



White
paper

The Plant-based Plan

**10 scientific reasons for
more plant-based eating**



Introduction

We live in a time where consumers are constantly bombarded with dietary advice on how to improve their health and avoid chronic diseases such as heart disease and cancer. Some of this advice is measured and evidence-based, but much is ill-conceived and sensational, often promoting the latest trendy diet, leaving the poor consumer bemused and confused about what to eat to stay healthy.

It is becoming increasingly clear that focusing dietary advice on single foods and nutrients - such as polyunsaturated fatty acids, sugar or dietary fibre - is counterproductive. A more effective and scientifically more sound strategy is to look at dietary patterns and evaluate what their effects are on health outcomes. Traditional diets based on plant foods, such as the Mediterranean and East Asian diets, are thought to contribute to positive health and longevity. It has also been suggested that eating more plant foods while reducing animal foods is beneficial for the planet. With a growing population, rising incomes and urbanization, an increased demand for animal-derived foods is expected. Many believe this is neither sustainable nor feasible.

To explore both the nutritional, health and environmental benefits of plant-based eating patterns, an extensive review of the scientific literature was conducted by Janice Harland and Lynne Garton in 2015. This resulted in the publication of the book "The Plant-based Plan". The book can be ordered on the website of the publishing house Lannoo campus.

This white paper is a summary of the key insights from the book "The Plant-based Plan".

Table of contents

3	Introduction
4	Plant-based eating: what?
5	Plant-based eating integrated in the food-based dietary guidelines
7	Current nutritional status in Europe: far from plant-based eating
11	Plant-based eating: healthy and sustainable
11	Healthy balance of nutrients
13	Benefits for health
13	Weight control, managing blood glucose and cardiovascular health
15	Plant-based nutrition important for healthy ageing including bone health and cancer
18	Benefits for the planet
21	Plant-based eating: how to put it into practice?

1. Plant-based eating: What?

Currently, there is no exact definition for plant-based eating, yet many people associate this way of eating with being vegetarian, which is not the case. The term “vegetarian” is very broad and encompasses a variety of eating patterns - some include variable amounts of animal-derived foods (Figure 1).

Early studies investigating the benefits of plant-based diets tended to define this way of eating according to the relative absence of meat in the diet – from the complete avoidance of animal-derived foods (vegans) through to individuals who consume meat on a daily basis. However, recent thinking is that the health benefits of plant-based diets are not solely due to the lack of animal-derived foods in the diet but also to the increased quantity of plant-based foods. A better way to measure this is using dietary pattern analysis. Studies using this method have found plant-based dietary patterns that include small amounts of animal products still offer nutritional and health benefits (1;2).

There are different ways of eating more plant-based foods - **plant-based eating does not automatically exclude all animal products** but rather than animal-derived foods being the focus of the diet, plant-based foods should be at the core. This advice is in line with the World Cancer Research Fund (WCRF) recommendations suggesting that two-thirds of a meal should be plant-based foods and one-third animal products (3).

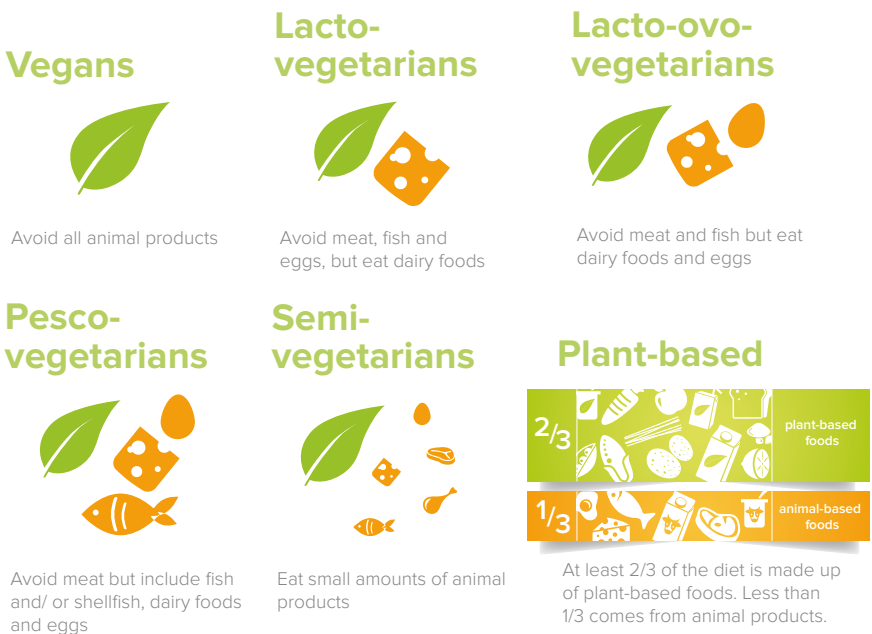


Figure 1: Different types of plant-based eating

2. Plant-based eating integrated in the food-based dietary guidelines

It is well recognized that good nutrition is one of the key factors in maintaining positive health and well-being. As such, it is important to identify the optimum range of nutrient intakes for a population that is consistent with supporting good health.

The most complete population **nutritional guidelines** are those published by the WHO/FAO (4) based on the best currently available scientific evidence on the relationship of diet, nutrition and physical activity to chronic diseases with a global perspective (Table 1). The WHO experts emphasize that energy consumed each day should match energy expenditure in order to prevent weight gain.

Nutrient	WHO
Fat (En%)	15 – 30
Saturated fat (SFA) (En%)	< 10
Polyunsaturated fat (PUFA) (En%)	6 – 11
Cholesterol (mg/day)	< 300
Protein (En%)	10 – 15
Fibre (g/day)	> 25

Table 1: Selected population nutrient-based guidelines from the WHO (4;5)

To be understood by the public, **nutrient goals need to be translated into relevant and meaningful food-based dietary guidelines**. These need to include information on the contribution of different foods or food groups to an overall diet that helps to maintain good health through optimal nutrition.

Nearly all EU countries have developed food-based dietary guidelines. Countries such as the UK and the Netherlands use a plate model (Figure 2 and 3). Others, like Belgium and Germany use a Food Pyramid (Figure 4 and 5). The different size segments represent the proportions in which these foods should be eaten as part of a healthy balanced diet.



Figure 2: UK – The Eatwell Guide
(new since 2016)



Figure 3: The Netherlands – The Wheel of Five
(new since 2016)



Figure 4: Germany
DGE-Lebensmittelpyramide (2005)



Figure 5: Belgium – The Active Food Guide
Pyramid for the Flemish community
(2005)

Common recommendations in all these models include eating plenty of fruits, vegetables and complex carbohydrates, and choosing foods which are lower in saturated fat, salt and sugar. Animal foods, including meat and dairy, represent smaller segments in these models, highlighting that only modest amounts are required as part of a healthy balanced diet. In contrast, plant-based foods represent larger segments.

- Many international and national dietary recommendations emphasize plant foods to promote good health as experts believe that increasing the amount of plant foods, and eating smaller amounts of animal foods, would be beneficial.
- As well as incorporating a healthy balance of foods to meet nutrition recommendations, a number of countries are now including sustainability in their food-based dietary guidelines.

