in the model varies between countries (68 for France, 277 for Spain, and 88 for Sweden). This gives different opportunities for developing different diets: with a greater number of more detailed foods it is possible to produce a wider number of different solutions.

3.1.3 Common Features

Examination of the three sample menus (and the corresponding work for Livewell UK) shows that there is considerable scope for variation and for adapting the diet for reasons of acceptability to consumers. The samples we have produced are just that: samples. They should not be taken as recommendations for a strict diet but rather give guidance on what direction dietary changes have to take in order to reduce GHG. Nonetheless, a number of overall similarities between these nutritious low GHGe diets can be observed:

1. All diets show a reduction in the total amount consumed of foods in the meat group. This is inevitable since these are the foods with the highest GHG emissions. On the other hand, we demonstrate that for a 25% reduction it is still possible to have a certain amount of meat and/or fish in the diet, sufficient to comply with nutritional recommendations and to ensure that there are some traditional dishes and meal patterns.
2. As sources of protein all diets show an increase in the consumption of legumes. This again is inevitable owing to the lower GHG emissions of legumes relative to most other sources of protein, even if they are imported long distances. In addition, this may help to keep the food budget constant or even to decrease it because legumes are not costly.
3. All diets show an increase in cereals and starchy foods, typically represented by increases in bread, pasta and potatoes.
4. Levels of consumption of dairy products remain relatively similar to current consumption.

We emphasise that the sample diets are based on a view related to the acceptability of a diet which can be created from the list of ingredients produced as the result of a mathematical model. Different assumptions about an acceptable diet could have produced different diets - for example it would be possible to run the model excluding meat altogether for vegetarians. Nonetheless we can make the following additional points:

1. A change which relates to 25% GHG reduction is possible while maintaining relatively recognisable meal patterns and composition. We note any general changes with each country, but there is generally enough flexibility to cater for this. This means that probably at least half the meals in the week are "normal" with possible reductions of amounts of meat or changes in proportion of different items.
2. All LiveWell diets strictly comply with national nutritional requirements. However, we note that these requirements for some items vary quite widely between countries: in particular, for Spain, the figures for zinc and iron are relatively high. It may be possible to produce a more acceptable diet if these constraints were partially relaxed.

3.2 Livewell for each country

3.2.1 France

Amounts of food selected by the Livewell model

Food items	EPIC food groups	Average intake, g/d	Amount in the LiveWell diet, g/d
Potato chips salted	1	1.49	0.0
Scalloped potatoes	1	7.47	7.5
Boiled potato	1	33.10	33.1
Fried potato (frozen)	1	8.99	9.0
Potato salad	1	4.95	5.0
Raw carrot	2	19.08	19.1
Raw endive	2	5.33	5.3
Canned green beans drained	2	21.25	71.1
Cooked onion	2	4.26	4.3
Green salad without dressing	2	26.86	26.9
Raw tomatoes	2	55.75	55.8
Tomato Provençal	2	8.68	8.7
Lentils cooked	3	8.79	150.0
Fresh banana	4	20.86	20.9
Clementine	4	22.67	60.5
Stewed apple	4	13.91	13.9
Walnuts	4	0.67	4.7
Fresh orange	4	16.02	16.0
Fresh unpeeled apple	4	87.22	80.0
French cheese (Camembert)d	5	7.86	30.0
Low fat cream	5	1.48	0.0
High fat cream	5	2.67	0.0
Cream cheese 20% fat	5	10.44	10.4
Gruyere cheese	5	6.37	13.5
UHT semi-skimmed milk	5	143.23	143.2
Yogurt with fruit	5	13.92	13.9
Yogurt	5	26.33	26.3
Appetizer cracker biscuit	6	1.23	0.0
Bread baguette	6	72.81	72.8
Bread wholegrain	6	7.24	99.5
Cooked pasta	6	41.27	41.3
Cooked white rice	6	23.41	23.4
Grilled lamb chops	7	3.72	0.0
Turkey	7	11.51	7.6
Cooked ham	7	23.38	7.0
Grilled bacon	7	3.31	0.0

Roasted chicken	7	24.24	7.7
Dried sausage	7	3.27	0.0
Ground beef 15% fat	7	24.62	24.6
Baked cod	8	2.89	0.0
Cooked shrimp	8	3.42	0.0
Hake cooked	8	5.26	0.0
Sardines canned in oil drained	8	1.00	29.0
Steamed salmon	8	9.63	0.0
Raw smoked salmon	8	1.75	0.0
Canned tuna in brine drained	8	5.88	0.0
Boiled egg	9	14.45	14.5
Unsalted butter	10	16.11	0.0
Olive oil	10	9.56	10.0
Sunflower oil	10	3.87	10.0
Honey	11	8.32	8.3
White sugar	11	23.36	7.6
Industrial packed cake (brioche)	12	12.62	0.0
Chocolate Bread (pain au chocolat)	12	14.47	14.5
Fruit tart (industrial)	12	39.20	0.0
Orange juice 100% e (pasteurized)	13	64.04	0.0
Cola drink	13	59.21	59.2
Low fat margarine	15	14.11	0.0
Vegetable soup (industrial)	16	17.70	17.7
Vegetable soup home-made	16	60.00	60.0
Cassoulet (canned)	17	11.34	11.3
Cheeseburger	17	6.34	0.0
Pizza	17	14.94	0.8
Fried breaded fish	17	11.07	0.0
Quiche Lorraine	17	13.59	13.6
Meat ravioli with tomato(canned)	17	16.11	16.1
Tabbouleh	17	9.96	10.0
Stuffed tomato	17	13.76	13.8

Sample menu created from the ingredients

	Breakfast	*Lunches*	*Evening meals*
Day 1	Coffee with milk sugared Chocolate Bread Clementine	Grated carrot+ vinaigrette Mashed lentils Sardines Bread Camembert canned applesauce	vegetable soup Vegan stuffed tomato bread wholegrain Yogurt with honey Apple
Day 2	Coffee with milk sugared White bread with honey Boiled eggs Orange	endive and potato salad with walnuts and vinaigrette Ground beef+Pilau Rice bread wholegrain Camembert Clementine cola-type soft drink	vegetable soup bread wholegrain Lentil salad+vinaigrette yogurt with fruit Apple
Day 3	Coffee with milk sugared Bread with honey Chocolate bread Orange	Green beans with vinaigrette turkey with Lentils +onion+ Carrots + olive oil White bread beat cream cheese with apple cola-type soft drink	Green salad with walnuts + vinaigrette Tomate farcie et macaroni Pain+ brie Clémentine
Day 4	Coffee with milk sugared Bread with honey Orange	Cream of vegetables Spaghetti bolognaise White bread Clementine	Green salad with lentils + vinaigrette 1 slice of Pizza 1 slice of quiche Lorraine Camembert+bread Apple
Day 5	Coffee with milk sugared Bread wholegrain with honey Orange	Lentil soup Chicken and chips fried potato and Tomato Provencal Camembert bread Apple cola-type soft drink soda	Tomato salad with green beans and walnuts + vinaigrette meat ravioli with tomato sauce Clementine

Day 6	Coffee with milk sugared French toast with honey Apple	Mixed salad Lentils cake White bread +camembert Clementine Cola-type soft drink soda	vegetable soup French flavour plate : Set of cassoulet and scalloped potatoes Bread beat cream cheese 20% m.g. nature banana
Day 7	Coffee with milk sugared Chocolate bread Clémentine	Green beans salad Sardines Camembert and Bread wholegrain Apple with Honey	Vegetable soup Spanish lentils gruyère Bread Banana

Dietary and nutrient recommendations for French women used in the model and nutrients intake from the Livewell diet (25% reduction of gas emission)

	Average observed	**Targets**	**Livewell diet (25% reduction)**
Total amount, g/d	1304	Free	1410
Gas emission	3478	<2609	2609
Cost, euros/d	4.9	Free	4.36
Nutrients			
Energy, kcal	1814	1800	1800
Proteins, g	68	>50	79.5
Carbohydrates, g	202	225-337 (50%-75%)	225.0 (50%)
Fibres, g	14	>25	26.3
Lipids, g	81	<70 (<35%)	63.4 (32%)
Saturated fatty acid, g	32	<20 (<10%)	20.0 (9.9%)
Sodium, mg	2053	<2365	2365
Calcium, mg	581	>900	927
Iron, mg	8	>14	14
Zinc, mg	7	>10	10
Vitamin B12	3	>2.4	5.5
Vitamin B9	188	>300	300.
Added sugar, g	39	<45 (<10%)	18.6 (2.6%)
Food groups			
Fruits and vegetable	4.52	>5	5.4
Fruit juice	0.32	<1	0.0
Nuts	0.03	<1	0.2
Grains	2.21	>3	4.7

Dairy products	2.06	=3	3
Meat, Fish, Eggs	1.48	1-2	1.0
Fish	0.30	>0.29	0.29
Fat	4.37	<3.5	2.0
Olive oil	0.96	>1	1
Sunflower oil	0.39	>1	1
Sweets products	4.24	<2	1.9
Sugar	3.17	<2	1.6
Drinks	0.30	<1	0.3

Since nutrient recommendations were only used for those that corresponded to the bounds used in the original Livewell UK research, we also show the results for some other key nutrients

Nutrients not included in the model	**Observed intakes**	**Targets**	**LiveWell diet (25% reduction of gas emissions)**
Magnesium, mg	182.8	360	249.8
Phosphorus, mg	944.6	750	1395.7
Potassium, mg	2349.8	3100	2645.1
Copper, mg	0.8	1.5	1.3
Selenium, mcg	41.3	50	36.5
Iodine, mg	82.6	150	78.8
Vitamin D, mcg	2.7	3	2.8
Vitamin E, mg	11.0	12	11.7
Vitamin C, mg	87.6	110	82.1
Vitamin B1, mg	1.0	1.1	0.9
Vitamin B2, mg	1.1	1.5	1.4
Vitamin B3, mg	13.7	11	13.1
Vitamin B5, mg	3.8	5	4.8
Vitamin B6, mg	1.4	1.5	1.5

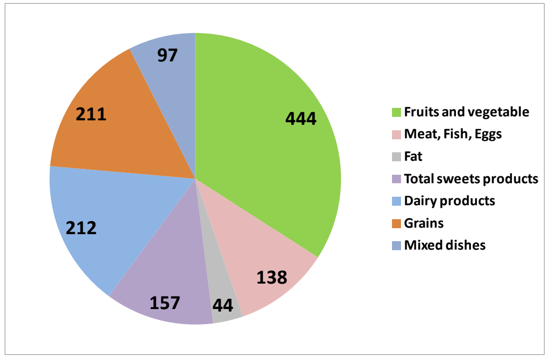
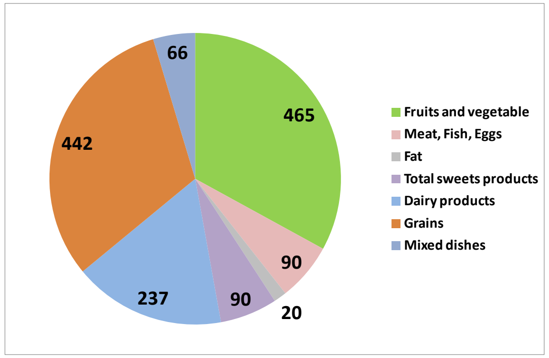
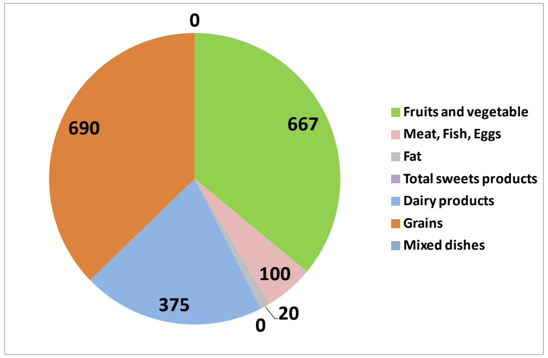
Comparison by food groups

EPIC food groups	Observed average. g/d	Modeled diet (25% reduction gas emission). g/d	Deviation. g
Legumes(3)	8.8	150.0	141.2
Cereals and cereal products(6)	146.0	237.0	91.0
Vegetables(2)	141.2	191.1	49.9
Fruits, seeds, nuts(4)	161.4	196.0	34.7
Dairy products(5)	212.3	237.4	25.1
Egg and Egg products(9)	14.5	14.5	0.0
Soups, bouillon(16)	77.7	77.7	0.0
Fish and shellfish(8)	29.8	29.0	-0.8
Potatoes and other tubers(1)	56.0	54.5	-1.5
Fat(10)	29.6	20.0	-9.5
Condiments (15)	14.1	0.0	-14.1
Sugar and confectionery(11)	31.7	15.9	-15.8
Miscellaneous(17)	97.1	65.6	-31.5
Meat and meat products(7)	94.0	46.9	-47.1
Cakes(12)	66.3	14.5	-51.8
Non-alcoholic beverages(13)	123.3	59.2	-64.0

As can be seen from this table the biggest increases are in legumes and cereals while the biggest decreases are in meat and meat products as well as highly processed sweet foods (cakes). Consumption of dairy foods increases but only modestly.

We show this graphically on the next page.

Graphical comparison

A: Observed Diet (3478 gCO2 eq/d)	B: LiveWell diet (25% reduction in GHG: 2609 gCO2 eq/d)	C: Minimized GHG diet (1499 gCO2 eq/d)
		

3.2.2 Spain

The LiveWell diet for Spain shows a reduction in GHG emissions of approximately 27% and a cost equivalent to that of the current diet.

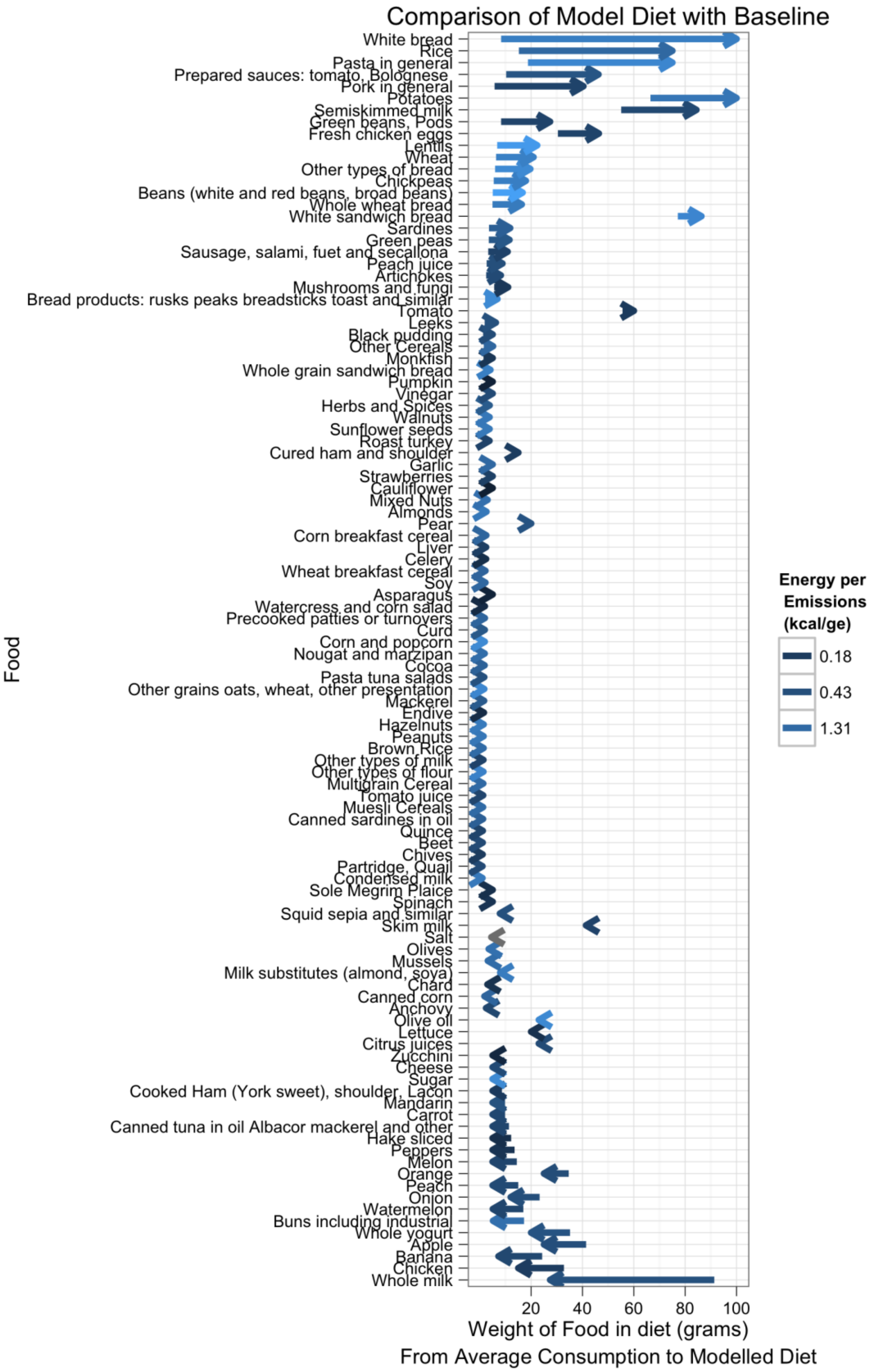
The model produces the following long list of ingredients

category	*food*	*Livewell diet (g/day)*	*Current average consumption (g/ day)*
Cereals	Bread products: rusks peaks breadsticks toast and similar	6.86	2.08
	Brown Rice	1.45	0.44
	Buns including industrial	5.17	17.23
	Canned corn	1.82	1.82
	Corn and popcorn	1.91	0.58
	Corn breakfast cereal	2.51	0.76
	Muesli Cereals	1.25	0.38
	Multigrain Cereal	1.32	0.40
	Other Cereals	5.15	1.56
	Other grains oats, wheat, other presentation	1.72	0.52
	Other types of bread	19.67	5.96
	Other types of flour	1.39	0.42
	Pasta in general	75.00	18.76
	Precooked patties or turnovers	1.95	0.59
	Rice	75.00	15.22
	Wheat	20.92	6.34
	Wheat breakfast cereal	2.18	0.66
	White bread	100.00	8.30
	White sandwich bread	86.31	77.14
	Whole grain sandwich bread	4.13	1.25
	Whole wheat bread	16.34	4.95
Drinks not including Milk	Citrus juices	23.00	23.85
	Peach juice	8.81	2.67
	Tomato juice	1.29	0.39
Eggs and Egg Products	Fresh chicken eggs	46.35	30.43
Fats and oils	Olive oil	23.00	23.03
Fruits and fruit products	Apple	25.00	41.42
	Banana	7.29	24.29
	Mandarin	5.00	9.83
	Melon	5.00	14.41
	Olives	3.48	3.48
	Orange	25.00	34.64