3. Current nutritional status in Europe: far from plant-based eating

Existing data suggests there are **significant gaps between the proposed nutrient goals and actual nutrient intakes in Europe**. For most European countries the percentage of energy coming from fat was above the recommended range set by WHO (28.4 to 45.0 En% in males and between 29.9 to 47.2 En% in females) (4). Furthermore, the fatty acid pattern did not meet the recommendations, with saturated fat (SFA) intakes being higher and polyunsaturated fat (PUFA) lower than recommended in most countries (5). Protein intakes were within or slightly above the recommended range, whereas dietary fibre intake in most countries was lower than is recommended for good health (Table 2).

Nutrient	Fat (En%)	SFAs (En%)	PUFAs (En%)	Cholesterol (mg/ day)	Protein (En%)	Fibre (g/ day)
WHO Recommendations	15-30	< 10	6-11	< 300	10-15	> 25
NORTH						
Men	31.0 – 44.9	12.0 – 14.6	4.7 – 8.9	256.0 – 477.9	13.7 – 16.8	18.0 – 25.0
Women	31.0 – 41.9	12.0 – 14.4	4.7 – 8.7	176.0 – 318.8	13.7 – 17.2	15.6 – 21.0
SOUTH						
Men	28.4 – 45.0	8.8 – 12.7	4.8 – 6.4	282.9 – 378.4	14.1 – 18.5	19.3 – 23.5
Women	29.9 – 47.2	9.4 – 13.2	4.5 – 6.9	227.6 – 310.8	14.4 – 19.3	16.9 – 23.7
CENTRAL & EAST						
Men	31.3 – 38.9	11.7 – 26.3	5.7 – 8.8	352.5 – 800.0	13.5 – 17.8	18.7 – 29.7
Women	31.2 – 39.7	11.7 – 24.8	5.6 – 9.2	277.0 – 680.0	13.1 – 17.1	19.7 – 24.7
WEST						
Men	34.8 – 36.5	13.7 – 14.6	6.7 – 7.0	250.0 – 279.0	14.7 – 16.3	12.8 – 24.4
Women	35.1 – 36.9	13.7 – 14.7	6.7	201.0 – 215.2	15.6 – 17.0	10.4 – 20.1

Table 2: Selected nutrient intakes (min. – max.) in adults across four European regions compared to international recommendations (4-6)

But it is difficult to make direct comparisons between countries due to differences in the dietary survey methodologies used in each country. Therefore it is more meaningful to compare data from the European Prospective Investigation into Cancer and Nutrition (EPIC) study because a consistent methodology to collect dietary data was used across the participating countries (7-9). Information collected in this way shows similar results, in that Germany, Spain, The Netherlands, Sweden and UK are **consuming too much fat and SFA, and not enough fibre or PUFA compared to the recommendations** (Figures 6 and 7). Out of these selected countries the only group that appears to meet the recommended ranges are the UK health-conscious cohort. This group includes lacto-ovo-vegetarians, pure vegans, pesco-vegetarians (fish) and meat eaters. Compared to the UK general population overall, this health-conscious cohort has a lower intake of animal products and fairly high intake of legumes, which may account for the nutritional differences (10).

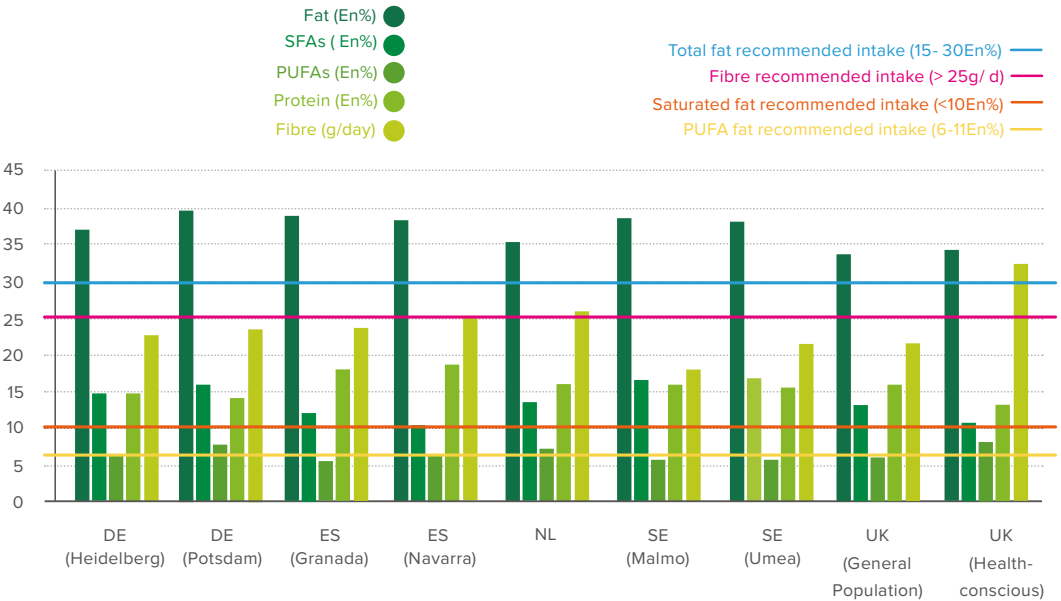


Figure 6: Mean selected nutrient intakes in men in the EPIC study

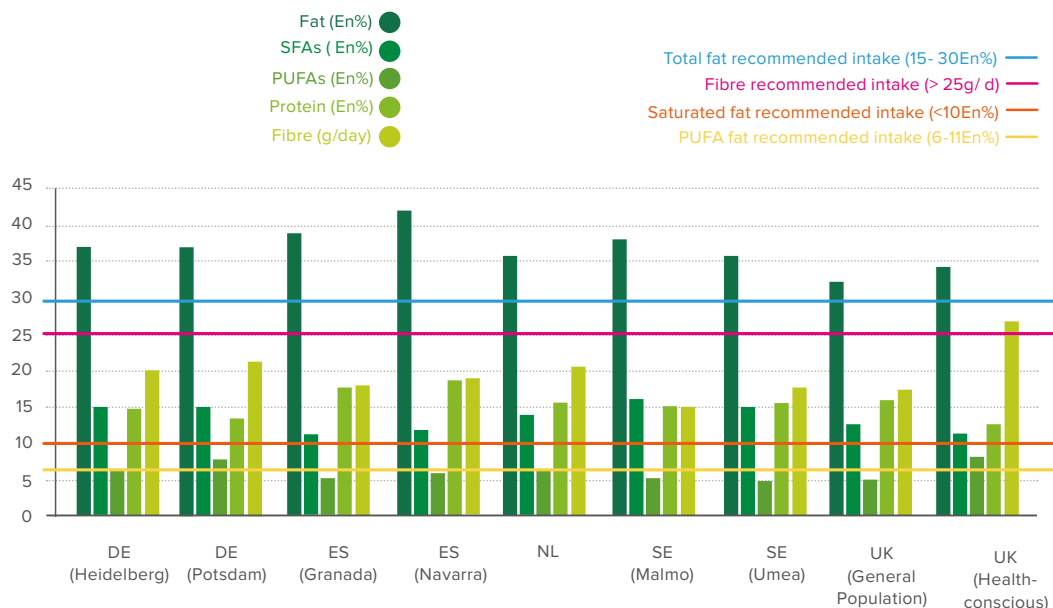


Figure 7: Mean selected nutrient intakes in women in the EPIC study

Comparing food-based dietary guidelines with actual intakes of food and drinks in the diet also indicate a big gap between recommendations and the real world. For example, comparing the UK's actual food intake (using consumption data from the National Diet and Nutrition survey) with the food-based dietary guidelines from the Eatwell Plate, it can be concluded that the meat group as well as food and drinks high in fat and sugar were in excess of recommendations whereas fruit, vegetables and starchy foods were not sufficient (Figure 8) (11). This imbalance in food groups and subsequent nutrient intakes needs to be the focus of public health campaigns across Europe. Driving these forward will improve the overall quality of the diet, help to achieve the ideal nutrient goals, and enable populations to enjoy positive health and well-being.