	Peach	5.00	14.98
	Pear	20.00	18.25
	Quince	1.16	0.35
	Strawberries	5.00	2.82
	Watermelon	5.09	16.96
Meat and meat products	Black pudding	5.00	1.30
	Chicken	15.00	32.78
	Cooked Ham (York sweet), shoulder, Lacon	5.00	8.61
	Cured ham and shoulder	15.00	12.40
	Liver	2.44	0.74
	Partridge, Quail	1.02	0.31
	Pork in general	40.34	5.76
	Roast turkey	3.76	1.14
	Sausage, salami, fuet and secallona	10.82	3.28
Milk, dairy and milk substitutes	Cheese	5.00	25.41
	Condensed milk	1.02	0.31
	Curd	1.91	0.58
	Milk substitutes (almond, soy)	7.96	7.96
	Other types of milk	1.39	0.42
	Semi skimmed milk	84.36	55.08
	Skim milk	41.39	41.39
	Whole milk	27.40	91.34
	Whole yogurt	20.00	35.15
Miscellany	Herbs and Spices	3.83	1.16
	Pasta tuna salads	1.72	0.52
	Prepared sauces: tomato Bolognese	46.22	10.27
	Salt	4.51	4.51
	Vinegar	5.00	2.24
Nuts and oilseeds	Almonds	2.57	0.78
	Hazelnuts	1.49	0.45
	Mixed Nuts	3.00	0.91
	Peanuts	1.45	0.44
	Sunflower seeds	3.80	1.15
	Walnuts	3.80	1.15
Seafood products	Anchovy	2.45	2.45
	Canned sardines in oil	1.25	0.38
	Canned tuna in oil, Albacor, mackerel and other	5.00	11.36
	Hake sliced	5.00	12.22
	Mackerel	1.65	0.50
	Monkfish	5.00	1.45
	Mussels	3.15	3.15
	Sardines	11.81	3.58
	Sole, Megrim, Plaice	5.00	4.32

	Squid sepia and similar	7.85	7.85
Sugar and sugar products	Cocoa	1.85	2.70
	Nougat and marzipan	1.88	0.57
	Sugar	5.00	7.04
Vegetables and legumes	Artichokes	8.18	2.48
	Asparagus	5.00	3.58
	Beans (white and red beans, broad beans)	16.67	5.05
	Beet	1.12	0.34
	Carrot	5.00	9.85
	Cauliflower	5.00	2.87
	Celery	2.44	0.74
	Chard	2.99	2.99
	Chickpeas	17.92	5.43
	Chives	1.09	0.33
	Endive	1.58	0.36
	Garlic	5.00	2.60
	Green beans, Pods	27.36	8.29
	Green peas	11.55	3.50
	Leeks	6.24	1.89
	Lentils	22.34	6.77
	Lettuce	20.00	20.72
	Mushrooms and fungi	11.00	5.61
	Onion	12.05	23.30
	Peppers	5.00	13.55
	Potatoes	100.00	66.48
	Pumpkin	5.00	2.21
	Soy	2.18	0.66
	Spinach	5.00	4.42
	Tomato	60.00	55.60
	Watercress and corn salad	1.95	0.59
	Zucchini	5.00	6.25

The graph below shows the major changes by food item



We produced a menu from these ingredients, shown below. Some of the ingredients have very low amounts for a weekly menu and the diet in general shows that there is considerable variety across Spain. We have tried to reflect this by including regional dishes in the menu. The menu should therefore be seen as indicative of the types of dishes which can be eaten in a diet with a 25% reduction in GHGe, rather than an absolute recommendation for consumption in a seven day period.

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Breakfast	Coffee with semi skimmed milk. Toast with cooked ham. Orange juice.	Coffee with skim milk. Corn breakfast cereal.	Coffee with semi skimmed milk. Buns with marzipan.	Tea with milk. Toasted white sandwich bread with sugar and olive oil.	Coffee with semi skimmed milk. Cured ham sandwich (white bread).	Coffee with whole milk. Wheat breakfast cereal. Pear juice.	Chamomile. White sandwich bread with salami.
Mid Morning snack	Breadsticks.	Apple.	White bread with cocoa.	Tangerine.	Rusk with quince preserve.	Ham and cheese sandwich.	"Patatas bravas". Tomato juice.
Lunch	Olivier salad (Ensaladilla Rusa). Zarzuela fish stew. Strawberries with whole yogurt. White bread.	Green beans and cured ham stir fry. Garlic chicken. Banana. White bread.	Roasted vegetables with Romesco sauce. Potato omelette with corn salad and Cherry tomato salad. Rice pudding. White bread.	Gazpacho. Fideua. Crème brûlée (Natillas o Crema Catalana). White bread.	Tomato salad. Lentil stew with black pudding. Fruit salad with peach juice. White bread.	Spinach Cannelloni. Steamed mussels. French toast (Torrijas). White bread.	Vegetable Paella. Pickled quail. "Tarta de Santiago". White bread.
Afternoon snack	Roast turkey sandwich.	Peaks (breadsticks).	Whole yogurt with muesli.	Fuet sandwich.	Espresso cut with skim milk. Toasted white sandwich bread with cheese.	Fruits and soy juice.	Peanuts.
Supper	Steamed artichokes. Scrambled eggs with mushrooms and toasted whole grain sandwich bread. Curd with sugar.	Garden salad with sunflower seeds. Toast with canned sardines in olive oil and anchovy. Fruit salad with condensed milk. White bread	"Arroz a banda". Pork sausages and white beans. Pear. White bread.	Vegetable stew with potato and cured ham. Grilled sardines with fried cauliflower. Orange slices. White bread	Ratatouille (Pisto). Fried eggs with French fries. Watermelon. White bread.	Cream of chickpeas. Pork loin with Piquillo peppers. Apple. White bread.	Macaroni with mackerel and tomato sauce. Stewed squid with carrots. Strawberries White bread

A nutritional comparison reveals the following

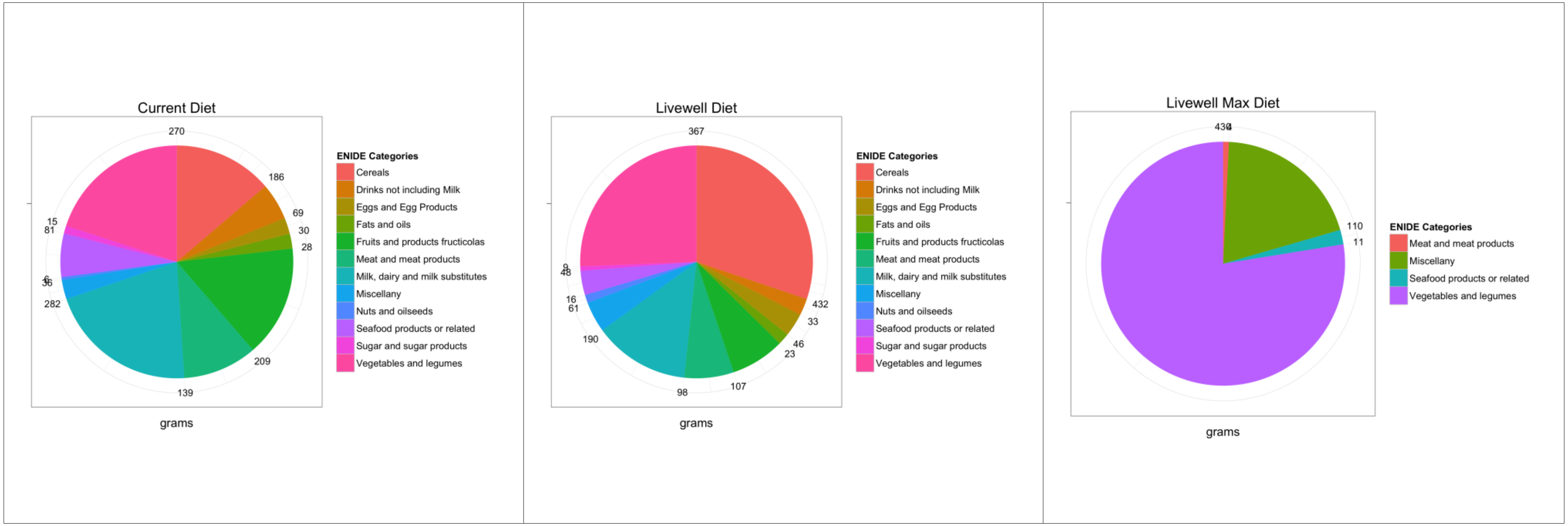
	Average consumption	Livewell diet	National nutritional recommendation
Energy	1884.01	2220.38	(no rec)
Protein g	83.83	97.22	>33.00
Fat g	86.32	82.30	<105.00
Fat (Saturated) g	25.67	21.00	<21.00
Fat (Polyunsaturated) g	12.26	14.24	<30.00
Carbohydrate g	187.35	259.84	>165.00
Vitamin A	597.02	1093.16	750.00
Vit B1 mg	1.47	2.19	1.05
Vit B2 mg	1.66	2.01	1.60
Vit B3 mg	36.09	36.25	17.50
Vit B6 mg	1.99	2.28	1.70
Vit B11 ug	327.60	588.69	200.00
Vit B12 ug	5.83	6.11	2.00
Vit C mg	146.16	118.87	60.00
Vit D	5.40	5.50	2.50
Vit.E.mg	13.56	18.27	12.00
Ca mg	715.32	725.00	725.00
Fe mg	10.37	18.00	18.00
Zn mg	10.32	15.00	15.00

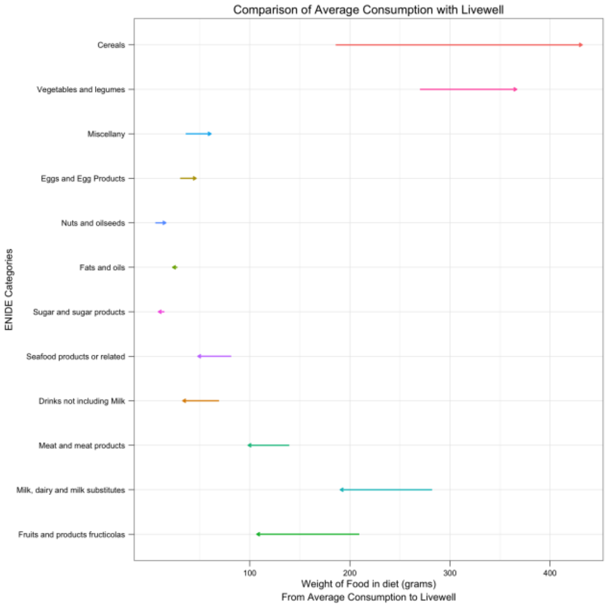
This shows that the Livewell diet meets all recommendations for nutrient consumption where we had reliable data[7]. The figures for the average diet possibly underestimate the nutritional content since it includes foods which we did not examine in detail and where some nutrient data may be missing.

Comparisons between food groups are shown below, demonstrating the pattern of other diets of an increase in cereals and starchy foods, an increase in legumes, and a decrease in meat and seafood. The diet showing maximal decrease in GHG consists largely of legumes. The decrease in fruit and vegetables may seem surprising but represents the balance between the different food groups.

[7] We excluded iodine, for example, due to unreliable figures in nutritional tables

Pie chart comparison




Comparison of Average Consumption with Livewell
ENIDE Categories
Cereals
Vegetables and legumes
Miscellany
Eggs and Egg Products
Nuts and oilseeds
Fats and oils
Sugar and sugar products
Seafood products or related
Drinks not including Milk
Meat and meat products
Milk, dairy and milk substitutes
Fruits and products fructicolas
100
200
300
400
Weight of Food in diet (grams)
From Average Consumption to Livewell

3.2.3 Sweden

The Swedish diet similarly shows a reduction in GHG emissions of 25% but a cost approaching that of the current diet.

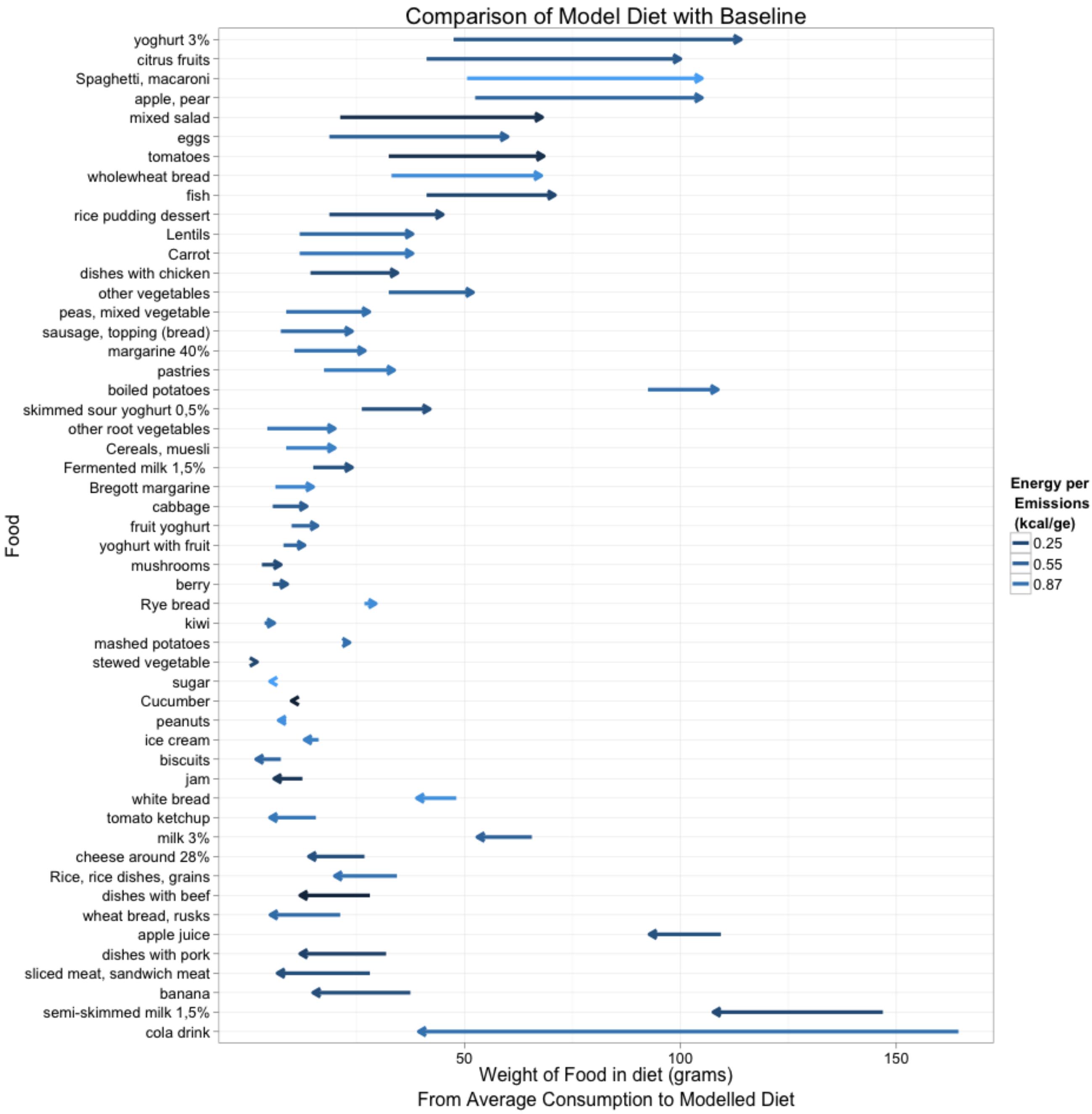
food	*Livewell diet (g/day)*	*Current average consumption (g/ day)*[8]
boiled potatoes	108.67	92.50
mashed potatoes	23.42	21.88
Lentils	38.00	11.88
whole grain bread	67.79	33.13
Rye bread	29.48	26.88
white bread	39.00	48.13
Cereals, muesli	20.00	8.75
Rice, rice dishes, grains	20.00	34.38
Spaghetti, macaroni	105.00	50.63
wheat bread, rusks	5.10	21.25
Carrot	38.00	11.88
other root vegetables	20.00	4.38
Cucumber	10.00	10.63
tomatoes	68.36	32.50
cabbage	13.50	5.63
mixed salad	68.00	21.25
mushrooms	7.50	3.13
peas, mixed vegetable	28.00	8.75
stewed vegetable	2.00	1.25
other vegetables	52.00	32.50
banana	15.00	37.50
citrus fruits	100.00	41.25
apple, pear	105.00	52.50
kiwi	6.00	3.75
berry	9.00	5.63
cheese around 28%	14.00	26.88
yoghurt 3%	114.00	47.50
skimmed sour yoghurt 0,5%	42.00	26.25
milk 3%	53.00	65.63
fruit yoghurt	16.00	10.00
yoghurt with fruit	13.00	8.13
semi-skimmed milk 1,5%	107.64	146.88
Fermented milk 1,5%	24.00	15.00
dishes with beef	12.00	28.13
dishes with pork	12.00	31.88

[8] Allowing for 25% under-reporting

dishes with chicken	34.50	14.38
sliced meat, sandwich meat	6.75	28.13
sausage, topping (bread)	24.00	7.50
fish[9]	70.96	41.25
eggs	60.00	18.75
Bregott margarine	15.00	6.25
margarine 40%	26.97	10.63
sugar	5.00	5.63
tomato ketchup	5.00	15.63
peanuts	7.00	8.75
pastries	33.76	17.50
biscuits	1.80	7.50
ice cream	13.00	16.25
rice pudding dessert	45.00	18.75
jam	5.97	12.50
apple juice	92.85	109.38
cola soft drinks	39.45	164.38

A number of the items here are rather generic, but for the purposes of modelling we chose either a specific item as a representative or averaged the values for a number of items (e.g. fish). This allowed us to make direct comparisons with the average consumption, shown graphically below:

9 "fish" is represented by 60% salmon 30% cod and 10% herring



The generic nature of some of the items made the creation of a sample menu more difficult, but we sought to do this through examining the model diets produced by SNO and trying to adapt them, using comments from various sources on current consumption. The result is as follows:

	Breakfast	Lunches	Evening Meals
Day 1	Muesli with yoghurt Apple juice Crispbread	Fish Salad Bread	Fish and potatoes, salad Ice cream and berries

	Bread with toppings		
Day 2	Fruit yoghurt Bread with toppings	Lentil and vegetable soup Bread	Pork with pasta, vegetables Apple
Day 3	Muesli with yoghurt Apple juice Crispbread Bread with toppings	Chicken pasta salad	Fish and potatoes, vegetables Danish pastry
Day 4	Fruit yoghurt Bread with toppings	Omelette with tomatoes Bread	Chicken dinner Orange
Day 5	Muesli with yoghurt Apple juice Crispbread Bread with toppings	Lentil and vegetable soup Bread	Fish and potatoes, vegetables Danish pastry
Day 6	Bread with toppings	Root vegetable stew Bread	Meatballs with potatoes cucumber and lingonberry jam Apple
Day 7	Poached egg Cheese Bread	Omelette with tomatoes Bread	Chicken with pasta, vegetables Prepared dessert (rice pudding)

Snacks:
Bread with toppings
Fruit (apple/orange/banana/kiwi) – 13 fruits only one is banana, one kiwi
Cola drink
Peanuts
Sugar for coffee/tea
Milk
Yoghurt

This should not be seen as a recommended diet but rather as an indication of the way in which the diet would have to change in order to reduce GHG. In many cases substitution would be easy based on personal taste (for example cinnamon buns in place of Danish pastries, or other processed desserts in place of rice pudding).

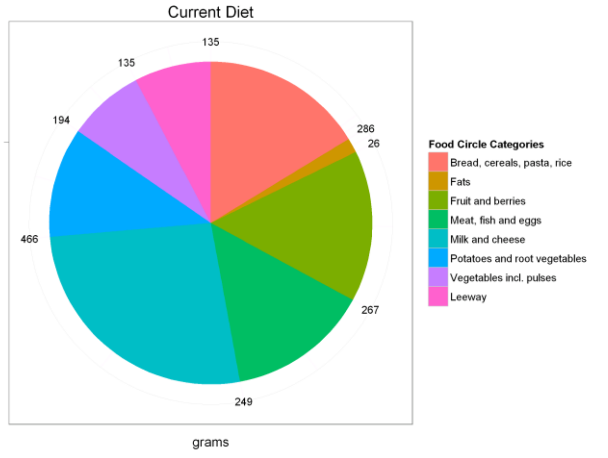
The menu above follows strictly the Swedish Nutritional Recommendations as follows:

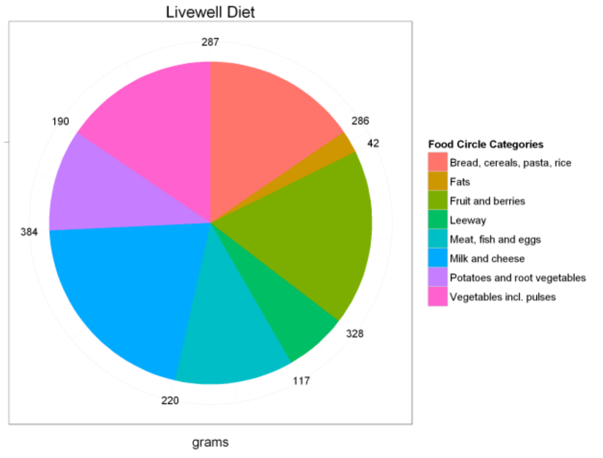
	Average consumption	Livewell diet	National nutritional recommendation
Energy kcal	2509.25	2450.00	>2450.00
Protein g	102.26	94.88	>37.50
Fat g	92.51	87.20	<90.00
Carbohydrate g	301.53	303.82	>180.00
Fibre g	25.58	30.00	>30.00
Thiamin mg	1.77	1.50	1.25
Riboflavin mg	2.16	1.94	1.45
Vitamin C mg	94.21	142.26	60.00
Niacin equivalents	41.94	40.30	17.00
Vitamin B 6 mg	2.53	2.44	1.35
Folate micro g	294.35	415.54	300.00
Vitamin B 12 micro g	8.75	6.99	2.00
Vitamin D micro g	8.77	13.05	5.00
Vitamin E mg	10.45	14.16	9.00
Calcium mg	1126.38	896.30	800.00
Phosphorus mg	1767.75	1649.37	600.00
Potassium mg	3662.10	3605.97	3300.00
Sodium mg	2903.67	2171.67	2000.00
Iron mg	11.96	12.50	12.50
Zinc mg	14.29	11.95	8.00
Selenium micro g	49.31	57.10	45.00
Magnesium mg	359.94	383.28	315.00

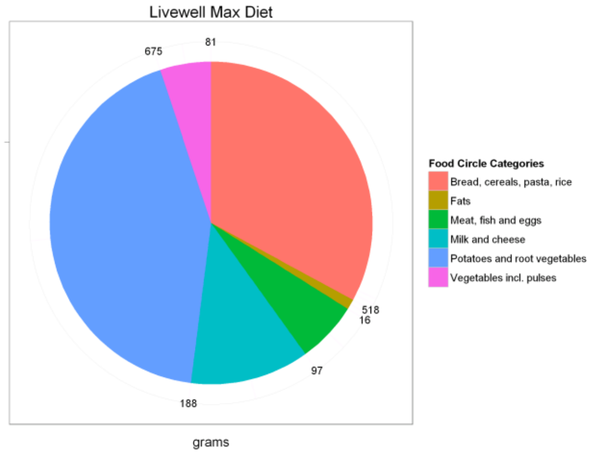
Below we show a comparison based on the categories used for the Food Circle – where the instructions are to eat at least one item from every sector each day. This shows a decrease in meat and “leeway” (items not necessary for the diet) and an increase in vegetables and dairy products. In some ways this is misleading, because as can be seen from the initial table in this section, there is a real change in the composition of the categories with big increases in lentils and carrots and a shift in meat consumption from beef and pork towards chicken. Sources of protein show real increases in both fish consumption and in eggs. There is a decrease in cheese but increases in other diary products, particularly yoghurt.

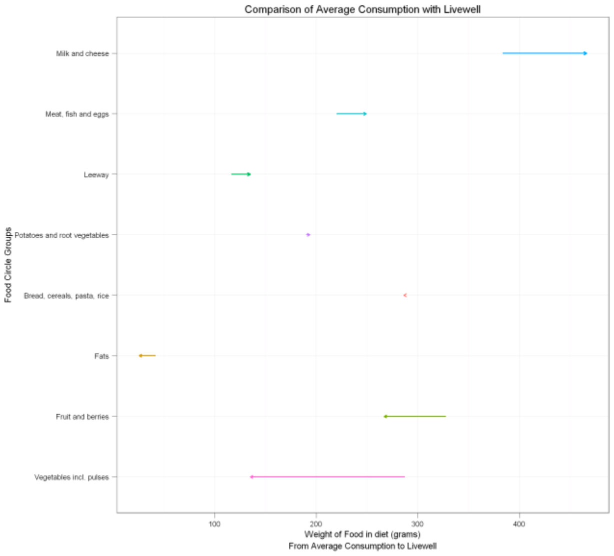
A diet with maximal reduction in emissions shows these tendencies taken further with an increase in root vegetables and cereals as well as legumes.

Pie chart comparison









4. Analysis

This section explains in more detail the way in which we approached the modelling and how we addressed a number of issues in doing this.

4.1 Approach to Data

For detailed discussion of our methodology in finding appropriate data see Annex 4

The quality and consistency of the data varied between the three countries and in some cases this created challenges. In approaching questions related to data (or deficiencies within the data) we took the following general approach

1. Where possible we used national data and filled in any gaps with data from other countries, even when the other countries' data was of better quality or more comprehensive. For all three countries there were existing dietary surveys, nutritional recommendations, and nutritional information (provided by task 1 – see Annex 6). Specifically for Spain, the nutritional information had some gaps which we sought to fill by using data from Sweden and France and through estimations where appropriate.
2. For the purposes of the model, the key question is the *consistency* and *comparability* of the data. Therefore we sought to make sure that data derived from different sources (e.g. for GHGe) was as consistent as possible, by comparing a set of common items and through this deriving a "conversion" factor. This was a particular issue for GHG where there are very different estimates for the same item but the relative values and trends are much more consistent (that beef has a much higher GHG footprint than pork, for example) – see reference 5 regarding reviews of different data sources for meat in Sweden, for example.

This approach has some effect on the final results of our work and in particular we note the following:

1. Comparability between countries is limited because the basis of figures is slightly different. The results should therefore be used to examine the effects of change, rather than, for example, seeking to determine which country has the most sustainable diet. In any case, constraints related to cost, nutrition and sustainability have varied between countries so the diets are not strictly comparable even if we had completely accurate and comparable GHG data.
2. Although we quote absolute figures in our reports, we have more confidence in relative figures. So, for example, we can have confidence that the GHG emissions of the Livewell diet are substantially less than the current average diet, and that the cost is not more. On the other hand, the estimate of average GHG emissions in absolute terms is more open to discussion.

4.2 Approach to defining acceptability

"Acceptability" of the diet is a slightly nebulous concept and we can conceive that there are a number of different acceptable diets which conform to the Livewell criteria. Again we used slightly different approaches for France and for the other two countries.

For France, acceptability was defined using upper bound constraints (expressed in number of maximal daily portion acceptable) for each food, and also by minimizing the sum of the absolute values of the differences (calculated for each food variable) between the observed amount eaten in the population of adult women and the optimised quantity chosen by the solver. See reference 7 for an explanation of the methodology used here.

For Spain and Sweden, we tried to be systematic using the following approach to work on acceptability through iteration and putting bounds on particular foodstuffs by:

1. Ensuring that popular[10] foodstuffs were not removed from the diet, generally ensuring that at least 30% of the most popular foodstuffs remained.
2. Ensuring that there was appropriate variety by putting an upper bound on most foodstuffs. Initially we put higher bounds (in terms of multiples of the current average consumption and/or standard deviations) for more popular foodstuffs, specifically to avoid introduction of large amounts of unpopular foodstuffs into the diet
3. Where appropriate removing foodstuffs which were present only in small amounts in the average diet to avoid creating a shopping list with too many small items.
4. Following health recommendations for particular specific types of food (e.g. semi-skimmed rather than full fat milk, whole meal rather than white bread). In general we did not take this to an extreme, but rather limited any increase in the total to being through healthy options.
5. Removing small items of ambiguous composition (sauces etc) so that there is more confidence related to the nutritional composition of the final diet
6. Putting lower bounds, particularly on popular foods, in order to regulate minimum portion sizes (one piece of fruit, a piece of meat which can be used in one meal etc).
7. Moving the model in a particular direction for cultural reasons. For example, bread, potatoes and pasta have fairly similar characteristics as far as GHGe and prices are concerned, but the model will seek to optimise to one particular foodstuff. For this reason consumption of pasta was limited in Sweden and potatoes in Spain.
8. Finally, a certain amount of trial and error was used to create a diet with ingredients which could be combined together

10 Popularity was defined using what data we had from dietary surveys - see sections on individual countries for details

Some of the adjustments described above were also performed for France because they are unavoidable when translating a modelled diet (i.e. a theoretical food combination) into a concrete food plan. In addition, then nutritional constraints introduced in the French models included constraints ensuring that national dietary guidelines were fulfilled. Because these guidelines are expressed in consumption frequencies of predefined portion-sizes of food-groups, this helped (but did not guarantee) the introduction of integer portions for some foods (i.e. when the upper or lower bound for a given food groups were reached and when they were reached with only one food).

Whilst we tried to make this systematic, a key point here is that other decisions could have produced an equally valid diet – for example, it is not necessarily the case that popular foods should be increased in greater percentages than unpopular ones (the population may like pasta but it doesn't mean that they want to eat it every day; just because carrots are the most popular vegetable doesn't mean that there isn't a need for variety). Our aim for variety was also influenced by the idea that we were producing a weekly shopping list and sample menu, limiting the number of items we should buy. If we had produced a list for a longer period it would have been more appropriate to include a larger number of small items (for example varieties of fish in Spain).

For France we had data which was more clearly related to the current diet and therefore we were able to design a diet which is as close as possible to this current diet, by minimizing the gap between the modelled and the observed, average, diet.

Finally we note that something which is acceptable to the "average" person may in reality be acceptable to only a small proportion of the population. A mean diet is in itself unrealistic because, by definition, nobody does eat the average diet, due to the extremely high inter-individual variability of food intake patterns. Indeed, what is an average population diet? It is a combination of all the foods consumed by a given population, in the amount at which they are consumed, in average, in the whole population, including people not consuming at all this particular food. For instance, if only 5% (i.e. one twentieth) of individuals consume 50g of liver per week, the mean diet will contain 50/20, i.e. 2.5g of liver per week and per person, a totally unrealistic amount of food to be consumed. Therefore, it is not only the modelling approach chosen that is responsible for producing somewhat unrealistic food combinations and quantities, but also the definition of what is an "average" diet.

In addition, an underlying assumption made when modelled diets derived from average population diets are proposed as acceptable diets for individuals, is that it is assumed that individuals have a greater food repertoire than they do have in reality (because, by definition, in the average diet, all the foods are present, even in very small amounts). Such *over*estimation of food diversity was not really a problem in the present study because it was counterbalanced by at least two reasons of rather *under*estimating food diversity. First, due to the lack/incompleteness of dietary data (in particular GHGe food data) the models included a relatively small list of food variables. Second, the diet modelling process in itself is likely to decrease food diversity because it is orienting food selection towards those particular foods with a good nutritional quality for their GHGE value.

We have not sought to analyse the degree of spread of different types of diet within the population (nor do we have full data on this). There must be a further route for research in considering different approaches to creating an acceptable diet for different minority groups. To increase the acceptability of modelled diets, individual diet modelling approaches (as opposed to population diet modelling) have been developed – see reference 13, but they require precise individual food intake data and specific modelling skills, that were beyond the scope, aims covered by, and time and means allowed to, the present study.

4.3 Approach to sample menus

Creating a sample menu from the shopping list produced by the modelling process was also an iterative process. Our general approach was as follows:

1. To examine existing menus and dietary patterns to gain a general vision of the proportions of different types of food and meals and some typical combinations. For Sweden we used the SNO, for Spain we used recipes and guidelines from the Mediterranean Diet Foundation. For France, the dietary guidelines were already included in the nutritional constraints list.
2. To produce an outline menu based on these criteria and using the majority of the items defined in the shopping list (the balance being things which could be considered to be snacks or added easily e.g. fruit and drinks)
3. Discussion of the results with a dietician from the country concerned

This produced the sample menus which are shown elsewhere in this report. We hope that this approach has produced menus which are appropriate culturally and acceptable in the countries concerned. Nonetheless, there should be some warnings in their applicability:

1. The sample menus are just that: a sample. There are many other ways of combining foods and it is important that the sample is seen merely as a way of showing that the shopping list can produce a viable diet, and not being seen as a strict recommendation.
2. While we have sought to have dishes which we believe are acceptable on a cultural basis, there is always a question of how acceptable these are for the majority of the population – we need to be clear that the menu is for what people typically eat, not what nutritionists and dieticians feel that they ought to eat.
3. In creating “normal” meals, we feel that the message may have become distorted. At first glance it may seem that GHG can be reduced without significant changes to the diet. Only closer inspection shows that these diets, for example, contain less meat and more legumes than would normally be consumed. In using the sample menus it is important to be clear that the fact that they are in some way “acceptable” does not mean that individual meals are precisely what people already eat in another combination.

4.4 Approach to modelling

The basic approach to modelling the diets using linear programming is the same in all three cases, but the way in which we used the model in order to produce the Livewell diet varied between the countries.

For Spain and Sweden a methodology was used which was equivalent to that used for the Livewell UK diet, as follows:

- The model was optimised to minimise GHGe while complying with nutritional guidelines
- General constraints were included to comply with food-based dietary guidelines, and overall acceptability (for example encouraging more of popular foods and excluding unpopular ones, minimum portion sizes).
- Additional bounds were put on individual foods in an iterative process to produce a diet where foods could be combined in an acceptable way while GHGe were reduced by at least 25%

For France we exhibit a different approach to the same dietary model.

- An "acceptability" function was developed showing the variation from the current diet and this was optimised subject to a 25% reduction in GHGe and compliance with nutritional guidelines
- Constraints were included to comply with food based dietary guidelines and portion sizes
- Additional bounds were put on individual foods for reasons of acceptability to fine-tune the result.

It was easier to use this approach in France than in the other two countries owing to better quality of detailed data including, for example, portion sizes.

It is important to understand that the two different approaches would not be expected to produce different final results. Rather, the model gives a wide variety of different ways in which the overall constraints (GHGe at 25%, cost not increased, compliance with nutritional guidelines) can be met and a strategy needs to be developed to find the most acceptable diet within this. The choice of approach relates to the availability of detailed information, and personal choice and the results should not be seen a qualitatively different from each other.

We hope that exhibiting different approaches gives some useful guidance for researchers developing diets in other countries or with other data.

4.5 Extreme Diets

For each country we ran the model to determine the degree to which GHGe could be reduced, keeping constraints only on nutrition and cost. Actual details of the diets produced are shown in Annex 3

These diets give an idea of how much further we could reduce GHG, although some caution is needed in examining them because:

- The reduced variety and increased amount of particular foodstuffs will create some inaccuracy in nutritional values (in any case some foodstuffs are not "pure" and may vary in nutritional content). In general it is good nutritional policy to have wider variety.
- The figures for GHGe and cost are also approximate and therefore not accurate at the extremes.