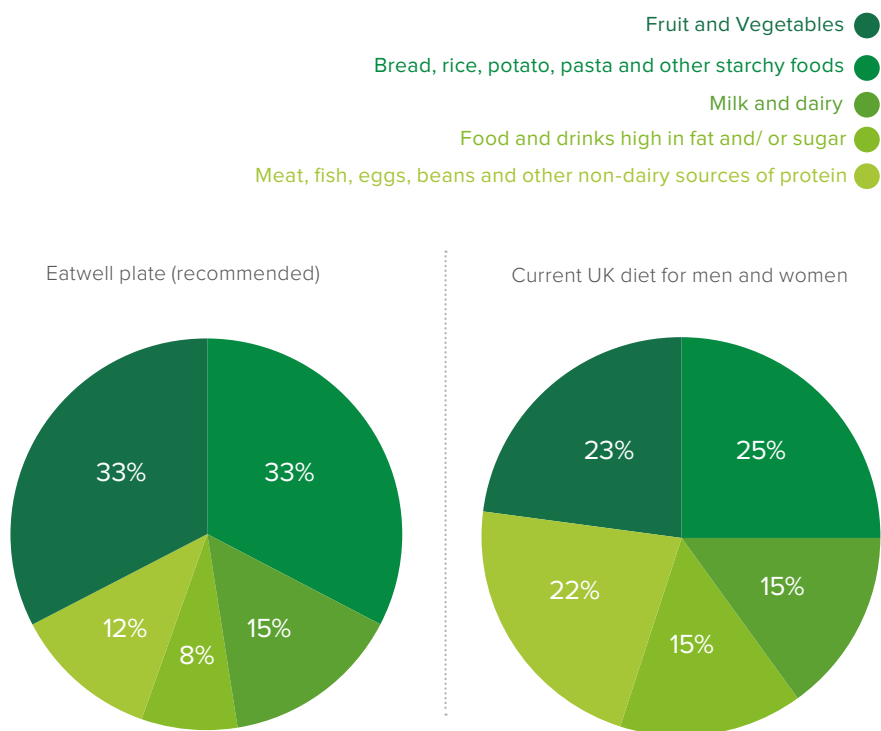


Figure 8: The current UK diet displayed in the eatwell plate food groups: illustrating the discrepancy between current intake and recommendations.

- Diets in many Western European countries are higher in total fat and SFA and lower in fibre and UFA than is recommended for good health.
- Eating smaller amounts of animal foods, which are the main sources of SFA in many of these diets, and replacing these with legumes, nuts, oils and seeds can improve the quality of the diet and help achieve current dietary recommendations.
- Dietary macro and micronutrient quality can also be enhanced by consuming more fruits, vegetables and other fibre-rich foods such as wholegrain cereals.

4. Plant-based eating: healthy and sustainable

a. Healthy balance of nutrients

Evidence supporting the nutritional benefits of plant-based eating is provided by a number of population studies (described more in detail in the book). For example, dietary characteristics were examined in the Oxford arm of the EPIC study (12). Subjects included meat eaters (N=33,883), fish eaters (N=10,110), lacto-ovo-vegetarians (N=18,840) and vegans (N=2596). The nutritional contents of these diets are outlined in Figures 9 and 10.

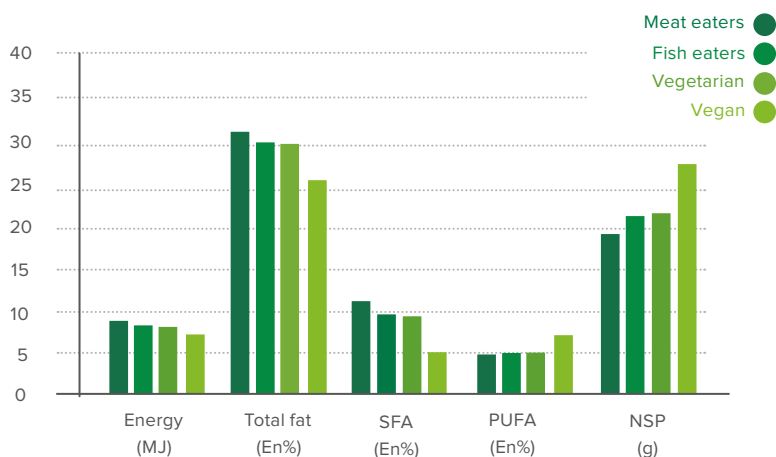


Figure 9: Men's average daily intake of selected nutrients by diets in the Oxford arm of the EPIC study



Figure 10: Women's average daily intake of selected nutrients by diets in the Oxford arm of the EPIC study

From these figures it is clear that the average SFA intake is lowest in vegans (approximately 5 En%) and less than half that of meat eaters (10-11 En%). SFA intakes in fish eaters and vegetarians were intermediate at approximately 9 En%. In addition, PUFA intake was highest in the vegan group, followed by fish eaters and vegetarians. Meat eaters had the lowest intake of PUFA. Fibre was highest in the vegan group, followed by vegetarians and fish eaters, while meat eaters consumed the least amount of fibre.

It is thought that the **lower intake of SFA in plant-based eating patterns may be due to plant foods displacing other foods in the diet that are high in SFA**. Jenkins et al (13) calculated the effect of substituting animal sources of protein (from milk, yogurts, steak and bacon) in a typical US diet (providing 33 En% fat and 11 En% SFA) with equivalent amounts of soya protein (13-58 g/d). He determined that a 13 g/d soya substitution would result in a reduction in SFA from approximately 11 En% to 8 En%. This would be further lowered to 5.8 En% if 58 g animal-derived protein was substituted with soya. Dietary cholesterol would also be reduced from 316 mg/d to between 205 to 267 mg/d, whereas PUFA would increase from 5.7 En% to between 7.5 to 8.0 En%.

A Dutch study also noted **improvements in saturated fat intake when meat and dairy foods were replaced with plant-based alternatives** (14). The purpose of this study was to examine the environmental and nutritional effects when meat and dairy foods were swapped with comparable plant-based substitutes. Data was obtained from 398 Dutch females (aged 19 to 30) and a modelling scenario was used where either all, or 30% of meat and dairy foods were replaced with plant-based alternatives. In the 100% scenario SFA reduced from 13.2 En% to 9.2 En% and when 30% of these foods were replaced, saturated fat reduced to 12.1 En%.