Nonetheless we can conclude the following

- It is possible to reduce GHG considerably more than 25% through choice of diet, and almost certainly more than 50%[11].
- We did not make a detailed examination of diets with 50% reduction but note that it is possible to do this using choices among existing foodstuffs. However, extreme diets are likely to be unrecognisable and unacceptable to the majority of the population

4.6 Areas outside the model

In producing the model we note that there were a number of areas which were not examined that would have had an effect on GHG emissions, even within the proposed diet:

1. We did not consider seasonality – which can have an important effect not only on price but also on GHG emissions. While the GHG emissions for an average tomato imported from Spain to Sweden are less than an average hot-housed tomato from Sweden itself, this perhaps does not apply for tomatoes grown seasonally. Seasonal eating of fruit and vegetables could have an impact on GHG emissions, although this is difficult to estimate since it would alter other patterns of eating (if we only eat local apples, then what fruit do we eat out of season?).
2. We used quite broad categorisations of food, particularly due to the nature of dietary surveys. It may be possible to be more specific in terms of which foods are eaten and through this to reduce GHG. We note that nutritional categories sometimes contain items which have widely differing GHG emissions. The data on GHG is still in its infancy, but better data could inform the choice of consumers in this respect.
3. Surprisingly, guidelines on nutrients vary significantly between countries. For example the recommendation for zinc for a Swedish woman is 7mg compared to 15mg and 10mg for Spanish and French women, respectively, and a 4.9g general WHO recommendation for women. It would perhaps be interesting to discover whether this has a significant effect on GHG emission through

11 We note that this figure relates to primary production and the final net reduction would be lower. See reference 2 for a more detailed overall estimate.

modelling. Certainly, for example, zinc was a key constraint on the model in Spain.
4. We found it difficult to disaggregate energy spent on cooking and processing foods in the home, but this is clearly a component of GHG production: more efficient ways of cooking and less processing could therefore have an effect on GHG emissions. It seems possible that more energy-efficient ways of food preparation can also be healthier, but this needs to be tested.
5. We used data on the nutritional composition of foods without consideration of the actual bio-availability (i.e. the ability of the body to absorb the nutrient from the food). For example it is suggested that the absorption of zinc and iron from cereals is less efficient than from meat (see reference 8). To some degree this can be mitigated by methods of food preparation (for example fermentation, soaking and sprouting of grains). We considered this issue to be too complex for analysis here and further work is required.
6. We avoided consideration of drinks outside fruit juices milk and one soft cola drink - and in particular excluded alcohol from the model. Drinks cause some data issues, for example related to relative level of dilution and, in any case, tend to be a personal choice which is not seen as part of the diet (i.e. a change in the menu will not have a significant effect on what the average person drinks with their meal). On the other hand, drinks can be a significant contributor to GHG (for example tea and coffee) whilst alcohol may have other nutritional impacts (for example overall energy)

4.7 Cost of the diet

Cost was never a binding constraint in terms of finding a solution which reduced GHGe appropriately, and this shows that a healthy and sustainable diet is not necessarily an expensive one – see Annex 5 for more details of sensitivity analysis. In general key constraints related to nutrition. In some cases we used recommendations which were higher than the average consumption reported in the dietary survey (for example the recommended intake of zinc is almost 50% higher than the average consumption in Spain).

Cost did have some binding effect on acceptability, however: for both the Spanish and Swedish sample menus, the cost is estimated to be the same as the current average diet. In other words, cheaper menus are possible, but at the expense of being near to current consumption.

4.8 Specific issues for each country

4.8.1 France

Data for France was based on the diet consumed by women participating in the nationally representative INCA 2 dietary survey (2007 - reference 14). After exclusion of energy under-reporters following the appropriate procedures (see reference 15), dietary data from 1142 women were used to estimate the mean population diet, i.e. the observed diet consumed by women in France. To limit the bias of acceptability induced by the estimation of the mean population diet, average consumption of food items was weighted. A weight was estimated for each food item according to its consumption among an EPIC[12] food group. More precisely, this weight was calculated by the ratio between the consumption of this corresponding food item and the sum of the consumption of selected food item in the EPIC food group. This lead to a weight value between 0 and 1 and the sum of each weight in a given EPIC group is 1. Then, average consumption of each EPIC food group was calculated and, in a last step, each food item weight was applied to the average consumption of EPIC food group, leading to a weighted average consumption for each food item.

All models were run using **linear programming**. When applied to nutrition, linear programming is a mathematical tool used to find the optimal solution of a linear function (the **objective function**) of **food variables** fulfilling a set of linear equality and inequality **constraints**. In the present study, two kinds of models were developed. The first model was built to produce a LiveWell diet: it minimized total departure from the mean population diet (objective function) while achieving nutritional constraints subject to a 25% GHG reduction. A sensitivity analysis was run by increasing the reduction of GHG to 50% and 70% (see Annex 3). The second set of models (A, B and C) aimed to directly minimize total GHG while achieving nutritional constraints (results in appendices). The nutrient content and GHG values were available for a list of 68 frequently consumed food items, which constituted the **food variables** in all the models. The healthiness of the modelled diets was ensured by the fulfilment of several **nutritional constraints**, i.e. a set of constraints on nutrients (the list of which was the same as that used for producing the original UK Livewell diet) plus another set of constraints on food groups, the latter being based on the French food-based dietary guidelines (FBDGs) for the general population (http://www.mangerbouger.fr/). In the LiveWell model, social **acceptability constraints** were added to avoid an unrealistic diet.

To analyse the impact of a cost reduction on GHG, a cost sensitivity analysis was conducted (See Annex 5).

The detail of the methodology for each model is displayed in Table 1.

12 EPIC food groups were used a neutral system of classification, although they do not correspond exactly to either the INCA survey or French food-based dietary guidelines.

Table 1. Summary of LP models.

	LiveWell model	GHG minimized models			
		M1	M2	M3	
Minimized Objective Function	Sum of the absolute deviation from average individual food intake[13]	Total GHG of the diet.	Total GHG of the diet.	Total GHG of the diet.	
GHG constraint	Total GHG lower than 75% of observed GHG (i.e. 25% reduction)	-	-	-	
Nutritional constraints	Nutrient recommendations (see Table 2)plus French FBDGs (see Table 3)	Nutrient recommendations (see Table 2)	French FBDGs (see Table 3)	Nutrient recommendations (see Table 2)plus French FBDGs (see Table 3)	
Cost	None	None	None	None	
Acceptability constraints	Maximal number of portions on each individual food (see Table 4).	-	-	-	

13 This function was non-linear. To apply linear programming the function was transformed into a linear function using a published method (see reference 7)

Table 2. Daily energy and nutrient intakes of French women (n=1142) based on the INCA2 dietary survey (2007 reference 14), and corresponding nutrient-based recommendations for that population - reference 16 - (used as nutrient-based constraints where needed).

Nutrient	Observed mean intakes	Corresponding recommendations Minimum	Maximum
Energy, kcal	1814	1800	1800
Proteins, g	68	50	
Carbohydrates, g (%TE)	202 (44.5%)	225 (50%)	337 (75%)
Fibres, g	14	25	
Lipids, g (%TE)	81 (40%)		70 (35%)
Saturated fatty acids, g (%TE)	32 (15.8%)		20 (10%)
Sodium, mg	2053		2365
Calcium, mg	581	900	
Iron, mg	8	14	
Zinc, mg	7	10	
Vitamin B12, mcg	3	2,4	
Folates, mcg	188	300	
Added sugars, g (%TE)	39 (8.6%)		45 (10%)

Table 3. Food group intakes of French women (n=1142) based on the INCA2 dietary survey (2007 reference 14) ,and corresponding food-based dietary guidelines (FBDGs, used as constraints on food groups where needed).

French PNNS food groups	Observed mean intakes portions/d	Corresponding FBDGs Minimum	Maximum
Fruits and vegetable	**4.52**	**5**	
Fruit juice	*0.32*		*1*
Nuts	*0.03*		*1*
Starchy food	**2.21**	**3**	
Dairy products	**2.06**	**2.5**	**3.5**
Meat, Fish, Eggs	**1.48**	**1**	**2**
Fish	*0.30*	*0.29*	
Fat	**4.37**		**3.5**
Olive oil	*0.96*	*1*	
Sunflower oil	*0.39*	*1*	
Sweet products	**4.24**		**2**
White *sugar and honey*	**3.17**		**2**
Drinks	**0.30**		**1**

Table 4. List of foods (with portion size) used as variables in the models and their average consumption by French adult women.

Food items	EPIC food groups[1]	Average intake, g/d	Portion size, g	Maximal number of portions*
Potato chips salted	1	1.49	150	1
Scalloped potatoes	1	7.47	150	1
Boiled potato	1	33.10	150	1
Fried potato (frozen)	1	8.99	150	1
Potato salad	1	4.95	150	1
Raw carrot	2	19.08	80	1
Raw endive	2	5.33	80	1
Canned green beans drained	2	21.25	80	1
Cooked onion	2	4.26	80	1
Green salad without dressing	2	26.86	80	1
Raw tomatoes	2	55.75	80	1
Tomato Provençal	2	8.68	80	1
Lentils cooked	3	8.79	150	1
Fresh banana	4	20.86	80	1
Clementine	4	22.67	80	1
Stewed apple	4	13.91	80	1
Walnuts	4	0.67	20	1
Fresh orange	4	16.02	80	1
Fresh unpeeled apple	4	87.22	80	1
French cheese (Camembert)d	5	7.86	30	1
Low fat cream	5	1.48	125	1
High fat cream	5	2.67	125	1
Cream cheese 20% fat	5	10.44	125	1
Gruyere cheese	5	6.37	30	1
UHT semi-skimmed milk	5	143.23	200	1
Yogurt with fruit	5	13.92	125	1
Yogurt	5	26.33	125	1
Appetizer cracker biscuit	6	1.23	150	1
Bread baguette	6	72.81	60	3
Bread wholegrain	6	7.24	60	3
Cooked pasta	6	41.27	150	1
Cooked white rice	6	23.41	150	1
Grilled lamb chops	7	3.72	100	1
Turkey	7	11.51	100	1
Cooked ham	7	23.38	100	1
Grilled bacon	7	3.31	100	1
Roasted chicken	7	24.24	100	1
Dried sausage	7	3.27	100	1
Ground beef 15% fat	7	24.62	100	1

Baked cod	8	2.89	100	1
Cooked shrimp	8	3.42	100	1
Hake cooked	8	5.26	100	1
Sardines canned in oil drained	8	1.00	100	1
Steamed salmon	8	9.63	100	1
Raw smoked salmon	8	1.75	100	1
Canned tuna in brine drained	8	5.88	100	1
Boiled egg	9	14.45	60	1
Unsalted butter	10	16.11	10	3
Olive oil	10	9.56	10	3
Sunflower oil	10	3.87	10	3
Honey	11	8.32	10	1
White sugar	11	23.36	10	1
Industrial packed cake (brioche)	12	12.62	40	1
Chocolate Bread (pain au chocolat)	12	14.47	40	1
Fruit tart (industrial)	12	39.20	100	1
Orange juice 100% e (pasteurized)	13	64.04	200	1
Cola drink	13	59.21	200	1
Low fat margarine	15	14.11	10	1
Vegetable soup (industrial)	16	17.70	200	1
Vegetable soup home-made	16	60.00	200	1
Cassoulet (canned)	17	11.34	200	1
Cheeseburger	17	6.34	200	1
Pizza	17	14.94	200	1
Fried breaded fish	17	11.07	200	1
Quiche Lorraine	17	13.59	200	1
Meat ravioli with tomato(canned)	17	16.11	200	1
Tabbouleh	17	9.96	200	1
Stuffed tomato	17	13.76	200	1

*** A maximal number of portions per day was imposed to each food variable to help ensure social acceptability to the Livewell diet**

[1] see task 1 for references about definition of EPIC food groups

4.8.2 Spain

Spain has produced a remarkably comprehensive and detailed dietary survey, detailing consumption of many individual and infrequent items such as specific types of fish and sea food. Dealing with this wide range of different foods (the final model had 277 different foods) caused some challenges in developing the data for modelling, particularly the following:

1. Lack of GHG data specifically for Spain – as explained in Annex 4 we adapted data from elsewhere. Many of the specific items where data was difficult to find had very low consumption and for this we believe that estimates from comparable foodstuffs suffices.
2. Some deficiencies in the nutritional data. The BEDCA database for Spain does not cover all the foodstuffs in the ENIDE national dietary survey. We used data from France and Sweden to cover the gaps for nutritional information. In addition, inspection of details for individual foods showed some missing figures, specifically related to iron and zinc which we estimated from comparable foods.[14] Inspection of data suggested that iodide composition was not in all figures and was unreliable and therefore we took this out of the model even though it is a Spanish nutritional recommendation.

Spanish recommendations for iron and zinc (and iodide content) are relatively high compared to other countries and we note that the average diet does not fulfil the recommended amounts for these minerals. We considered whether to make an adjustment for under-reporting based on this fact – but since it is possible to produce a diet without this adjustment we have not done this.

To define general bounds for different foodstuffs we defined popular foods using comparison of the standard deviation to the mean (Tchebyshev's inequality[15]). We started modelling with a combination of the following constraints:

1. For popular foods we allowed consumption to increase by 4.5 times, and not to fall below 30% of the average value or 5g/day
2. For other foods we allowed consumption to increase by 3.3 times and excluded foods where the maximum would be less than 1g a day (to avoid excessive numbers of small items).

The figures chosen here were determined empirically in order to create a diet with appropriate variety and acceptability.

Additional bounds were imposed in order to produce an acceptable diet. Some discussion was necessary here because the nutritional recommendations (specifically related to iron) resulted in small amounts of liver and black pudding in the diet which were difficult to integrate into the menu. Initially we tried to put

14 The missing figures were generally related to areas where there was a benchmark figure e.g. different cuts of meat from the same animal

15 We had figures for the deviation and the mean but no indication directly of the percentage of the population eating each foodstuff

restrictions on the degree of divergence of food groups from the average but experimentation showed that it was difficult to produce an acceptable menu with these conditions.

We note that the very large number of small items in the dietary survey might suggest wide differences in individual diets and certainly suppose that there are real regional differences within Spain in the cost and availability of different foods, and actual menus. However, we have based our research purely on an average menu.

4.8.3 Sweden

The latest dietary survey (Riksmaten) is now more than ten years old. This is currently being renewed, but the results for the current survey will not be published until Autumn 2012 and therefore we were unable to take them into account. This caused some issue with price information, which we took from a recent Household Budget Survey (2009), but checking items on online supermarket portals suggests that there is an acceptable match and that the average Swedish diet has not changed markedly during this period.

The fact that the survey is old does not in itself have a marked effect on modelling, since the data used for the model (GHGe, nutrition, and cost), is up to date. However, the survey data caused some issues, most specifically with regard to the fact that some items were very generic (e.g. fish in total). Since we used the survey as a benchmark and reported change against it, we were obliged to use the same categories in our modelling.

For generic items we made estimates for the production of appropriate GHG, nutrition and cost data. For example for fish we estimated consumption based on HBS data and current prices and produce GHG estimates and nutritional data based on this. In modelling, however, this leads to the production of a LiveWell diet categorised in the same way and therefore does not consider the effects of different combinations (e.g. more herring and less cod). We left this position since it fits more clearly with acceptability criteria and in any case the model produces a feasible solution.

We noted that the energy from the average diet is considerably less than the levels recommended in SNR. To avoid distortions created by increasing foods purely for energy content, and noting experience from elsewhere (for example decisions made in the LiveWell UK work) we increased consumption by 25% on the basis that this was caused by under-reporting.

As initial constraints for the model we used the following for acceptability:

1. Consumption of food in each of the "food circle" categories at least 75% of the current SNO recommendations
2. Bounds on popular foods (50% of either men or women eat this food) based on 4 times more or at least 30% of average consumption
3. Bounds for unpopular foods (less than 25% of men and less then 25% of women eat this food) bound at 2 x current average
4. For other foods, a bound of 3 x average current consumption

Additional bounds were imposed in order to produce an acceptable diet

The figures chosen here were determined empirically in order to create a diet with appropriate variety and acceptability.

5. Conclusions

5.1 General

The research here shows that it is possible to work in three different European countries using the principles and methods embodied in the Livewell UK research. Although there were differences in the availability and quality of data, we have demonstrated that it is possible to put together linear programming models which show that it is certainly possible to reduce GHG emissions by choice of foods without increasing the cost of the diet, falling outside nutritional guidelines, or producing menus which would be unacceptable to the majority.

In doing this, as well as producing a set of sample menus which demonstrate the possibility of achieving a 25% reduction in GHGe, we have produced:

1. Sensitivity analysis showing in general terms what is achievable
2. Details of methodologies for developing an acceptable diet based on a linear programming model but working on slightly different bases
3. Approaches to coping with data deficiencies and making sufficient assumptions in order to make valid conclusions

We hope therefore that this report can form a guide for future researchers in the same topic in other countries and situations as well as being a first step in showing how sustainable diets can be created in the three countries under observation.

5.2 Research Questions

We return to the key research questions which we sought to answer.

5.2.1 Can a healthy diet be more environmentally sustainable?

Answer: Yes, for all three countries

It is clear that, although nutritional recommendations act as binding constraints, it was relatively easily to construct a healthy diet which reduces GHG emissions. In doing this we should recognise some limitations of the methodology and the need to have better information on nutrients. Specifically:

- some constraints (such as specific fatty acids) were missing from recommendations and from nutritional data
- we did not take into account differential nutrient bio-availability depending on the sources of nutrients (important for Fe, Zn, Ca, proteins, vit A) – this is an important factor, bearing in mind that, for example, iron and zinc are chiefly sourced from meat and dairy in current diets but it is also acknowledged that the degree of absorption is higher from meat rather than vegetable sources: for further discussion see reference 8.

Nonetheless, we can suppose that this result partly relates to the “unhealthy” part of the current diet, which to some degree can include over-consumption in general and unnecessarily high consumption of high-GHG foods (specifically meat).

5.2.2 Can a diet be healthy, economic and respect the environment?

Answer: Yes, for all three countries

Although the cost of the LiveWell diets approached that of the current average diet, this related in general to choices made to enhance acceptability. Without acceptability constraints, healthy diets which reduce GHG emissions are almost inevitably cheaper than current diets.

5.2.3 What is the lowest level of GHG emissions that may be reached while fulfilling nutritional recommendations and not increasing diet cost?

Our models suggest that it is possible to have a diet which fulfils current dietary recommendations and reduces GHG emissions by at least 50%. Although the models show that it is possible to reduce emission further than this, the resultant diets have a limited number of different foods (very low variety) and are so extreme that the validity of the data is questionable. Even with a 50% reduction in emissions the diet would be unrecognisable to most consumers, typically requiring a reliance on legumes as a source of protein, a much larger amount of vegetables, and much less meat.