As well as a reduction in animal-based products, the wide variety of nutrients (fibre, complex carbohydrates, UFA, plant proteins, vitamins and minerals) found in plant-based foods are also thought to contribute to the potential health benefits associated with more plant-based eating. Specific attention should be given to the **fibre content of these foods** (both soluble and insoluble fibre) as currently the intake of fibre in many European countries is below the recommended amounts. Including more of these fibre-rich foods can help to meet the dietary recommendations.

- Plant-based eating patterns tend to be low in total fat and SFA, include a good level of unsaturated fats leading to better overall fat quality, and are high in fibre – all in line with global dietary recommendations.
- Many plant-based foods (fruits, vegetables, and other fibre-rich foods such as wholegrain cereals) are typically rich sources of a variety of vitamins and minerals, important for good health.
- At least two-thirds of a plate should be made up of plant foods (vegetables, fruits, whole grains, cereals, pulses, soya, nuts and seeds) and foods from animal origin should make up less than a third.

b. Benefits for health

Weight control, managing blood glucose and cardiovascular health

The nutritional characteristics of plant-based eating are thought to be responsible for the lower prevalence of obesity, lower rates of coronary heart disease, hypertension, and/or diabetes observed in people whose diets are mainly based on plant foods. Other specific components found intrinsically in plant foods may also work together to bring further heart health benefits.

Overweight affects 30 – 70% of adults in the countries of WHO European Region and over 20% of adults are obese. The average BMI has continued to increase in the last decade and there is no evidence that this will come to a halt. About 20% of children and adolescents are overweight and about one third of these are obese. The trend in obesity is especially of concern in children and adolescents. Over 60% of children who are overweight before puberty will be overweight in early adulthood. Obesity is a health risk in its own right, but it is also associated with an increased risk of diabetes, cardiovascular disease and certain cancers. Obesity and overweight create an enormous burden of disability and mortality and is estimated to be responsible for 10-15% life-years lost in the EU (15). The prevalence of Type 2 diabetes is around 8% in the WHO European Region. Incidence of diabetes is increasing and is associated with an increased risk of heart conditions, renal failure and other chronic diseases. Cardiovascular disease is the single most important cause of death in Europe as a whole and results in over 4 million deaths per year, representing 47% of all deaths. It is obvious that **prevention is important**. Unhealthy diet, physical inactivity and smoking are the most important behavioural risk factors responsible for about 80% of cardiovascular disease.

Weight management

The Seventh-day Adventist Study-2, contains data from 22,434 men and 38,469 women, approximately half of whom are omnivores and half vegetarians. Participants were grouped as vegan (2731), lacto-ovo-vegetarian (20,408), pesco-vegetarian (5617), semi-vegetarian (3386) or non-vegetarian (28,761). It was shown that **as people progress from, a vegan diet to mixed diet there is a gradual increase in BMI** (Figure 11) (16). Plant-based foods have a lower energy density, are typically low in SFA, high in UFA and fibre. These components are associated with lower body weight and less weight gain over time.

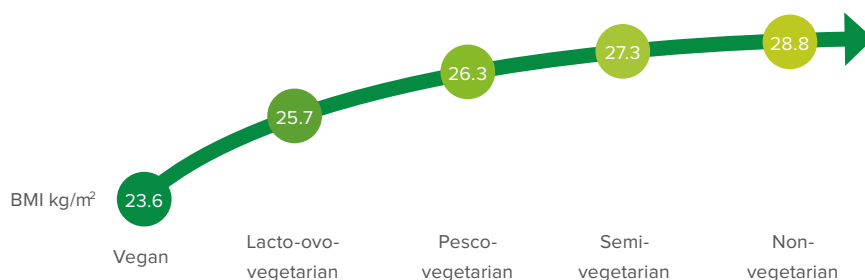


Figure 11: BMI according to vegetarian status in the Adventist Health Study

Managing blood glucose

In a further analysis of the Seventh-day Adventist Study-2 it was shown that **as the consumption of meat and animal products increase, there is an increasing prevalence of diabetes** (Figure 12) (17). Moreover, intervention studies have shown that replacing animal protein with plant protein can be beneficial in enhancing glycemic control. Diets emphasizing a replacement of animal with plant protein at a median level of ~35% of total protein per day significantly improved glycaemia (lower blood glucose levels) and insulin sensitivity (less insulin needed for glucose metabolism). This indicates that replacing sources of animal (e.g., meat, dairy, etc.) with plant (e.g., legumes, soy, nuts, etc.) protein leads to modest improvements in glycemic control in individuals with diabetes. **Replacing animal protein with major sources of plant protein may be one strategy that can be combined with standard therapy to help improve and manage glycemic control in individuals with diabetes** (18).

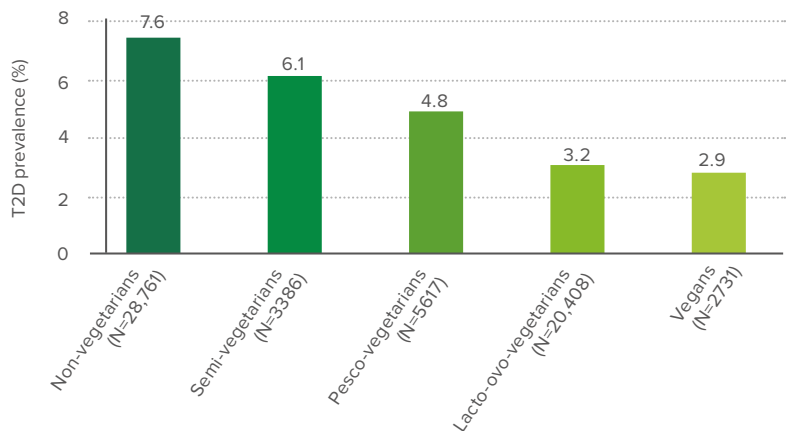


Figure 12: The effect of eating pattern in Type 2 Diabetes prevalence in the Adventist Healthy Study-2

Cardiovascular benefits

The typical nutrient profile of plant-based foods (beneficial UFA/SFA ratio) has been associated with lower blood LDL-C (19). There is wide acceptance among scientists that one of the important ways plant-based eating improves heart health is by its action on blood lipids. Professor Jenkins et al recently explored the extent to which the displacement of animal-derived foods (high in SFA) from the diet with a soya was responsible for the cholesterol lowering properties of soya foods. Using data from 11 interventions, he calculated that **when comparable amounts of animal proteins were replaced with soya proteins there was a 3.6-6.0% reduction in LDL-C due to the displacement of SFA and cholesterol from the diet** (13). This he called the extrinsic effect. **Overall the total reported LDL-C reductions for soya protein have been estimated to be between 7.9-10.3%** and the difference between this total and the extrinsic effect, has been called the intrinsic effect. It is highly likely that other plant foods have a similar extrinsic effect on the diet and part of their beneficial effect on health is related to an overall healthier nutrient composition. However, there are intrinsic benefits of plant foods, too. **Some of the intrinsic effects may be the result of direct blood lipid-lowering effects such as seen with soya, nuts, oats, and soluble fibres.**

The significance of reducing blood cholesterol has been expressed in public health terms by the WHO: each 1% reduction in LDL-C in the population could lead to a 2%–4% reduction in CVD (20). From the intervention studies identified, it can be seen that **plant-based eating is associated with a LDL-C reduction of between 7–15%**. Using this data as a basis for calculating CVD-risk reduction, **this would be equivalent to a decrease in CVD risk of 14–30%**. This extent of risk reduction is confirmed by reference to the observational studies; those following vegetarian or plant-based eating pattern have been shown to have a lower incidence of cardiovascular death of around 20%: eg. data from the EPIC-Oxford study (N=47,254) comparing vegetarians with meat eaters who had no previous history of cardiovascular disease or cancer, the adjusted death rate ratios were 0.81 for heart disease representing a reduced risk of 19% in vegetarians (21).