5.2.4 What would be a healthy sustainable diet which reduces GHG by 25% and minimises change from the current diet?

The LiveWell diets shown in this report demonstrate one possibility for this. Our experience in creating these diets would suggest that there is a variety of diets which would also meet the criteria, particularly noting that the concepts of "acceptability" and "change from the current diet" are inevitably partially subjective. We note from the reception of the Livewell UK report, that detailed menus can create quite strong reactions and we again emphasise that these are samples: the evidence suggests that there are other solutions which may be more acceptable to different sectors of society than those we exhibit. On the other hand, a reduction of 25% does mean real changes in the diet and not the same things in a different combination. All the diets show real changes in composition, particularly the decrease in meat, and increase in cereals and legumes.

5.2.5 How can we show consumers that this is a viable change in diet?

We have demonstrated that it is possible to produce an “acceptable” weekly menu which can be used as a tool in promoting a more sustainable diet.

More work needs to be done on communication and how it is interpreted by consumers, using this as a tool. We note that many years of public nutritional guidance and food-based dietary guidelines seem to have disappointingly little effect on people's eating habits, but we would hope that sustainability can be incorporated into national guidelines as they develop in the future.

5.2.6 What are the general implications?

We can see from the analysis here that it is possible to produce a "LiveWell" diet for three very different Western European countries. The implication is that the same exercise could be done for other European countries and a diet for each developed. We hope that this report demonstrates a methodology which could be used and explains the ways in which we adapted data for cases where it was fragmentary, inconsistent, or non-existent.

It seems likely that with judicious adjustment of the diet (for example, eating local and seasonal foods in preference to imported ones, and accepting a lower amount of meat), it would be possible to decrease GHG even further. The 25% is an arbitrary figure for the exercise based on overall carbon targets and does not represent a boundary for acceptability or possibilities of reduction.

It is not clear whether the same approach will produce a valid result in countries further afield. Countries in Eastern Europe have a different supply chains (until fairly recently, the countries participated much less in the global food market), have more markedly different eating habits, have a greater percentage of the population who produce their own food, and are currently in transition to a more globalised economy. We can hypothesise that diets are sufficiently similar that a similar result could be obtained, but we feel there is need for further research. We note that we have had difficulty getting data for Spain and have therefore had to make widespread assumptions regarding applicability of data for other countries. We suspect that this will be a greater challenge for Eastern Europe since it will be more difficult to support assumptions based on comparisons with Western Europe.

We also seek to identify the impact of the LiveWell diet on farmers in Europe. We can make the following observations:

1. The changes will reduce the consumption of livestock products and this will have a net negative effect on agricultural output, unless European farmers switch to more exports. Several studies have shown that this switch reduces the monetary value of farm-gate sales (reference 17).
2. Widespread adoption of a Livewell diet would reduce the demand for meat and dairy products and reduce these sectors of production changes in line with consumption.
3. The changes are unlikely to be abrupt and will be absorbed by market adjustments. However, change at the margins may be significant in this adjustment phase. The immediate effect would be a contracting domestic market for meat and dairy products which will depress prices and reduce incentives for production expansion.

However, a number of additional factors come in to play and need to be considered:

1. There are links between production of different foodstuffs, most particularly between beef (meat) production and dairy.
2. The current food system is heavily dependent on comparative advantage for cereal and maize production for animal feed in Europe complemented by protein crop production in South America. The change would lead to a fundamental change to these structures, for example up to a 75% reduction in the need for imported soy (see reference 18).
3. Optimising the food system in terms of GHG emission reduction requires better LCA data (though this should not be an excuse for inaction). The environmental costs of production are not reflected in costs and as a result options that increase GHG emissions may be more economic. In some cases, reducing GHG emissions may be counter-intuitive, for example when food transported over long distances has a lower impact compared with locally grown food.
4. The effect on prices can be complex. If the population consumes less meat then in the short term the price would fall.[16] There is a danger that this would naturally give the consumer an incentive to eat the wrong things. Changing the food system requires careful planning and adjustments of prices.

5.3 Need for further research

This type of analysis is in its infancy and there is much further work to be done. We would like to highlight the following as areas for further work

1. Generation of better and more consistent GHG data. Already some work has been done (for example HLCWG, LCAfood and Eat England) which groups together data to allow some idea of a consistent database for further countries, but still there is a need to add to this. Full LCA needs to take into account effects of land use change which we have ignored for the purposes of the current report.
2. Research on the question of seasonality in food: to what degree would diets with a strong seasonal component have an effect on GHG emissions? And would there be adverse health implications?
3. Research into the question of GHG emissions related to cooking and preparation of food. We did not take this into account systematically.
4. Further research and consideration of the effect on farmers of a changing diet, and the way in which subsidy and support mechanisms need to be adjusted to support this. Such research should bring into consideration links between production of different foods (e.g. meat and dairy).
5. Consideration of minority and regional diets: for large and diverse countries such as UK, France and Spain, should there be different LiveWell diets for different geographical locations and sectors of society?

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16 We temporarily ignore the effect of subsidies and supermarket monopoly/monopsony

6. Research into the bio-availability of certain key nutrients and the effects of changing the sources. Specifically we need more data on sources for iron, zinc and calcium. A better understanding here would allow more consistent guidelines for recommended amounts of these nutrients in the diet.
7. Research into shopping habits and how this can affect GHG emissions (for example in transport costs and in trade-offs between better variety of low-GHG food and the GHG burden of transport in finding it)
8. Incorporation of other factors in the definition of sustainability including considerations of water and biodiversity
9. It may be appropriate to revisit the Swedish diet in the light of the renewed survey in autumn 2012.

Annex 1 - Shopping Lists

France

Food items	Nutritionally equivalent foods	Number per week x portion size (g)
Camembert	Soft cheeses	7x30
Gruyere cheese	Hard cheeses	2x30 and 1x34.2
UHT semi-skimmed milk		7x150
yogurt with fruit or specialty dairy unspecified	All types	2x125
specialty yogurt or dairy type	All types	
beat cream cheese 20% m.g. nature	cream cheese	2x50
turkey	chicken, poultry, prey	53.2
roasted chicken meat with skin		54
cooked ham	Pork	48.9
ground beef 15% m.g. cooked	All types	1x100 and 1x72.3
sardines canned in oil drained	Canned mackerels	2x101 .5
egg	Fried, scrambled, boiled, poached	50 .6x2
pasta	All types (noodles, macaroni)	150x1 and 138 .9x1
white rice	All types (brown rice)	150x1 and 13 .8x1
bread	All types of French bread (baguette..)	2.5 baguettes
bread wholegrain	All types	3.5 breads wholegrain
scalloped potatoes		52 .3
potato boiled in water		100x1 and 131 .7x1
potato salad		34 .7
chips fried potato	Fresh, frozen	62 .9
lentils cooked	Fresh, canned	7x150
cassoulet	Canned, homemade, frozen	79 .4
meat ravioli with tomato sauce	Fresh, homemade, canned	112 .8
tabbouleh or couscous salad	Homemade, canned	69 .7
pizza	Homemade, frozen	2x50
quiche Lorraine	Homemade, frozen	
stuffed tomato	Homemade, frozen	96 .3
raw carrot		53 .6x1 et 80x1
raw endive		37 .3
green beans	Fresh, canned, frozen	2x80 and 1x160 and 1x177

		.7
cooked onion		29 .8
green salad		2x80 et 1x28
Raw tomato	All types	4x80 et 1x70 .3
Tomato Provencal	All types	60 .8
vegetable soup	Canned, frozen	123 .9
vegetable soup homemade		1x100 and 3x106 .7
fresh banana		1x80 and 1x66
compote	Canned, fresh	97 .4
walnuts	Seeds, nuts	11x3
fresh orange		80x1 and 32 .1x1
clementine		7x60 .5
Fresh unpeeled apple		80x7
honey	marmalade	5x10 and 8 .3x1
White sugar		7x7 .6
chocolate Bread puff pastry	Artisanal, processed	2x40 and 1x21 .3
cola-type soft drink coca-cola or pepsi	Soft drinks, all types	120x3 and 1x54 .5
olive oil		10x7
sunflower oil		10x7

Spain

This list has a large number of small items on it and would perhaps be more appropriate for a shopping list over a longer period than a week. In this sense it should be taken as demonstrative of the foods to be bought over a longer period and not the exact set of food items to be bought in a single weekly shopping expedition.

Category	*Items*	*Amount (g)*
Cereals	bread (white, whole grain)	1585
	bread products (rusks etc)	48
	breakfast cereals	87
	rice	178
	pasta in general	175
	precooked items (buns, patties)	50
	wheat flour	146
	other flour and cereals (corn)	48
Fruit juice	orange juice	161
	other (peach, tomato)	71
Eggs	eggs	361
Oil	olive oil	161
Fruit	apple	197
	pear	156
	orange and mandarin	298
	banana	77
	olives	30
	other (melon peach quince strawberries watermelon)	179
Meat and meat products	black pudding	35
	chicken	152
	ham	140
	pork	307
	sausage, salami, fuet etc	76
	roast turkey	26
	other (liver, partridge, quail)	24
Dairy products	cheese	35
	milk (whole, semi-skimmed, skimmed)	1072

	yoghurt	140
	other types of milk and substitutes	73
	curd	13
Miscellany	prepared tomato sauce	324
	pasta tuna salads	12
	herbs and spices	27
	salt	32
	vinegar	35
Nuts and oilseeds	almonds hazelnuts peanuts walnuts sunflower seeds	113
Seafood	Anchovy	20
	Canned sardines in oil	11
	Canned tuna in oil, Albacor, mackerel and other	49
	Hake sliced	54
	Mackerel	16
	Monkfish	45
	Mussels	69
	Sardines	176
	Sole, Megrim, Plaice	49
	Squid sepia and similar	93
Sugar and sugar products	cocoa	13
	nougat and marzipan	13
	sugar	35
Legumes	beans	39
	chickpeas	62
	lentils	53
Vegetables	Artichokes	133
	Asparagus	39
	Beet	12
	Carrot	35
	Cauliflower	78
	Celery	19
	Chard	24

	Chives	8
	Endive	14
	Garlic	39
	Green beans, Pods	231
	Green peas	202
	Leeks	59
	Lettuce	175
	Mushrooms and fungi	77
	Onion	93
	Peppers	42
	Potatoes	778
	Pumpkin	47
	Soy	15
	Spinach	35
	Tomato	420
	Watercress and corn salad	14

Sweden

Owing to the generic nature of the initial diet and the way in which the initial dietary survey was created, this shopping list includes some wide categories. In this sense it should be seen as indicative and if it is used as a basis for a diet, then discretion should be used, for example in exactly which vegetables are bought.

Category	*Items*	*Amount (g)*
Potatoes	boiled mashed	1027g
Legumes	lentils	89g
Bread	whole grain, white, rye bread	954g
	crispbread	36g
Cereals	muesli/breakfast cereals	140g
	rice	47g
Pasta	spaghetti, macaroni	245g
Vegetables	carrots	266g
	other root vegetables	140g
	cucumber	78g
	tomatoes (fresh)	479g
	cabbage	123g
	mixed salad	476g
	mushrooms	53g
	peas, corn, mixed vegetables	196g
	other vegetables for stir-frying	388g
Fruit	banana	159g
	oranges	1000g
	apples/pears	826g
	kiwi	49g
	berries	63g
Dairy products	cheese (28%)	98g
	yoghurt (3% + 0.5%)	1092g
	full milk	371g
	fruit yoghurt	203g
	semi-skimmed milk	753g
	fermented milk	168g
Meat and meat products	beef	85g

	pork	91g
	chicken	350g
	deli meats	47g
	sausage and toppings	168g
Fish	salmon (60%) cod (30%) herring (10%) (fresh)	621g
Eggs	eggs (around 8)	420g
Margarine	bregott margarine	105g
	margarine (40%)	189g
Miscellany	sugar	35g
	tomato ketchup	35g
	peanuts	49g
Sweet foods	pastries and biscuits	249g
	ice cream	91g
	prepared dessert (e.g. rice pudding)	315g
	jam	42g
Drinks	apple juice	650g
	cola drink	276g

Annex 2 – Detailed Menus

This annex shows the detailed amounts of different foods in the dishes in the menus shown in section 3.

France

Evening meals	
vegetable soup Vegan stuffed tomato bread wholegrain Yogurt with honey Apple	106.7ml vegetable soup homemade kind 70.3 g tomato 69.7 g semolina 106.7g Canned green beans drained 10g sunflower oil 150g bread wholegrain 125g Yogurt with 10g honey 80g apple
vegetable soup bread wholegrain Lentil salad+vinaigrette yogurt with fruit Apple	123.9g vegetable soup homemade kind 30g bread wholegrain 150g lentils + 10ml sunflower oil 125g yogurt with fruit 80g apple
Green salad with walnuts + vinaigrette Tomate farcie et macaroni Pain+ brie Clémentine	80g green salad + 11g walnuts+10 ml sunflower oil 96.3 g stuffed tomato + 150g pasta 30g bread wholegrain + 30g brie 60.5 g clementine
Green salad with lentils + vinaigrette 1 slice of Pizza 1 slice of quiche Lorraine Camembert+bread	80g green salad+150g lentil+10ml olive oil 50g pizza + 50g quiche Lorraine 30g camembert 30g bread

Apple	80g apple
Tomato salad with green beans and walnuts + vinaigrette meat ravioli with tomato sauce Clementine	80g tomato +80g Canned green beans drained + 11g walnuts 10g sunflower oil 112.8 g meat ravioli with tomato sauce, canned + 30 g gruyere cheese 60.5g clementine
vegetable soup French flavour plate : Set of cassoulet and scalloped potatoes Bread beat cream cheese 20% m.g. nature banana	106.7 vegetable soup homemade kind 79.4g cassoulet + 52.3 scalloped potatoes 49.7g White bread 50g beat cream cheese 20% Fat nature 80g fresh banana
Vegetable soup Spanish lentils gruyère Bread Banana	106.7 vegetable soup homemade kind 150g lentils + 37.4g boiled potatoes+80g tomato+10 ml sunflower oil 30g Gruyere 60g White bread 66g Banana
Lunches	
Grated carrot+ vinaigrette Mashed lentils Sardines Bread Camembert canned applesauce	53g carrot + 10g olive oil 150g lentils 101.5g sardines canned in oil drained 30g White bread 30g camembert 97.4g canned applesauce
endive and potato salad	37.3g raw endive + 100g boiled potato+11g walnuts+10ml

with walnuts and vinaigrette Ground beef+Pilau Rice bread wholegrain Camembert Clementine cola-type soft drink	olive oil 100g ground beef+150g white rice pasta 30g bread wholegrain 30g camembert 60.5g Clementine 120g cola-type drink
Green beans with vinaigrette turkey with Lentils +onion+ Carrots + olive oil White bread beat cream cheese with apple cola-type soft drink	80 g Canned green beans drained+5g olive oil 150g lentils+53.2g turkey+29.8g onions+ 80g carrots+5 g olive oil 30g white bread 50g beat cream cheese + 80g apple 120g cola-type drink
Cream of vegetables Spaghetti bolognaise White bread Clementine	100g vegetable soup homemade kind 138.9g pasta +80g tomato + 72.3g ground beef +34.2g gruyere 30g White bread 60.5g Clementine
Lentil soup Chicken and chips fried potato and Tomato Provencal Camembert bread Apple cola-type soft drink soda	150g Lentil 54g chicken + 62.9g chips fried potato frozen cooked +10g olive oil+60.8g tomato Provencal 30g white bread + 30g camembert 80g apple 120g cola-type soft drink
Mixed salad	160g green beans+80g tomato+28g green salad+ 48.9

 Lentils cake White bread +camembert Clementine Cola-type soft drink soda	cooked ham+10g sunflower oil 131.7g boiled potato + 150g lentils 40g white bread+30g camembert 60.5g Clementine *54.7g* Cola-type soft drink soda
Green beans salad Sardines Camembert and Bread wholegrain Apple with Honey	177.7 Canned green beans drained + 10g Olive oil 101.6 sardines canned in oil drained 30g Camembert+120g bread wholegrain 80g Apple + 10g Honey
Breakfast	
Coffee with milk sugared Chocolate Bread Clementine	150g milk + 7.6g sugar 40g Chocolate Bread 60.5g clementine
Coffee with milk sugared White bread with honey Boiled eggs Orange	150g milk + 7.6g sugar 60g white bread+10g honey 50.6g Boiled eggs 80g orange
Coffee with milk sugared Bread with honey Chocolate bread Orange	150g milk + 7.6g sugar 90g white bread+30g white bread+10g honey 21.3g Chocolate bread 32.1g orange
Coffee with milk sugared Bread with honey	150g milk + 7.6g sugar 90g white bread+10g honey

Orange	32g orange
Coffee with milk sugared Bread wholegrain with honey Orange	150g milk + 7.6g sugar 126.6g bread wholegrain +10g honey 60g orange
Coffee with milk sugared French toast with honey Apple	150g milk + 7.6g sugar 120g Bread wholegrain+50.6 boiled eggs+10g olive oil+8.3g honey 80g apple
Coffee with milk sugared Chocolate bread Clémentine	150g milk + 7.6g sugar 40g Chocolate bread 60.5g Clementine

Spain

Olivier salad.

Potatoes	200g
Carrots	15g
Green beans	30g
Hard-boiled egg	15g
Canne tuna in olive oil	35g
Mayonnaise: egg	25g
Olive oil	25ml
Salt	1g

Zarzuela fish stew.

Monkfish	15g
Hake slice	25g
Sole	25g
Tomato sauce	30ml
Wheat	0,5g
Garlic	2g
White wine	15ml
Chives	7g
Olive oil	3ml
Salt	1g

Green beans and cured ham stir fry.

Green peas	70g
Tomato sauce	50ml
Garlic	1g
Onion	5g
Cured ham	25g
Liver	15g
Olive oil	3ml

Salt	1g

Garlic chicken.

Chicken	100g
Garlic	5g
White wine	15ml
Wheat	3g
Pepper	1g
Parsley	1g
Brown rice	10gs
Olive oil	3ml
Salt	1g

Roasted vegetables with Romesco sauce.

Pumpkin	35g
Endive	11g
Potatoes	75g
Romesco: Mixed nuts	20g
Vinegar	3ml
Garlic	1g
Rusk	5g
Tomato sauce	20ml
Dry peppers	1g
Olive oil	3ml
Salt	1g

Potato omelet with corn salad and Cherry tomato salad.