Plant-based foods and eating patterns are typically low in SFA, high in UFA and fibre and usually have a low energy density. Fibre is important as it helps glycaemic control, may improve satiety and is useful in maintaining body weight. Soluble fibres have been shown to reduce blood cholesterol. The low fat content and the beneficial fat quality (low in SFA, high in PUFA) further play a role in maintaining healthy blood cholesterol levels and can subsequently contribute to a healthy heart. In addition, specific plant foods or components have been shown to reduce blood cholesterol, e.g. soya protein (22;23), nuts (24), oat/barley beta glucans (25) and plant stanols and sterols (26).

Plant-based nutrition important for healthy ageing including bone health and cancer

In the European Region of WHO 20.5% of the population is already aged 60 years or older. Furthermore it is predicted that the population aged 80 years or older will more than triple by 2050, while the number of centenarians is expected to increase 15-fold during this time. In virtually all countries women comprise the majority of the older population, largely because globally women live longer than men (27).

Unfortunately, this increased longevity has brought with it increased number of years of ill health, because age is the main risk factor for the majority of chronic diseases such as heart disease, stroke and cancer, which are the main causes of morbidity and mortality in the developed world. In addition to the increased risk of major chronic diseases, older age is also associated with other conditions which, although not life-threatening, can have an impact on **quality of life of older subjects** such as cognitive decline, arthritis, osteoporosis, and gastrointestinal disorders.

Ageing

Nutrition can be considered an important contributor to healthy ageing. In terms of the **association of plant-based diets with lower mortality**, it is no coincidence that the two dietary patterns most closely linked to longevity – the Mediterranean diet and the Okinawa diet from Japan – are both characterized by an abundance of plant-based foods and low to moderate amounts of fish and lean meat (28;29). Those following vegetarian or plant-based eating pattern have been shown to have a lower incidence of cardiovascular death of around 20% (21). Furthermore, higher adherence to plant-based eating patterns (Mediterranean diet or prudent diet), particularly when combined with other lifestyle factors (healthy body weight, no smoking

and exercise), resulted in a lower disease burden and about two years longer in good health as quantified by Disability-Adjusted Life Years (30).

Plant-based eating is just as relevant, if not more so, to the ageing population as it is to the population at large. It is associated with a lower incidence of obesity, which is beneficial in its own right, but also as it reduces the risk of developing cardiovascular disease, Type 2 diabetes and cancer - the main non-communicable diseases - and causes of premature mortality. Micronutrients can be inadequate in the diets of older people and care should be taken to ensure a sufficient intake of calcium, vitamins B12 and vitamin D by consuming a wide range of plant foods. Fibre can aid laxation (often a problem in elderly) and can help encourage gut microbiotic diversity.

Nutritional concerns for older adults are related to both under- and overconsumption of energy and nutrients. Elderly are especially vulnerable to malnutrition. Particular concerns are ensuring adequate protein intake to reduce risk of muscle weakness (sarcopenia). On the other hand, overweight or obesity is also a concern in older adults. Plant-based eating can help maintain a healthy weight.

Bone health

Another challenge for older people is maintaining **bone health**. Plant-based eating supports normal bone growth and development throughout life, provided a wide variety of plant foods are consumed, and adequate intakes of protein, calcium and vitamin B12 and vitamin D status are maintained (31). Dietary factors in plant-based diets that support the development and maintenance of bone mass include calcium, vitamin D, protein, potassium and soya isoflavone (32). **There appears little difference in bone mineral density between omnivore and vegetarian populations** (33) as shown in figure 13. However, it appears that for those consuming vegan-type diets, care should be taken to preserve protein and calcium intake, particularly during adolescence and young adulthood when peak bone mass is attained. **Overall, it appears that plant-based diets can provide adequate amounts of key nutrients for bone health.** In addition plant-based eating tends to be associated with other beneficial lifestyle factors, including greater physical activity, less smoking and overall a lower energy dense and nutrient-rich diet, all of which contribute to good bone health.

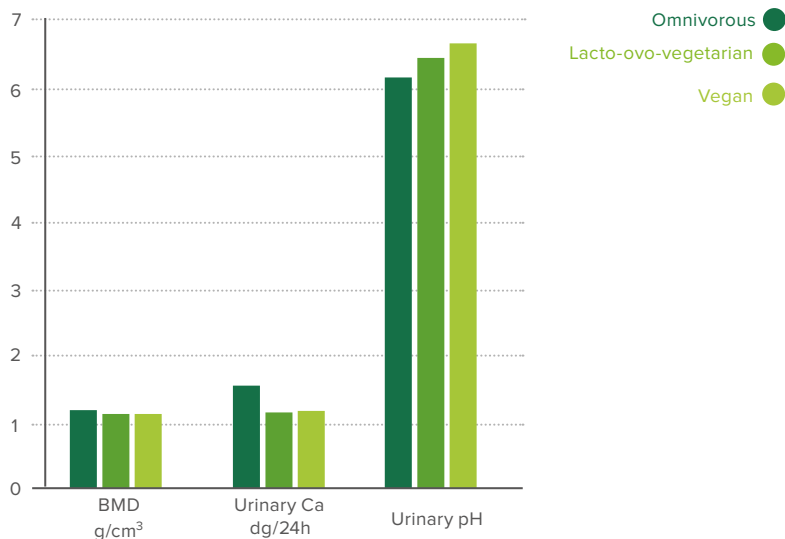


Figure 13: Bone mineral density and urinary measures by diet group

Cancer

There is general agreement that **lifestyle, including diet, impacts risk of cancer**, although the extent to which this is true varies greatly among specific types of cancer. It is also clear that a precise understanding of the relationship between diet and risk of specific cancers remains elusive. Observations from migration studies, changes in cancer rates over time within a population, and differences in cancer rates within the same genetic population living in different geographical regions, all lend support to the link between lifestyle and cancer risk.

But in comparison to other chronic diseases (such as cardiovascular disease and diabetes) the health advantages of plant-based diets are not nearly as evident when it comes to cancer. This may be due in part to the fact that cancer is not a single disease; it is actually different cancer types with different etiologies. Moreover **it is possible that the impact of diet on cancer risk occurs early in life**. For example, there is evidence that soya foods reduce risk of breast cancer only if exposure occurs during childhood and/or adolescence (34-36). This early exposure hypothesis may be particularly relevant to vegetarians, many of whom adopted their plant-based diet as adults. Most female vegetarians may not have introduced soya foods to their diets until adulthood and therefore may not reap the proposed cancer-protective benefits of soya foods. Early dietary habits may be especially relevant since the transformation of a normal cell into a cancer cell and eventually a tumor is believed to usually take decades. While diet may impact this process at many different stages, this also means that only long-term vegetarians are likely to benefit from the protective effects of a plant-based diet. Epidemiologic studies often do not take early dietary habits into account.

So far epidemiologic studies have not shown impressive differences in cancer rates between vegetarians and non-vegetarians. **A large meta-analysis including 124,706 participants observed in vegetarians a significant 18% lower risk of cancer incidence compared to non-vegetarians** (37).

Still, since plant-based diets are associated with overall health benefits, the lack of robust data in support of cancer-protective effects should not dissuade health-conscious individuals from following a plant-based dietary pattern. **Plant-based dietary patterns conform more closely to dietary recommendations aimed at reducing cancer risk in comparison to typical Western diets**. Moreover people following plant-based eating tend to be less obese and have better weight management, which is positively associated with a number of cancers.

Finally, the best available evidence suggests that plant-based diets are potentially advantageous for cancer survivors. The World Cancer Research Fund International (38) concluded in 2014 that there may be links between better survival of breast cancer patients and 1) healthy body weight 2) being physically active 3) eating foods containing fibre 4) eating foods containing soya and 5) a lower intake of total fat, especially SFA.

- The nutritional characteristics (low in SFA, high in UFA and fibre) of plant-based eating are thought to be responsible for healthier hearts, body weights and blood sugar levels observed in people whose diets are mainly based on plant foods. Other specific components found intrinsically in plant foods may also work together to bring further heart health benefits.
- As a result there is evidence that plant-based eaters have a lower prevalence of obesity, lower rates of coronary heart disease, hypertension, and diabetes.
- The lower prevalence of obesity, as well as the nutritional characteristics of plant-based dietary patterns, are in line with recommendations aimed at reducing cancer risk.

- Plant-based eating supports normal bone growth and development throughout life, provided a wide variety of plant foods are consumed, and adequate intakes of protein, calcium and vitamin B12 and vitamin D status are maintained.
- Adherence to plant-based eating patterns is overall associated with lower disease burden and longer life in good health.

c. Benefits for the planet

For many years dietary messages have mainly focused on the benefits a nutritious diet provides to health. However, it is now recognized that what a person chooses to eat can make a big difference to the environment. The growing global population, increasing urbanization and economic growth are placing a huge demand on worldwide food supplies. Food production already uses up 33% of all ice-free land, 70% of freshwater and 20% of all energy production. By 2050, a world with 2.3 billion more people will need 60-100% more food. **This global food demand is neither sustainable nor feasible.** It will place even greater stress on an already limited supply of land and natural resources such as energy and water. Furthermore it will have a noticeable impact on climate change and biodiversity. All of these factors pose major challenges for food provision and security. The good news is that plant-based eating is not only good for health, but is also more sustainable for the planet (39).

Conversion of plant protein from feed crops into animal protein for human consumption is clearly resource-inefficient: since approx. 6 kg of plant protein as animal feed is required to yield 1 kg of animal protein, on average, merely 15% of the protein and energy in these crops will ever reach (indirectly) a human mouth, thus 85% is wasted (40). Currently, over 38% of the world grain harvest and approximately 75% of soya is fed to livestock, with resource losses of about 85%. In light of doubling food production, such wasteful practice will need to be discontinued.

The food system is a significant contributor to global greenhouse gas emissions (GHGe), accounting for approximately 30% of the European Union's total GHGe. Various studies have attempted to calculate the GHGe from different food products. A summary of values for key agricultural products is given in Table 3; also shown is the impact on water footprint and fossil fuel requirements. It can be seen that GHGe from milk, eggs and poultry are lower than beef, lamb and pork, but these can increase with processing. In contrast, **plant foods have been estimated to produce far fewer GHGe.**

More fresh water is used for agriculture than for any other human activity. The water required to produce various foods and feed crops ranges from 500 to 3000 litres of water per kilogram of crop produced. If irrigation systems are needed, this amount can increase considerably. **Producing 1 kg of animal protein requires about 100 times more water than producing 1 kg of grain protein.** The actual amount of water that is drunk directly by livestock is very small (1.3% of the total water used in agriculture). However, when the water to make the feed and forage is taken into account this volume increases dramatically. Estimates of the amount of water required for different foods are summarized in Table 3.

Food provides energy but at the same time it requires energy to be produced: fossil fuel estimates for different food productions are summarized in Table 3. One study calculated that, on average, to produce 1 kcal of plant protein 2.2 kcal of fossil energy is required. In contrast, producing animal protein is more energy intensive, requiring 25 kcal of fossil fuel to produce 1 kcal of meat protein, thus more than 11 times that of plant protein (41).

Animal-derived foods generally require more resources than plant-based foods, typically resulting in 15-fold more GHGe and requiring 10-fold more water and 5-fold more fossil fuel input.

Foodstuff	GHG emissions (kgCO ₂ e)	Water footprint (L/kg)	Fossil fuel input (MJ)
Beef	6.3 - 37	15,500	15 - 56
Sheep meat	7.6 - 17	6100	17 - 19.3
Pig meat	3.6 - 6.4	4460 - 5900	17 - 21.06
Eggs	2.2 - 5.5	3900	14 - 22.2
Poultry	1.1 - 4.6	2390 - 4500	12 - 25
Cow's milk	0.4 - 1.4	1000	2.5 - 3.6
Soya beans	0.9	1800	5.9
Rice	0.4	3400	8.8
Wheat	0.3	1300	2.1 - 2.8
Oranges	0.25	500	2.96
Apples	0.24	500 - 700	2.87
Potatoes	0.17 - 0.24	105 - 500	1.17 - 1.4
Tomatoes	0.1 - 10	0.04	3.4 - 37.7

Table 3: Global livestock emissions as GHGs (kgCO₂e), water footprint (L/kg) and fossil fuel input (MJ) (European Parliament STOA (2009))

Effect of different dietary patterns on the environment

The data from the EPIC-Oxford UK cohort were used to evaluate the environmental impact of different dietary patterns (42). The differences in estimates of dietary GHGe were calculated using dietary records from 2041 vegans, 15,751 vegetarians, 8123 fish eaters and 29,589 meat eaters. The average GHGe gradually decreased the less meat was consumed: from 7.19 kgCO₂e/day in high meat eaters (≥100 g/d) to 2.89 kgCO₂e/day in vegans (Figure 14). From the figure it can be concluded that **dietary GHGe in self-selected meat eaters are approximately twice as high as those in vegans**, and hence it is likely that reductions in meat consumption would lead to reductions in dietary GHGe.