Eggs	100g
Potatoes	125g
Onion	10g
Olive oil	3ml
Salt	1g

Corn salad	15g
Tomato	18g

Gazpacho.

Tomato	175g
Peppers	5g
White bread	15g
Garlic	1g
Vinegar	25ml
Olive oil	3ml
Salt	1g

Fideua.

Noodles	230g
Monkfish	20g
Garlic	2g
Tomato sauce	30g
Saffron	1g
Paprika	1g
Olive oil	3ml
Salt	1g

Tomato salad.

Tomato	200g
Onion	10g
Lettuce	40g
Soy	15g
Olive oil	10ml
Salt	1g
Vinegar	3ml

Steamed mussels.

Mussels	22g
Olive oil	2ml
Salt	1g

Lentil stew with black pudding.

Lentils	150g
Onion	10g
Black pudding	35g
Potatoes	40g
Garlic	1,5g
Paprika	1g
Olive oil	3ml
Salt	1g

Spinach Cannelloni.

Cannelloni pasta	60g
Spinach	35g
Chard	21g
Tomato sauce	35ml
Other types of flour	6g
Other types of milk	50ml
Walnuts	25g
Olive oil	3ml
Salt	1g

Vegetable Paella

Rice	250g
Green beans	40g

Onion	10g
Peppers	35g
Tomato sauce	30ml
Garlic	1g
Green peas	10g
Saffron	1g
Olive oil	3ml
Salt	1g

Pickled quail.

Quail	25g
Carrot	10g
Onion	10g
Garlic	1,5g
Potatoes	50g
White wine	20ml
Parsley	1g
Pepper	1g
Thyme	1g
Laurel	1g
Olive oil	3ml
Salt	1g

Steamed artichokes.

Artichokes	55g
Olive oil	3ml
Salt	1g

Scrambled eggs with mushrooms and toasted whole grain sandwich bread.

Eggs	100g

Mushrooms	75g
Whole grain sandwich bread	25g
Garlic	1g
Olive oil	3ml
Salt	1g

Toast with canned sardines in olive oil and anchovy.

Whole wheat bread	125g
Canned sardines in olive oil	10g
Anchovy	15g
Olive oil	5ml

Garden salad with sunflower seeds

Lettuce	100g
Sunflower seeds	25g
Celery	15g
Asparagus	35g
Onion	10g
Canned corn	15g
Olives	25g
Beet	8g
Olive oil	10ml
Salt	1g
Vinegar	5ml

Arroz a banda

Rice	250g
Hake slice	10g
Sole	10g
Potatoes	40g

Onion	5g
Tomato sauce	30ml
Garlic	2,5g
Saffron	1g
Laurel	1g
Paprika	1g
Olive oil	3ml
Salt	1g

Pork sausages and white beans.

Pork sausages	100g
White beans	100g
Olive oil	2ml
Salt	1g

Vegetable stew with potato and cured ham

Green beans	40g
Leek	40g
Garlic	1g
Cured ham	15g
Potatoes	60g
Olive oil	2ml
Salt	1g

Grilled sardines with fried cauliflower.

Sardines	80g
Olive oil	2ml
Salt	1g
Cauliflower	35g
Wheat	5g

Ratatouille.

Zucchini	40g
Tomato sauce	100g
Peppers	20g
Onion	10g
Garlic	1g
Parsley	1g
Olive oil	3ml
Salt	1g

Fried eggs with French fries.

Eggs	100g
Potatoes	100g
Olive oil	20g
Salt	1g

Cream of chickpeas.

Chickpeas	125g
Potatoes	50g
Olive oil	2ml
Salt	1g

Pork loin with Piquillo peppers.

Pork loin	125g
Peppers	20g
Garlic	1g
Olive oil	2ml
Salt	1g

Macaroni with mackerel and tomato sauce.

Macaroni	230g
Mackerel	12g
Tomato sauce	50ml
Onion	5g
Oregano	1g
Olive oil	2ml
Salt	1g

Stewed squid with carrots.

Squid	55g
Carrot	20g
Wheat	7g
White wine	15ml
Olive oil	2ml
Salt	1g

Sweden

Evening meals

Fish and potatoes, salad	124g fish + one egg + breadcrumbs 164g potatoes 200g salad creme fraiche
Fish with potatoes, veg [twice]	124g fish 200g potatoes 100g veg 100ml milk
Pork with pasta, veg	84g pork 250g pasta 100g veg ketchup
Meatballs with potatoes	84g beef 200g potatoes 42g lingonberry jam 35g cucumber
Chicken dinner	90g chicken 140g rice 100g veg 100ml yoghurt
Chicken with pasta, veg	90g chicken 250g pasta 100g veg

Desserts

Ice cream + berries	91g ice cream 13g biscuits 60g berries
Danish pastry [twice]	118g pastry
Rice pudding desert	315g
Fruit [3 times]	apple/orange 100g

Lunches

Fish + salad	124g fish 200g salad bread
Chicken pasta salad	62g chicken 235g pasta 50g mushrooms 100g yoghurt

Vegetable/lentil soup [twice]	133g lentils 150g veg inc 95g cabbage bread
Root vegetable stew	100g carrots 140g other root vegetables bread
Omelette [twice]	3 eggs milk 50g tomatoes bread
Breakfast	
Breakfast A [three times]	47g muesli 100ml yoghurt 217ml apple juice 12g crispbread (2 slices) 10g margarine bread with toppings
Breakfast B [twice]	100g fruit yoghurt bread with toppings
Breakfast C	1 egg poached 98g cheese (4 slices) bread
Breakfast D	bread with toppings
Snacks	
	Bread with toppings Fruit (apple/orange/banana/kiwi) – 13 fruits only one is banana, one kiwi Cola drink (276ml) Peanuts Sugar for coffee/tea (35g) Milk Yoghurt
Condiments	
	Ketchup 35g

Milk is in total 371ml full fat 754ml semi-skimmed 168ml fermented
Yoghurt is in total 798g with 3% fat and 294g with 0.5% fat
Bread is in total 475g wholemeal wheat, 206g wholemeal rye, 273g white [flour and breadcrumbs to be taken from this]
Toppings are 47g ham/salami 168g sandwich sausage, tomatoes and cucumber
Margarine is in total 105g bregott, 189g 40% fat [base for sauce and frying taken from this]

Annex 3 – Extreme Diets

Taking the model to its extreme of looking only at nutritional constraints and ignoring acceptability to produce diets which minimise GHG emissions using the same foods as in the national dietary surveys.

For France, we can exhibit a diet (fulfilling nutrient recommendations only) which reduces GHG up to 74% (921 g CO2 eq/d) and cost to 45% (2.7 euros/d).

Table 1. Minimized GHG model with nutrient constraints only.

Food items	Quantity (gram/day)
Total diet	1119
lentils cooked	465
cooked pasta	419
sardines canned in oil drained	158
sunflower oil	31
white sugar	45

Fulfilling French FBDGs only we can display a diet which reduces GHG up to 64% (1243 g CO2 eq/d) and cost to 33% (3.3 euros/d).

Table 2. Minimized GHG model with French FBDGs only.

	Amount, g/day
Total diet	1686
Food items	
vegetable soup to warm	640
cooked pasta	558
UHT semi-skimmed milk	313
sardines canned in oil drained	100
sunflower oil	25
white sugar	20
walnuts	20
Olive oil	10

We can display a diet (fulfilling Nutrient recommendation and French FBDGs) which reduces GHG up to 57% (1499 g CO2 eq/d) and cost to 20% (3.9 euros/d).

Table 3. Minimized GHG model with nutrient recommendations and French FBDGs.

	Amount, g/day
Total diet	1851
Food items	
Cooked pasta	477
vegetable soup home-made kind	398
Yoghurt with fruits	375

Vegetable soup (industrial)	250
lentils cooked	213
sardines canned in oil drained	100
walnut	19
sunflower oil	10
Olive oil	10

For Spain we can exhibit a diet which reduces GHG by more than 90% and cost by 75%

category	food	quantity
Meat and meat products	Liver	4.291
Miscellany	Extracts bouillon cubes	6.750
Miscellany	Herbs and Spices	42.091
Miscellany	Mayonnaise and other dressings with the same ingredients	60.693
Seafood products or related	Eel	7.177
Seafood products or related	Oysters	3.499
Vegetables and vegetable	white pinto beans	430.109

For Sweden we have a diet which reduces GHG by more than 70% with a cost reduction of 25%

food	quantity
Whole grain bread	103.91
white bread	263.44
cracker	150.45
other root vegetables	674.82
cabbage	80.58
milk 3%	187.77
eggs	96.61
margarine 40%	16.24

None of these are realistic, not only because of acceptability (it would be difficult to make interesting or in any way “normal” meals from the ingredients) but also because the lack of variety and large amounts of foods which are normally eaten in small quantities gives rise to suspicion about the margin of error on nutritional and GHG figures. In this sense, these diets give an indication of the maximum reduction which could be achieved using current foods and methods of production.

Annex 4 – Data Methodology

This annex explains how we have approached gathering data for the different countries.

A. France

1. Breakdown of Foods

The INCA2 cross-sectional dietary survey („*Enquête Individuelle et Nationale sur les Consommations Alimentaires*", (*Individual and National Survey on Food Consumption*') conducted in 2006-2007 by ANSES (French agency for food, environmental and occupational health safety) was used to estimate mean/median consumption.

2. Availability of GHG Data

73 widely-consumed food items were selected as representative of French diets, by preferentially choosing foods with the highest percentage of consumers. Then, the GHGE associated with the consumption of these 73 representative food items were collected from the available literature and from studies conducted in France. Only studies using life cycle assessments were used to quantify the environmental impacts generated by a product throughout its life cycle, and we assumed that the selected food items were all obtained through the conventional and most frequent production and distribution processes in France. The food-related GHGE values covered the stages of agricultural production, processing, packaging and transportation to retail outlets but the stages that occur after purchase (transportation from store to home, storage, preparation, and cooking at home, management of end-of-life phases) were not recovered due to a lack of data.

3. Conversion of Data – Approach

The food-related GHGE values covered the stages of agricultural production, processing, packaging and transportation to retail outlets but the stages that occur after purchase (transportation from store to home, storage, preparation, and cooking at home, management of end-of-life phases) were not recovered due to a lack of data (use of post retail constant factor?).

For nutritional, cost and GHG data, a consumed factor was used in order to take into account wastage, cooking and hydration.

4. Nutritional Data

All of the food items declared as consumed (including the 73 highly consumed foods) by the participants during the survey were listed in a survey-associated food database giving the nutritional composition of each food item. The nutritional composition of the foods was computed from the INCA2 food composition database.

5. Cost Data

The cost of all the food items declared as consumed (including the 73 highly consumed foods) was collected from 2 types of sources:

- From the TNS Worldpanel 2006 study (nearly 90% of the food item list)
- From supermarket (nearly 10% of the food item list)

6. Constraints – Nutrition

Constraints on nutrition can be separated into 2 categories: food-based dietary guidelines and nutrient recommendations.

The French food-based dietary guidelines defined 9 rules (8 on food consumption and one on physical activity) expressed in frequency (at least 5 fruit and vegetable per day) or in grams (Not more than 8 grams of salt a day) [see Task 1 report 2.1.2]. For rules expressed in frequency, we have had to make decisions in order to assess a portion size to each food item.

Nutrient recommendations were collected from the Recommended Daily Intake in France published by the French agency for food (ANSES). In task 1 French recommendation for fibres was missing. The minimum recommended intake for fibre is 19g/d for French women.

7. Constraints – Acceptability

A first diet-modelling has been run to reach a target of energy intake of 1800Kcal which is the recommended energy level for women.
Constraint of acceptability for each food item will be added:

A minimum value equal to the 5^{th} percentile of consumption observed in the population (non consumers included).

A maximum of the 95^{th} percentile of consumption observed in the population (non consumers excluded).

We tried other acceptability constraints depending on the preliminary results from first LP models runs.

B. Spain

1. Breakdown of Foods

The ENIDE survey gives a comprehensive breakdown of foods. Most items are clear and can be triangulated against possible GHG and nutrition data.

2. Availability of GHG Data

Examination of literature produces almost no direct data on GHG emissions related to food in Spain. Although there have been a number of papers, in general they use data estimated from international sources.

One exception is a per on the carbon footprint of the Galician fishing activity (reference 11) which we have used to estimate GHG figures for different types of fish.

3. Conversion of Data – Approach

In view of the difficulties of making any overall estimates of GHG emissions, we have used the following general approach:

- GHG data is "to retailer" but adjusted for amounts consumed
- Where possible we have used data from France as being the nearest country where there is a set of consistent and comparable data.

Where there are gaps we have used the following substitutes:

- Data for fishing based on the Galician fishing fleet
- Data from HLCWG, using a multiplication factor to allow for transport etc between RDC and retail. The multiplication factor is based on comparison of similar foods where there is French data available. Some allowance is made for origin of e.g. fruits in choosing a base figure.
- Conversion factors from McCance and Widdowson
- Some processed foods from Eat England data
- Estimations from comparable data (e.g. LCAfood regarding some fish and mussels).

For important foods (e.g. olives) we made some estimations of our own based on comparable or constituent products (for example papers produced on LCA of olive oil).

This still leaves some areas where there is no data, although in general these are areas of low consumption. In these cases we have made educated estimations.

4. Nutritional Data

Where possible we used information from the BEDCA online database. This was not comprehensive enough, unfortunately and therefore was supplements by data from French and Swedish sources. Examination of the data showed a need to find additional data on iron and zinc in a small number of cases. Iodide figures appear unreliable and not comprehensive and therefore we did not use this, even though it is included in nutritional recommendations.

5. Cost Data

We use a triangulation of the Household Budget Survey with the ENIDE survey.

C. Sweden

1. Breakdown of foods

The only data on current diet is the Riksmaten survey, as noted by Task 1. This is not in all cases very detailed and requires assumptions to be made regarding recipes, preparation methods, and detailed costs.

Specifically we note

- categories where the actual ingredients of proportion of ingredients are unclear (muesli, pancakes, pizza)
- categories where the origin/animal is unclear (meats, offal, sausages, fish)
- categories which are very vague (cakes, desserts)

We explain our assumptions for this below.

2. Availability of GHG Data

There are a number of papers on GHG emissions of food, but for the purpose of the exercise we need to have a set of data which is consistent and reasonably comprehensive. This requires examination of the full life cycle (different studies use different endpoints) and consideration of how imported goods are treated.

A study which has considerable data is that of Wallén et al. (reference 9) estimating emissions from farm to RDC. However, examination shows that this has been produced by examining energy requirements and converting this directly to CO_2 leaving a conclusion that emissions from pork and beef are roughly similar. In addition, examination of individual figures suggests that the author assumed that production of goods which were imported had the same footprint as those produced locally (for example compare values for tomatoes with that from HLCWG). We therefore regretfully did not use this data.

A more useful survey is done by Carlsson-Kanyama (AJCN 2009) (reference 6) which makes estimates from farm to table for a number of items. This appears well-worked out and consistent, but has many missing items.

The Swedish Institute for Food and Biotechnology has produced a number of LCA analyses for different food products (see reference 5). The figures shown include emissions to the point of consumption. Generally estimates appear low, for example compared with HLCWG, although this can be partly explained by the fact that domestic energy emissions in Sweden have a lower carbon content (greater reliance on hydro and nuclear power).

Figures for energy estimates can be derived from Carlsson-Kanyama and Faist and we sought to use these in making figures compatible. A survey by Orremo (1999) (quoted in SIK report 804 -see reference 5) states that the average shopping trip is

7.81km and 59% of trips are by private car so estimates for this component of emissions can be made in the same way as for HLCWG.

Statistics Sweden (2006) makes estimates of the emissions related to different purposes, including food, although figures do not include private consumption base don "operation of vehicles" and "heat energy". An older report (2003) seeks to categorise emissions by household activity and therefore gives an overall estimate for emissions for "cooking" (including food) and "shopping" (including food shopping) (reference 10). This, together with more general assumptions regarding the percentage of emissions from food (estimated in the range 18-29% in different literature) can give an overall figures for emissions where detail is unavailable.

3. Conversion of data – approach

First of all we make some overall top-down estimates – these are to be used for validation and as benchmarks only.

Statistics Sweden estimation of GHG both direct and indirect associated with cooking food comes to 14.39mtCO_2e. This does not include shopping, where total direct burden is 8.55mtCO_2e. Shopping includes other shopping and leisure activities. However, the latest transport survey suggests that 44% of trips not connected with work relate to shopping and elsewhere that 50% of shopping trips relate to food shopping. This would give an estimate of the total burden of food consumption as around 16mtCO_2e.

From an equally top down point of view, analysis in other countries suggests that food represents somewhere between 18% and 29% of overall GHG emissions. Eurostat figures for 2009 give the total emissions for Sweden as 59.994mt giving an estimate for food-related emissions of between 10.8 and 17.4mtCO_2e. We can hypothesise that Sweden will be towards the higher end bearing in mind that it has a generally low per capita emissions pattern but that this is due to the composition of electricity, while significant parts of the food life cycle relate to carbon-based transport and agriculture.

Using these figures and examining parallels with HLCWG as well as individual LCA reports for Sweden from SIK we propose that we use a benchmark of 15mtCO_2e divided 57% pre-RDC (8.5), 20% RDC to retail including processing (3.1), 13% transport to consumer (1.9), and 10% cooking and household (1.5).

As with the original LiveWell report, we divide the RDC to retail figure in proportion to weight. While this may not be the most appropriate division, it is difficult to determine from the consumption data whether food was cooked at home or was bought as ready meals and therefore apportionment of processing between before and after retail is not possible in a consistent way.

Where it is possible to use figures from either CK or SIK we have done so, adapting these by appropriate multiplication factors from the analysis above to gain a figure/kg for the product finally consumed.

Where there is no figure available we have used HLCWG figures, adapted for post-RDC emissions and in proportion to imports based on FAOSTAT data, or figures provided by Eat England (generally for processed foods). For these figures we have also taken into account the fact that consumed weight may not be the same as the weight at RDC due to wastage (banana skins, bones), cooking (meat shrinkage) and hydration (pasta). Conversion factors are taken from McCance and Widdowson.

For areas where the categories are broad or vague we have chosen a value based on typical figures for that type of food using the sources above and informed by any likely concentration (e.g. of types of fish).