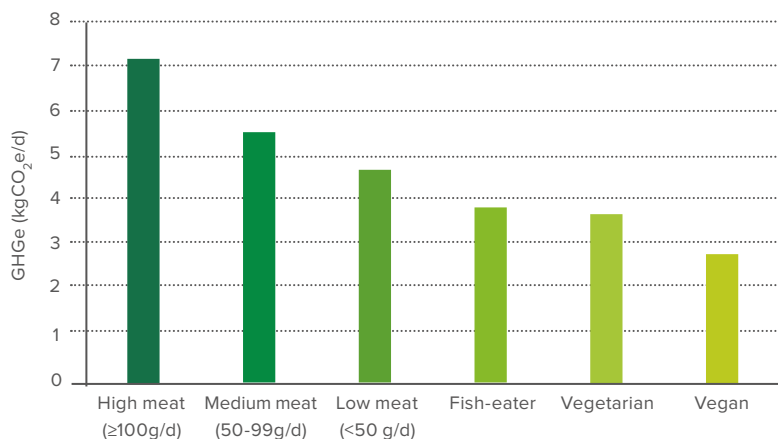


Figure 14: Dietary GHGe (kgCO₂e/d) for subjects following different dietary patterns in the EPIC Oxford Cohort (42)

A very recent study attempted to quantify the health effects associated with adopting low GHG emission diets in the UK. Consumption data from 1571 UK adults that participated in the National Diet and Nutrition survey were used in this modelling study. Diets were optimized to achieve the 2003 WHO nutritional recommendations (4) and to reduce GHG emissions while remaining as close as possible to existing dietary patterns. Average dietary intake patterns were optimized primarily by increasing the consumption of fruit and non-starchy vegetables and reducing the amount of red and processed meat, to achieve target reductions in dietary GHGe of 10%, 20%, 30%, 40%, 50% and 60% while meeting the WHO recommendations. The authors state that **if the average UK dietary intake were optimized to comply with the WHO recommendations, it would result in a 17% reduction in GHGe, save almost 7 million years of lives lost prematurely in the UK over the next 30 years, and average life expectancy would increase by over 8 months.** Diets that result in additional GHG emission reductions could achieve further net health benefits (39).

As well as incorporating a healthy balance of foods to meet nutrition recommendations, a number of countries are now including sustainability in their food-based dietary guidelines because more and more evidence continues to support plant-based foods being preferable for the environment as they require less land, water and energy resources and produce fewer greenhouse gas emissions than animal-based products.

- The global demand of food, based on current food consumption patterns is neither sustainable nor feasible as it puts tremendous pressure on the environment.
- Animal-derived foods generally require more resources than plant-based foods, typically resulting in 15-fold more GHGe and requiring 10-fold more water and 5-fold more fossil fuel input
- Shifting towards plant-based eating, while cutting down on animal foods, can make a big difference to both our health and that of the planet.
- A number of countries are now including sustainability in their food-based dietary guidelines.

5. Plant-based eating: how to put it into practice?

Although there is universal consensus that we should be eating more plant-based foods, many people think this is difficult to achieve. This may be because they do not have enough information about plant-based eating or how to put it into practice. At the same time, health professionals are becoming aware of the important role they have in helping people make sustainable dietary choices. With this in mind, as well as outlining the evidence supporting the nutritional, health and environmental benefits, the 2015 update of “The Plant-based Plan” provides practical advice on how to motivate and get people started on their eating plan.

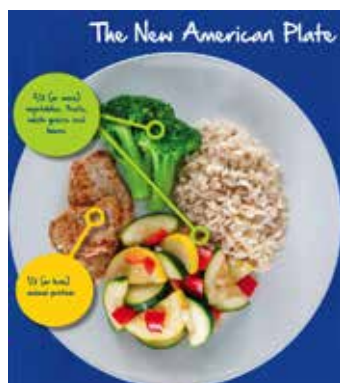
One of the main barriers identified to adopting a plant-based diet is not being aware of what it entails. **It is important to stress that this is not about giving up animal foods, but about putting plant foods first.** It is likely that the health benefits seen in plant-based eating patterns are associated with the increased quantity of plant foods eaten rather than the lack of meat consumption. Plant foods on which to focus include whole grains, legumes, fruits, vegetables, seeds and nuts. These should make up two-thirds of the diet, with the remaining one-third coming from animal foods. Choosing a wide variety of plant foods helps ensure nutritional adequacy, which in turn can help overcome concerns related to the nutritional content of the diet. Another barrier highlighted is cost. However, **modelling studies examining the financial implications have found that a plant-based diet is not more expensive, and in some cases cheaper, than the typical diet (43).** Many plant proteins such as pulses, beans, tofu, and soya mince are often cheaper than animal proteins, which tend to be the most expensive item in a meal. Including more plant proteins, at the expense of animal proteins, as well as careful planning and shopping, makes plant-based eating financially beneficial.

Plant-based eating is not about transforming the diet but about making **small changes to put plant-based foods first.** There is more than one way to include more plant-based foods into the diet, e.g. reshaping what is on the plate, making simple dietary swaps, giving meals a plant make-over and opting for meat-free days. Doing it gradually, is more likely to result in a permanent shift towards plant-based eating.



At least 2/3 of the diet is made up of plant-based foods. Less than 1/3 comes from animal products.

Nutrition professionals are in an ideal position to help people adopt a plant-based eating pattern. They have the skills to translate the science into meaningful and understandable information; they are able to discuss potential barriers and provide solutions to overcome these difficulties; and they can provide practical suggestions with regard to shopping, preparing and cooking ideas. All in all, they can help people change their eating habits for good, enabling plant-based eating to become a permanent feature of the diet.



The New American Plate

Reprinted with permission from the American Institute for Cancer Research

The World Cancer Research Fund and the American Institute for Cancer Research have suggested that at least two-thirds of the plate should be made up of plant foods (vegetables, fruits, whole grains, cereals, pulses, soya, nuts and seeds) and foods from animal origin should make up less than a third.

In practice: serve up plant foods first so there is less room on the plate for animal foods.

Reference list

1. Clarys P, Deliens T, Huybrechts I et al. Comparison of nutritional quality of the vegan, vegetarian, semi-vegetarian, pesco-vegetarian and omnivorous diet. *Nutrients* 2014;6:1318-32.
2. Orlich MJ. Vegetarian dietary patterns and mortality in adventist health study 2. *JAMA Internal Medicine* 2013;173:1230-8.
3. WCRF/AICR. Food, Nutrition and Physical Activity and the Prevention of Cancer: a global perspective. 2007. Washington, AICR.
4. WHO. Diet, Nutrition and the Prevention of Chronic Diseases. Report of a Joint WHO/FAO Expert Consultation. WHO Tech Rep Ser 916:i-vii, 1-149. 2003.
5. WHO. Joint WHO/FAO Expert Consultation on fats and fatty acids in human nutrition. *Ann Nutr Metab* 2009;54:8.
6. Elmadfa I, Meyer A, Nowak V et al. European Nutrition and Health Report 2009. *Ann Nutr Metab* 2009;55, Suppl 2:1-40.
7. Ocke MC, Larranaga N, Grioli S et al. Energy intake and sources of energy intake in the European Prospective Investigation into Cancer and Nutrition. *Eur J Clin Nutr* 2009;63, Suppl 4:3-15.
8. Cust AE, Skilton MR, van Bakel MM et al. Total dietary carbohydrate, sugar, starch and fibre intakes in the European Prospective Investigation into Cancer and Nutrition. *Eur J Clin Nutr* 2009;63, Suppl 4:37-60.
9. Linseisen J, Welch AA, Ocke M et al. Dietary fat intake in the European Prospective Investigation into Cancer and Nutrition: results from the 24-h dietary recalls. *Eur J Clin Nutr* 2009;63, Suppl 4:61-80.