In a few areas, there were significant differences between Swedish (CK + SIK) data and UK-based (HLCWG and Eat England) data. Notably these include eggs and milk. In these cases we have used Swedish data.

4. Nutritional Data

Nutritional data is taken from a public database of nutritional content of different foods. Generally this gives a more specific value than the broad categories in the Riksmaten survey and so "representative" foods have been chosen. We revisited some definitions when it became clear which foods are important.

5. Cost Data

We have produced very broad brush cost data using the approach of triangulating the 2009 household budget survey from Statistic Sweden with the Riksmaten survey. This has some dangers, since changes in relative consumption of different food categories will have an effect on the apparent price (e.g. if Swedes now eat proportionately more cheese, then the apparent price of cheese will go up). In any case, for some categories (e.g. dishes with beef) the price can vary by several multiples depending on the quality of the base item.

Initial comparison of relative prices with those found for a Swedish online retailer suggest that the relative figures are reasonably consistent.

6. Constraints – Nutrition

Sweden publishes two recommendations on diet: the Food Circle [FC] – see Task 1 report 2.1.3, and recommendations on minima and maxima for nutrients [SNR]. This is complemented by a study named Swedish Nutrition Recommendations Objectified [SNO]. SNO is not really a "recommendation" as such, more a way of using the nutritional recommendations to create a specific diet.

The actual recommendation to the general public is only the food circle (at least one portion from each segment each day). This does create a constraint because it requires a significant amount of meat and dairy. On the other hand, portion sizes seem to be poorly defined and we have had to make estimates in this respect.

We considered use of SNO as a constraint for acceptability, but this proved too difficult to do: following SNO in detail results in a rigid diet which cannot reduce GHG adequately while loosening the bounds merely means that the constraints are ineffective. Instead, we used the Food Circle as categorisations and made a constraint that the relative proportions of foods should not change too much, specifically that for each food circle category, the Livewell diet should include consumption of at least 80% of values used for the SNO diet.

SNO produces a set of sample diets, which we used when developing sample diets for LiveWell.

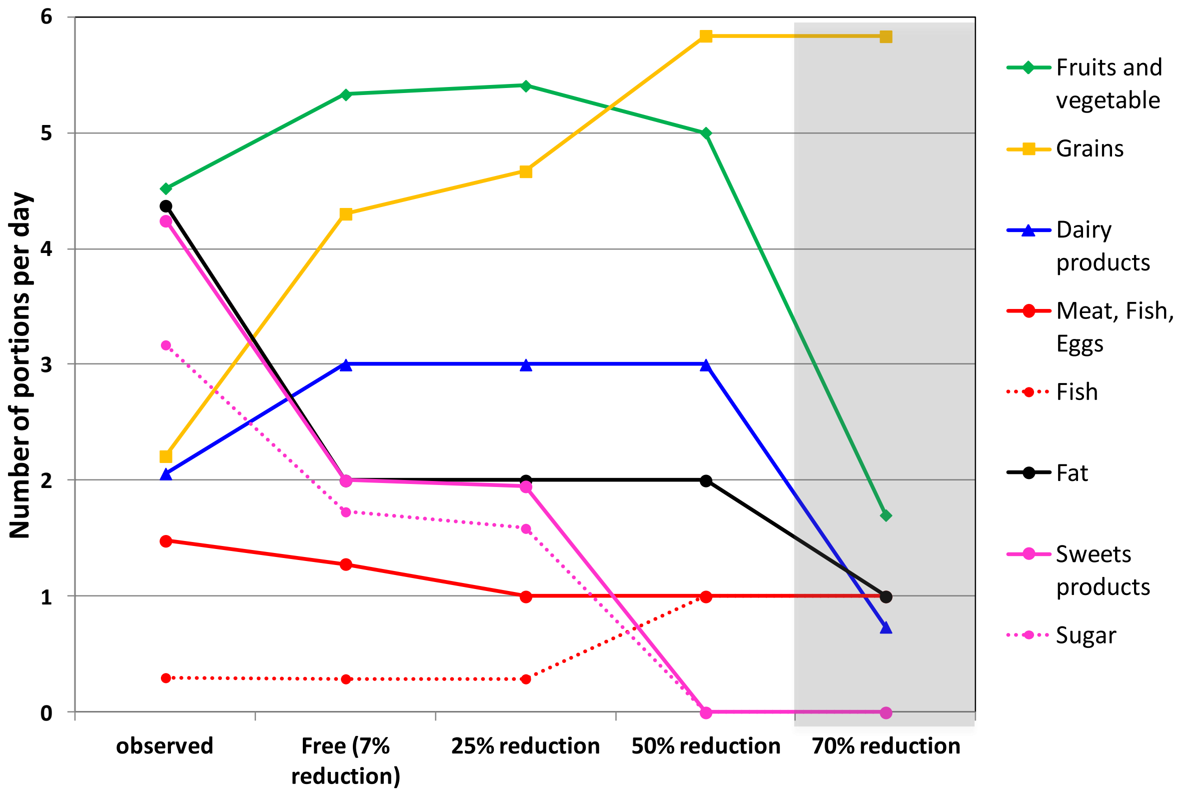
Annex 5 Sensitivity analysis

France

- GHG sensitivity analysis

To analyze the consequences of a step by step reduction of GHG in a healthy diet, 4 LiveWell models were run. The first model has no constraint on GHG, the other ones imposed a 25%, 50% and 70% (referred to the 2050 target in UK LiveWell plate) reduction of GHG. Figure 1 displays the impact on food choices represented by the PNNS food groups. The model simulating a 70% reduction of gas emission was not feasible. Indeed, the minimum achievable of GHG was 1499 g CO2 eq/d (57% reduction) subject to nutrients recommendation as well as to French FBDGs (Appendix 1). This means that it s not possible to make a healthy diet with a 70% reduction.

Figure 1. Observed diet and optimal food patterns modeling a reduction of GHG, expressed in PNNS food groups.



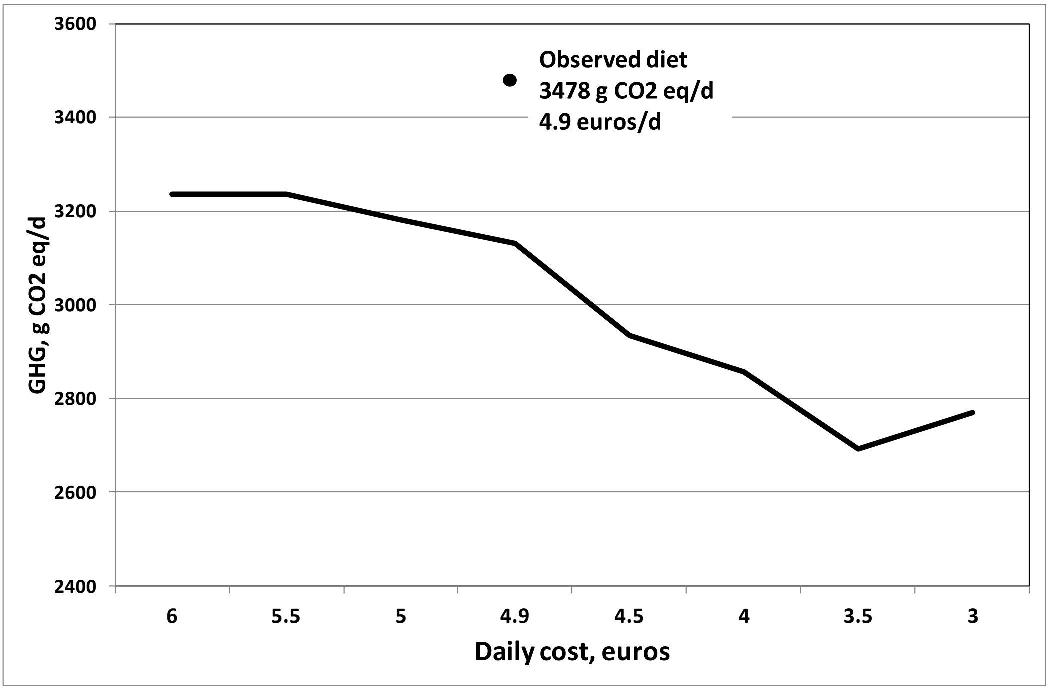
Footnote: Dash line indicated food categories which were included in the major food group (indicated by the same color).
The grey area indicates that the model was not feasible subject to a 70% reduction of GHG. For example the number of portions of fruits and vegetable do not match with the recommendation (i.e. at least 5 portions of fruits and vegetable).

- Cost sensitivity analysis

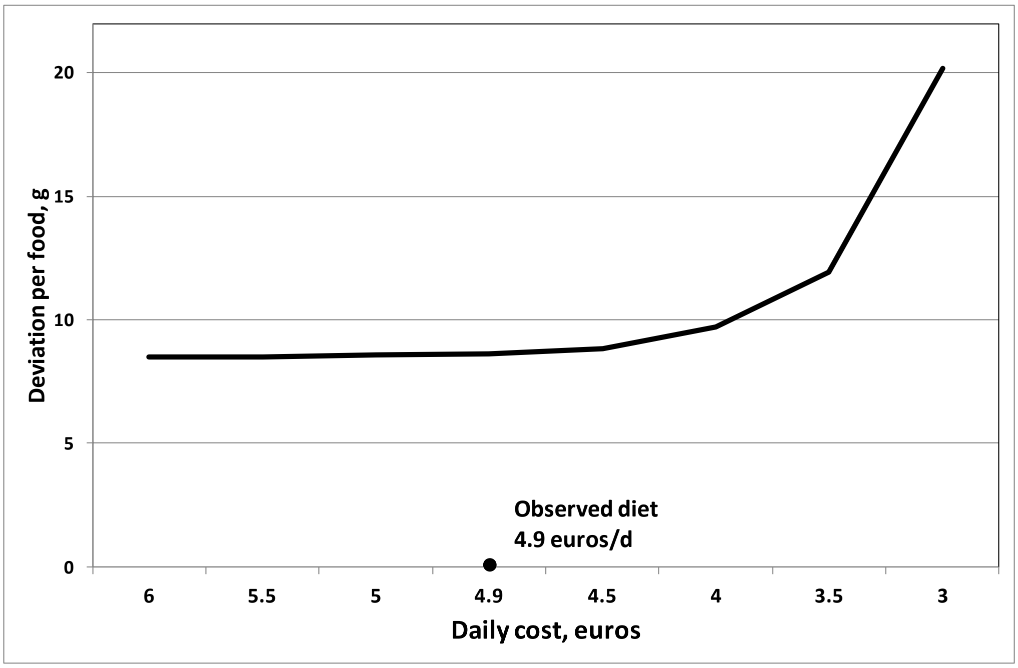
Imposing a reduction of cost induced a decrease in GHG and an increase of the deviation from observed diet. The minimal cost achievable assuming a healthy diet was 3 euros per day. A low cost healthy diet was compatible with a reduction in GHG (i.e. 20% from the actual) but huge modifications of food habits are needed.

Figure 2. Impact of a decreasing cost constraint on GHG (Panel) and on the deviation from food habits (Panel B)

Panel A

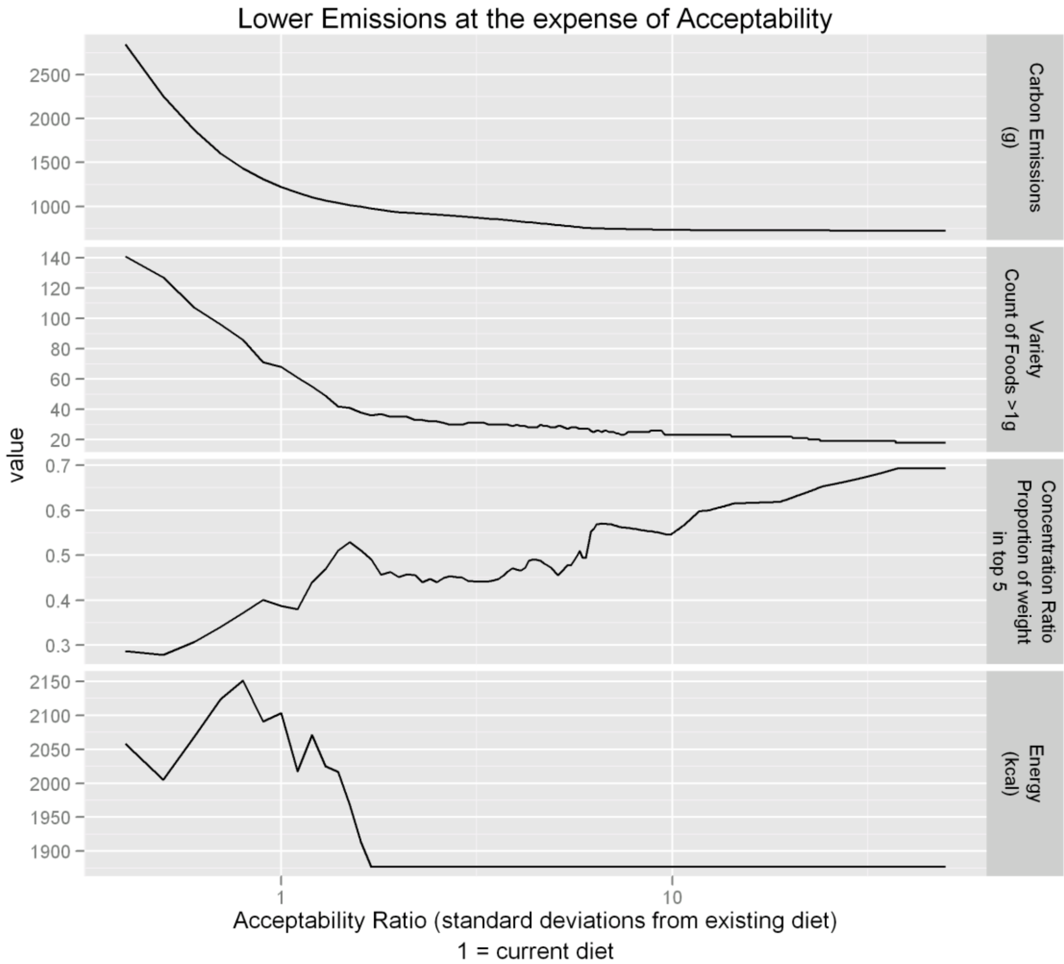


Panel B



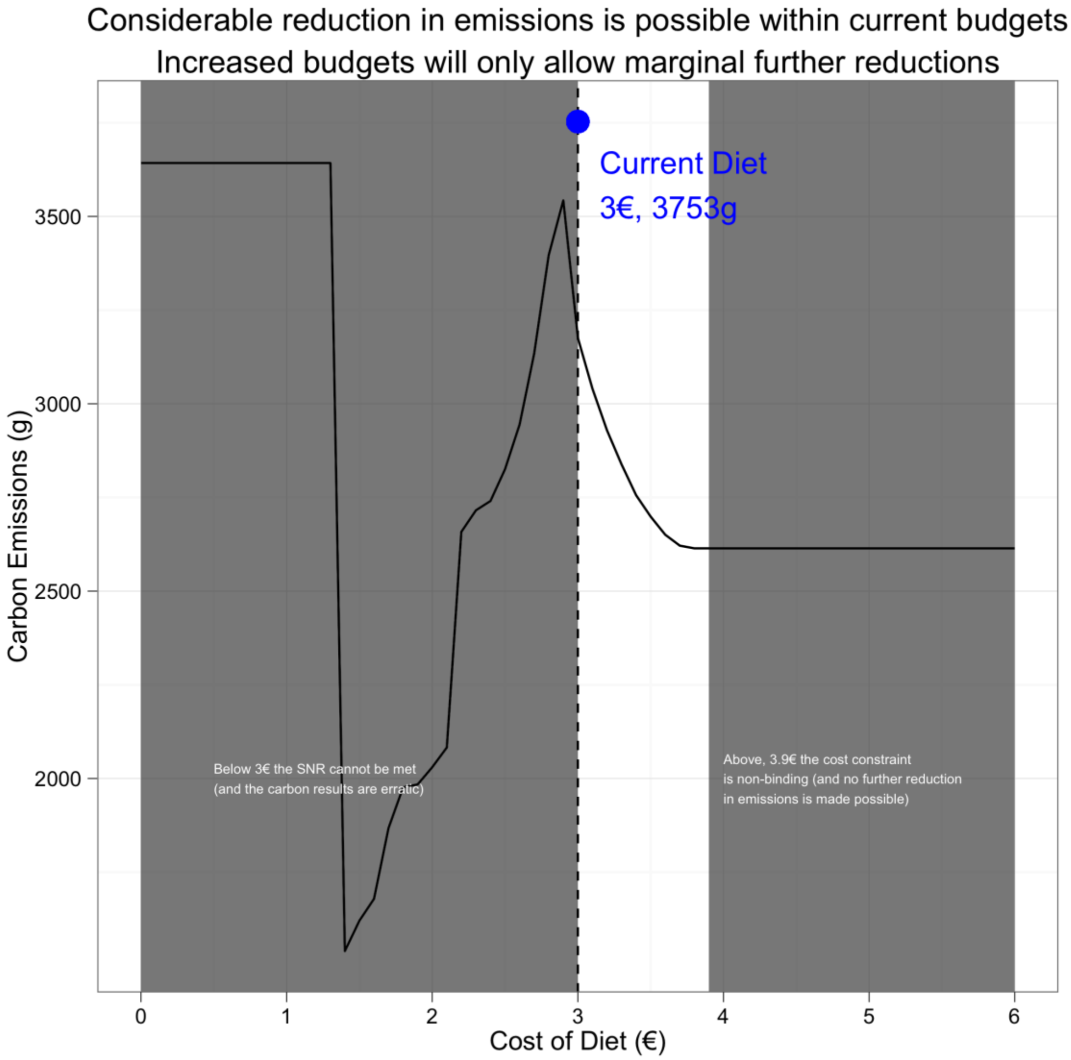
Spain

A more general analysis shows that there is a trade off between reducing emissions and ensuring acceptability which is not wholly simple. The figure below shows the effect of constraining each foodstuff by numbers of standard deviations from the current average diet and the effect that this has on GHG emissions and degree of variety of foods. This shows that after a certain point making the diet more extreme has little effect on GHG emissions. Of course diets here are probably not culturally acceptable, but the graphic gives an impression of the degree of change needed – and the fact that it does not take a great deal of movement in order to reduce GHG emissions by 75%.