10. Slimani N, Fahey M, Welch AA et al. Diversity of dietary patterns observed in the European Prospective Investigation into Cancer and Nutrition (EPIC) project. *Public Health Nutr* 2002;5:131-28.
11. WWF. Livewell: a balance of healthy and sustainable food choices. 2011.
12. Davey GK, Spencer EA, Appleby PN, Allen NE, Knox KH, Key TJ. EPIC-Oxford: lifestyle characteristics and nutrient intakes in a cohort of 33 883 meat-eaters and 31 546 non meat-eaters in the UK. *Public Health Nutr* 2003;6:259-69.
13. Jenkins DJ, Mirrahimi A, Srichaikul K et al. Soy Protein Reduces Serum Cholesterol by Both Intrinsic and Food Displacement Mechanisms. *J Nutr* 2010;140:2302S-11S.
14. Temme EH, van d, V, Thissen JT, Verkaik-Kloosterman J, van DG, Nonhebel S. Replacement of meat and dairy by plant-derived foods: estimated effects on land use, iron and SFA intakes in young Dutch adult females. *Public Health Nutr* 2013;10:1900-7.
15. WHO. European Food and Nutrition Action Plan 2015-2020. Regional Committee for Europe, 64th SESSION, Copenhagen, Denmark, 15-18 September 2014. 2014.
16. Sabate J, Wien M. Vegetarian diets and childhood obesity prevention. *Am J Clin Nutr* 2010;91:1525S-9S.
17. Trapp CB, Barnard ND. Usefulness of vegetarian and vegan diets for treating type 2 diabetes. *Curr Diab Rep* 2010;10:152-8.
18. Viguiouk E, Stewart SE, Jayalath VH et al. Effect of Replacing Animal Protein with Plant Protein on Glycemic Control in Diabetes: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Nutrients* 2015;7:9804-24.
19. Li Y, Hruby A, Bernstein AM et al. Saturated Fats Compared With Unsaturated Fats and Sources of Carbohydrates in Relation to Risk of Coronary Heart Disease: A Prospective Cohort Study. *J Am Coll Cardiol* 2015;66:1538-48.
20. WHO. Gaining health: The European strategy for the prevention and control of non-communicable diseases. 2006.
21. Key TJ, Appleby PN, Spencer EA, Travis RC, Roddam AW, Allen NE. Mortality in British vegetarians: results from the European Prospective Investigation into Cancer and Nutrition (EPIC-Oxford). *Am J Clin Nutr* 2009;89:1613S-9S.
22. Tokede OA, Onabanjo TA, Yansane A, Gaziano JM, Djousse L. Soya products and serum lipids: a meta-analysis of randomised controlled trials. *Br J Nutr* 2015;114:831-43.
23. Anderson JW, Bush HM. Soy protein effects on serum lipoproteins: a quality assessment and meta-analysis of randomized, controlled studies. *J Am Coll Nutr* 2011;30:79-91.
24. Del Gobbo LC, Falk MC, Feldman R, Lewis K, Mozaffarian D. Effects of tree nuts on blood lipids, apolipoproteins, and blood pressure: systematic review, meta-analysis, and dose-response of 61 controlled intervention trials. *Am J Clin Nutr* 2015;102:1347-56.
25. Whitehead A, Beck EJ, Tosh S, Wolever TM. Cholesterol-lowering effects of oat beta-glucan: a meta-analysis of randomized controlled trials. *Am J Clin Nutr* 2014;100:1413-21.
26. Ras RT, Geleijnse JM, Trautwein EA. LDL-cholesterol-lowering effect of plant sterols and stanols across different dose ranges: a meta-analysis of randomised controlled studies. *Br J Nutr* 2014;112:214-9.
27. WHO. Keep fit for life: Meeting the nutritional needs of older persons. 2002.
28. Willcox DC, Scapagnini G, Willcox BJ. Healthy aging diets other than the Mediterranean: a focus on the Okinawan diet. *Mech Ageing Dev* 2014;136:137-148-62.
29. Willcox BJ, Willcox DC, Todoriki H et al. Caloric restriction, the traditional Okinawan diet, and healthy aging: the diet of the world's longest-lived people and its potential impact on morbidity and life span. *Ann N Y Acad Sci* 2007;1114:434-55.
30. Struijk EA, Beulens JW, May AM et al. Dietary patterns in relation to disease burden expressed in Disability-Adjusted Life Years. *Am J Clin Nutr* 2014;100:1158-65.
31. Prentice A, Bonjour JP, Branca F et al. PASSCLAIM - Bone health and osteoporosis. *Eur J Nutr* 2003;42, Suppl 1:128-149.
32. Mangels AR. Bone nutrients for vegetarians. *Am J Clin Nutr* 2014;100, Suppl 1:469S-75S.
33. Knurick JR, Johnston CS, Wherry SJ, Aguayo I. Comparison of correlates of bone mineral density in individuals adhering to lacto-ovo, vegan, or omnivore diets: a cross-sectional investigation. *Nutrients* 2015;7:3416-26.
34. Shu XO, Jin F, Dai Q et al. Soyfood intake during adolescence and subsequent risk of breast cancer among Chinese women. *Cancer Epidemiol Biomarkers Prev* 2001;10:483-8.
35. Lee SA, Shu XO, Li H et al. Adolescent and adult soy food intake and breast cancer risk: results from the Shanghai Women's Health Study. *Am J Clin Nutr* 2009;89:1920-6.
36. Wu AH, Wan P, Hankin J, Tseng CC, Yu MC, Pike MC. Adolescent and adult soy intake and risk of breast cancer in Asian-Americans. *Carcinogenesis* 2002;23:1491-6.
37. Huang T, Yang B, Zheng J, Li G, Wahlqvist ML, Li D. Cardiovascular disease mortality and cancer incidence in vegetarians: a meta-analysis and systematic review. *Ann Nutr Metab* 2012;60:233-40.
38. WCRF. Continuous Update Project Report: Systematic review on diet, nutrition, physical activity and survival and second cancers in breast cancer survivors. 2014.
39. Milner J, Green R, Dangour AD et al. Health effects of adopting low greenhouse gas emission diets in the UK. *BMJ Open* 2015;5:e007364.
40. Aiking H. Protein production: planet, profit, plus people? *Am J Clin Nutr* 2014;100, Suppl 1:483S-9S.
41. Pimentel D, Pimentel M. Sustainability of meat-based and plant-based diets and the environment. *Am J Clin Nutr* 2003;78:660S-3S.
42. Scarborough P, Appleby PN, Mizdrak A et al. Dietary greenhouse gas emissions of meat-eaters, fish-eaters, vegetarians and vegans in the UK. *Clim Change* 2014;125:179-92.
43. van Dooren C, Tyszler M, Kramer GF, Aiking H. Combining Low Price, Low Climate Impact and High Nutritional Value in One Shopping Basket through Diet Optimization by Linear Programming. *Sustainability* 2015;12837-55.



This white paper is a summary of the key insights from the book
“The Plant-based Plan” written by Janice Harland and Lynne Garton in 2015.