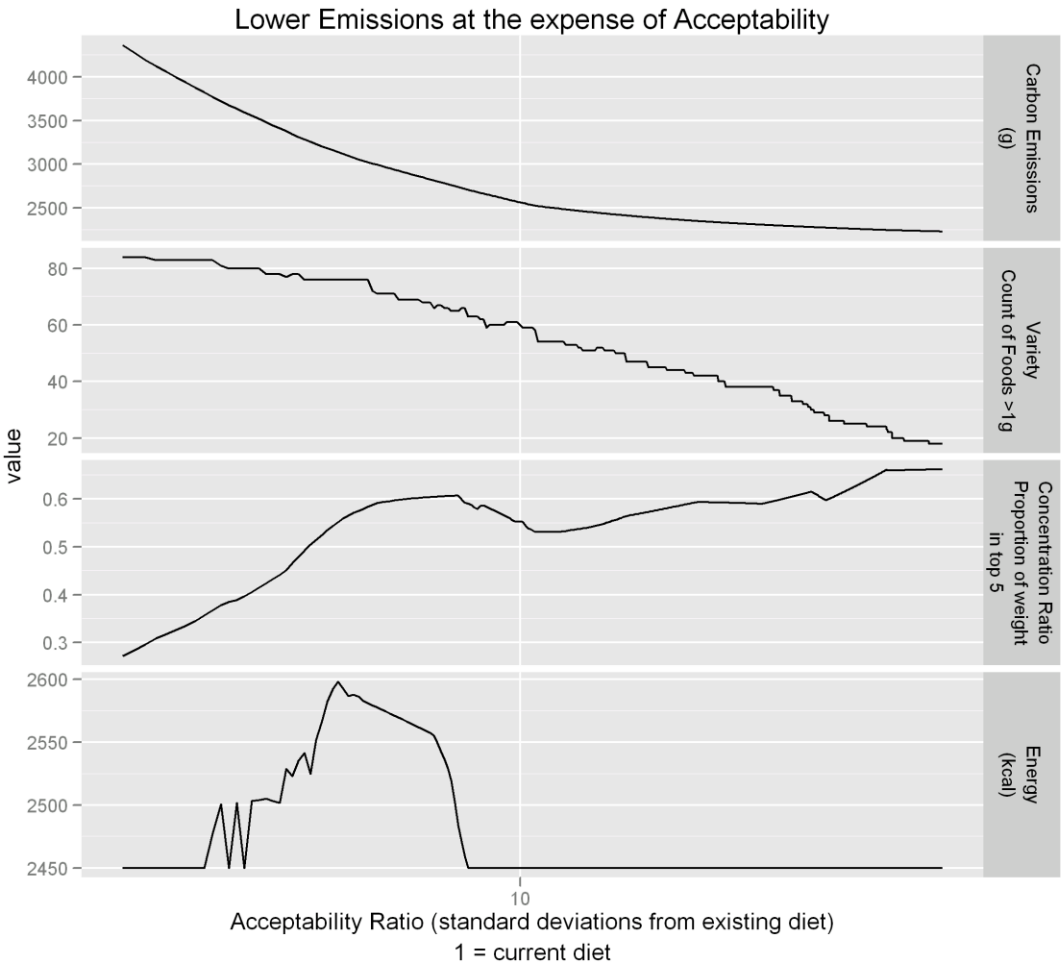
As noted, cost was not a binding constraint[17]. The analysis below by running the model with different constraints shows that, although spending more can reduce GHG emissions, this is not significant and that it is possible to find a diet which is cheaper than the current one for all diets which meet nutritional requirements.

17 Though we should note that adjustments to the final LiveWell diet in order to make it acceptable moved the price to something comparable with current spending.



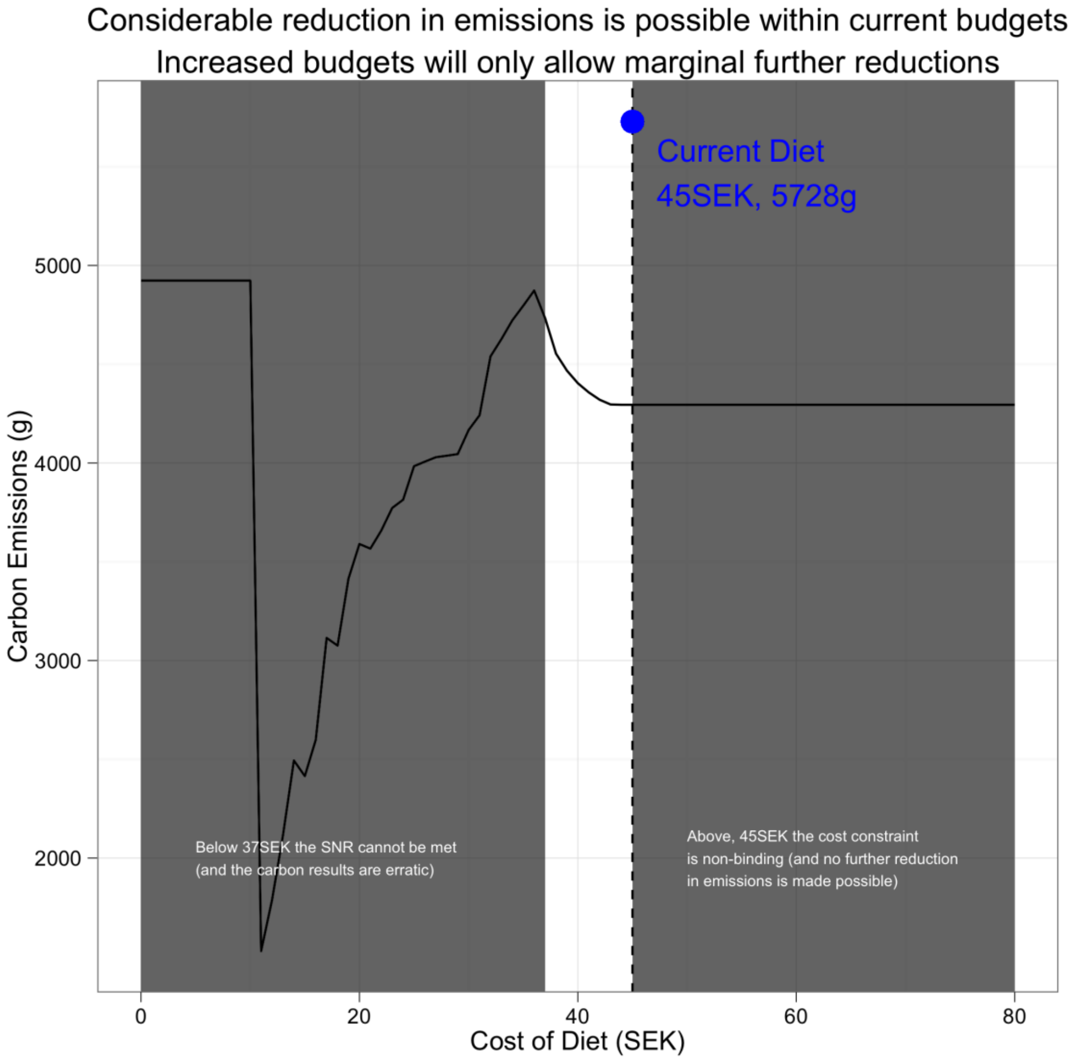
Sweden

A more general analysis shows that there is a trade off between reducing emissions and ensuring acceptability which is not wholly simple. The figure below shows the effect of constraining each foodstuff by multiples in terms of consumption of the current average diet and the effect that this has on GHG emissions and degree of variety of foods. This shows that after a certain point making the diet more extreme has little effect on GHG emissions. Of course diets here are probably not culturally acceptable, but the graphic gives an impression of the degree of change needed – and the fact that it does not take a great deal of movement in order to reduce GHG emissions by 75%.



As noted, cost was not a binding constraint[18]. The analysis below by running the model with different constraints shows that, although spending more can reduce GHG emissions, this is not significant and that it is possible to find a diet which is cheaper than the current one for all diets which meet nutritional requirements.

18 Though we should note that adjustments to the final LiveWell diet in order to make it acceptable moved the price to something comparable with current spending.


Considerable reduction in emissions is possible within current budgets
Increased budgets will only allow marginal further reductions
Current Diet
45SEK, 5728g
Carbon Emissions (g)
5000
4000
3000
2000
Below 37SEK the SNR cannot be met
(and the carbon results are erratic)
Above, 45SEK the cost constraint
is non-binding (and no further reduction
in emissions is made possible)
0
20
40
60
80
Cost of Diet (SEK)

Annex 6 – National Nutritional Recommendations

Table taken from Task 1

		France		Spain		Sweden		WHO		EU	
Nutrient	**Unit**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
Energy	kcal	2500-2700	2000-2200			2700	2200				
Protein	en%	11-15	11-15	10-12	10-12	10-15 e	10-15 e				
Fat	en%	30-35	30-35	<35	<35	<30	<30	20-35	20-35		
saturated	en%			<7	<7	<10	<10	<10	<10		
monounsaturated	en%			13-18	13-18	10-15e	10-15 e	15-20	15-20		
polyunsaturated	en%			<10	<10	5-10 e	5-10 e	6-11	6-11		
n-3 fatty acids	-			0.2-2 g/d	0.2-2 g/d	1 en%	1 en%	0.5-2 en%	0.5-2 en%		
trans fatty acids								<1	<1		
Carbohydrates	en%	50-55	50-55	50-60	50-60	55-65 e	55-60 e	>55	>55		
saccharose	en%					<10	<10				
Dietary fiber	g					25-35	25-35				
Alcohol	en%			<10	<10	<5	<5				
Alcohol	g			<30	<30	<20	<10				
vitamin A	µg RE	800	600	750	750	900	800	600	500	700	600
B1 thiamin	mg	1.3	1.1	1.2	0.9	1.4	1.1	1.2	1.1	1.1	0.9
B2 riboflavin	mg	1.6	1.5	1.8	1.4	1.6	1.3	1.3	1.1	1.6	1.3
B3 niacin	mg NE	14	11	20	15	19	15	16	14	18	14
B5 Pantothetic acid	mg	5	5					5	5	3--12	3--12
B6	mg	1.8	1.5	1.8	1.6	1.5	1.2	1.3	1.3	1.5	1.1
B7 Biotin	µg	50	50					30	30	15-100	15-100
folate	µg	330	300	200	200	300	300	400	400	200	200
B12	µg	2.4	2.4	2	2	2	2	2.4	2.4	1.4	1.4
vitamin C	mg	110	110	60	60	60	60	45	45	45	45
vitamin D	µg	5	5	2.5	2.5	5	5	5	5	0-10	0-10
vitamin E	mg	12	12	12	12	10	8	10	7.5	0.4*	>4->3
vitamin K	µg	45	45					65	55		
calcium	mg	900	900	600-850	600-850	800	800	1000	1000	700	700
phosphorus	mg	750	750			600	600			550	550
potassium	mg					3500	3100			3100	3100
sodium	mg	3200	3200			2000	2000	2000	2000	575- 3500	575- 3500
iron	mg	9	16	10-15	18	10	15 (12-18)	9	20	9	20
zinc	mg	12	10	15	15	9	7	7	4.9	9.5	7
copper	mg	2	1.5							1.1	1.1
iodine	µg	150	150	140-145	110-115			130	110	130	130
selenium	µg	60	50			50	40	34-26	34-26	55	55
magnesium	mg	420	360	350-400	330	350	280	260	220	150-500	150-500
Manganese	mg	2.0-5.0	2.0-5.0							1-10	1-10
Chromium	µg	30-100	30-100								
Molybdene	mg	50-100	50-100								
Fluoride	mg	2.5	2								

Sources: WHO/FAO, SCF 2004, AESAN, SENC, SEDCA, ANSES, Nordic Nutrition Recommendations 2004

Note that fat, carbohydrate and protein are expressed as en%. For the purpose of modelling we converted these to g/day equivalents.

Annex 7 – Project Brief

Note – the brief for Task 1 is included for completeness, but this report relates only to Task 2

Task 1 – To produce resource material on each pilot country's current dietary patterns

WWF proposes outlining the content of an average person's diet from France, Spain and Sweden, using existing national dietary data. Alongside this the diet related health problems in each country will be quantified. This will be compared to healthy eating advice in the form the Eatwell plate.

There is plenty of evidence available that the average person in the developed world is eating too much of the wrong type of food per day resulting in the related health problems. This is an issue recognised in the EU, and some industry bodies, such as Scientific Advisory Committee on Nutrition, the Food Standards Agency and the British Dietetic Association in the UK and organisations such as Cancer Research, the British Heart Foundation and the National Obesity Forum. A key part of this work will be clarifying the current consumption patterns and there relationship to dietary advice.

The Eatwell plate, published by the UK's Department of Health, is seen as one of the clearest and most recognised guides available that demonstrates pictorially the correct amount of food in your diet. Though it does not display quantities by the different parts, of the plate it is a clear, simple representation of what a balanced diet should look like. Most European countries take a similar approach and publish dietary guidance, usually either in plate or pyramid form, though France uses the less come staircase. This report will take as a basis for nutritional advice from the pilot countries using it as the definition of that country's healthy diet. The report will then use each definition of a healthy plate of food and use it to highlight the difference between that and the average diet in each of the pilot countries, based on national food consumption data and information from others sources such as the FAO.

The nutritional advice in the pilot countries will be compared to that in the UK and that in Brussels and produce a clear comparison of the advice and highlight similarities and differences.

For each country the final report will compare the current diet to a traditional one, identify reasons for change and where food tends to be sourced. What if any are the health issues and costs of these issues associated with the new current diet? Are any future trends identifiable if business as usual continues?

For details of an example of sources of information go to appendix 1, though these are not to be seen as a definitive list, other sources can and will be used.

This task, when completed, will form the basis for task 2 which will further develop these findings.

Outputs

- Quantification of current eating habits for each pilot country
- Comparison to nutritional advice
- Pictorial representation of results
- Accompanying report which compares reasons for change, health issues and costs.

Task 2 - To conduct analysis and produce a case study for each pilot countries

The Environment

WWF has recognised that the current food system has substantial impacts on the environment. As part of the One Planet Food programme we are looking at both production and consumption, and are working on seafood, soy, palm oil, meat and dairy, water and agriculture. We are aware that the current dietary habits of the developed countries are unsustainable and as more and more people start moving towards the developed world's high livestock product diet the impact on the natural world will be magnified and will accelerate habitat destruction and climate change. This will be compounded by the growing concern around food prices since the 2008 and 2011 price spikes and global food security.

As part of our work on consumption WWF is looking at the role of diet and its impact on the environment with the various elements being mapped out. Any diet will need to look at the impacts of food consumption in the pilot country and internationally. The investigation will need to incorporate local and seasonal food as well as food from the developing world. Where foods come from and the role of farmers will be different for each country, thus necessitating the need to look at these areas.

LiveWell for LIFE

WWF believes that a healthy diet is sustainable and the questions WWF are asking is 'is a healthy diet sustainable? Is it possible? Can we create a Livewell plate for each of the pilot countries – France, Spain and Sweden?' And 'If current dietary advice is not sustainable what changes would be needed?'

As part of this WWF feels it is important to show that meat, dairy and seafood can be part of a healthy, environmentally friendly diet.

WWF understands that the carbon data might not be available for each individual part of the diet and this should not be seen as a problem as there is evidence available as to the carbon footprint of many foods and there has been work conducted recently looking at the sustainable diets of various European countries (appendix 1) these and others can be used as building blocks for the research. The aim will be to produce a defined sustainable diet for each pilot country, similar to the LiveWell work in the UK.

WWF UK is looking for one lead body who if needed can outsource some of the work to the relevant experts in each country. The aim is not to compare the different diets but to demonstrate what the diet looks like for each country.

The LiveWell plate for each country could be designed in 2 formats, one with more general sections, such as the current UK Livewell plate (appendix 1), with the second more compartmentalised into the different types of protein, carbohydrates and other nutrients. As there are many sources of proteins it would be useful to demonstrate the different types and where they can be found. This will demonstrate that there are many different sources of protein beyond meat and wild caught fish.

An often expressed objection to following the healthy diet or to any changes is food consumption is that it will be difficult to make the transition or the resultant diet will be dull. This study will need to quantify the amount of food a person can eat in a week when following the recommendations. The resulting weekly menus will need to be varied and representative of the country's culinary heritage.

The proposed diet is meant to be practical, and much like the current Eatwell plate, a section will need to include foods high in fat and sugar.

Using the research a clear definition of a sustainable diet for each country will be made that can be expressed pictorially and verbally.

For each country a weekly shopping list will be produced as well as a weekly menu of suggested foods that incorporates some traditional dishes and cooking styles.

The final recommendations need to be easily communicable as guidance for consumers, based in science as a tool for retailers and government to build upon. The final plates should have some headline principles that go with it that are appropriate for each country and others for the EU as a whole; WWF will be able to help with these messages.

The research needs to be nutritionally correct and as such the final LiveWell plate should be presented to a relevant nutritional body for consultation and approval.

The end work will outline the key principles of a sustainable diet and will be able to be translated in to a LiveWell plate, with the economic and carbon potential savings being quantified

Once the LiveWell plate has been defined to make it truly sustainable it would be beneficial to explore whether the diet would have social, economic and other benefits.

Outputs

- Livewell plate for each country in 2 formats
- Identify different protein sources
- A clear definition of a sustainable diet for each country
- A weekly shopping list and menu including typical costs in each country – incorporating traditional dishes and cooking styles
- Easy communicate principles
- Economic and carbon savings will be quantified.

Summary

This assignment seeks to show:

- Current dietary habits in the pilot countries and the health impacts
- The environmental impacts of current consumption patterns in the pilot countries
- A sustainable diet for each pilot country
- How the LiveWell plate will benefit local traditions and food sectors.
- What a weekly diet will consist of, look like and cost for each pilot country
- A definition of a sustainable diet for each pilot country

The main work for this assignment is outlined above. Subsequent to Task 2, consultants are expected to provide further commentary around the results and to deal qualitatively with some of the issues not directly covered by the analysis. The commentary should cover the following questions:

A. How would the diet be potentially different for someone in other European states? Northern European, Southern, Eastern and Western.
B. How would a change to a sustainable diet impact on EU farmers?

This final diet needs to be seen by an approved nutritional or health body to ensure it is possible and ideally have appropriate publishable support. The final plates need to be peer reviewed.

Annex 8 - References

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