

White paper
Towards a more
plant-based diet



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Colophon

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Introduction:

Towards a more plant-based diet

A shift towards a more plant-based and less animal-based diet is not only better for our health, it is also more sustainable. The same applies to a shift towards more plant proteins and fewer animal proteins.

In the Dutch dietary guidelines, the Health Council of the Netherlands (Gezondheidsraad 2015) makes the following recommendation: 'Eat a more plant-based and less animal-based diet in accordance with the guidelines.' More plant-based and less animal-based diets have positive health effects. The findings on diets are in line with the guidelines previously formulated in the recommendation (the 15 Dutch Dietary Guidelines, ed.), which show that vegetables and fruit, legumes, nuts, wholegrain products, and vegetable fats and oils provide protection against the risk of chronic diseases, while processed and red meats are instead linked to a higher risk of chronic diseases (Health Council 2015).

In the policy brief 'Food for a circular economy', PBL Netherlands Environmental Assessment Agency also refers to a shift towards a diet with more plant proteins as a way of reducing the environmental impact: 'The production of plant proteins such as legumes is more efficient than the production of animal proteins, making more optimal use of raw materials.' As a shift in the diet towards fewer animal and more plant proteins leads to fewer raw materials being required, it is in line with a circular food system (Rood, Muilwijk et al. 2016).

The National Institute for Public Health and the Environment report 'What is on our plate? Safe, healthy and sustainable diets in the Netherlands' (Ocké, Toxopeus et al. 2016) provides facts and figures relating to the Dutch dietary pattern. Not eating excessive amounts of food, a diet with more plant-based and fewer animal-based products as well as fewer sugary and alcoholic drinks: these three opportunities can help to achieve a healthier and more sustainable diet. This diet will lead to a drop in the number of people suffering from chronic diseases, help to reduce health differences within the Dutch population and reduce the environmental impact of food. Lower meat consumption also means fewer food-borne infections (Ocké, Toxopeus et al. 2016).

In 2018, the Dutch Council for the Environment and Infrastructure recommended to set the following goal: 'reducing the percentage of animal proteins in the diet to 40% of total protein consumption by 2030. A sustainable and healthy diet means eating more plant proteins and fewer animal proteins.' Another recommendation by the Council was to 'adapt the Wheel of Five in line with the objective of reducing the proportion of animal proteins to 40% of total protein consumption. Make this objective feasible for people to achieve in recipes and menus.' Such a diet still provides scope for eating sustainably produced meat, dairy and eggs, albeit in moderation (Raad voor de leefomgeving en infrastructuur 2018).

The Biomass and Food Transition Agenda (2018) has six main lines of action, including the transition to more plant proteins. Its goal is to make both the production and the consumption of proteins far more sustainable: 'The aim is to reverse the animal-plant protein ratio in our diet from 60% animal and 40% plant protein today to 40% animal and 60% plant protein by 2050.'

The Food Agenda highlights the importance of continuing to develop safe, healthy and sustainable food (Dijkma and Schippers 2015). In order to achieve its ambitions, the government has given substantial boosts to the implementation of the food agenda in recent years, including:

- more vegetables on the menu, less salt, less saturated fatty acids as well as fewer calories due to increased efforts by the food industry, retail, hotel and catering sector to ensure a healthier supply;
- stimulating the opportunities and possibilities of new protein sources as well as enhancing innovative strength in the area of sustainable protein products from seaweed, legumes and mushrooms together with the industry and knowledge institutes (Letter to Parliament on the progress of the Food Agenda for safe, healthy and sustainable food, 21 November 2016).

The Climate Agreement (2019) also addresses a number of goals relating to more climate-friendly food. When it comes to consumer behaviour, the innovation challenge is how to halve the footprint caused by purchasing choices for both food and non-food. Less food waste, a higher consumption of fruit and vegetables, and a higher percentage of plant-based proteins are regarded as important contributions to the long-term climate policy. 'The parties aim to achieve a healthy balance between the ratio of animal and plant proteins in our diet by 2050, in accordance with the advice of the Netherlands Nutrition Centre.

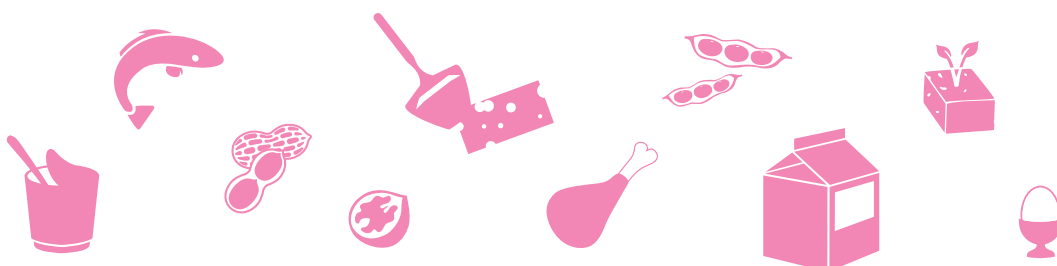
In addition, an average reduction of the total protein intake by 10–15% is desirable. (...) In particular, [supermarkets] can contribute to the protein transition and help encourage consumers to consume more plant-based proteins rather than animal products and products from the Wheel of Five in accordance with the National Prevention Agreement.'

The conclusion is that consumers can both eat and drink in a healthy, sustainable and varied way by following a diet that consists of fewer animal-based and more plant-based products.

1. What are the health benefits of a less animal-based and more plant-based diet?

According to the Health Council, a more plant-based and less animal-based diet reduces the risk of coronary heart disease and strokes.

The core of the Health Council's 2015 Dutch Dietary Guidelines is the recommendation to follow a more plant-based and less animal-based diet. This recommendation has been translated into guidelines for food such as fruit and vegetables, meat, fish, nuts, legumes, wholegrain products, dairy products, oils and fats, beverages, alcohol and table salt. According to the Health Council's conclusions, it has been convincingly demonstrated that the recommended diets (with fewer animal-based and more plant-based products, such as the Mediterranean, Scandinavian and DASH diets) reduce the risk of coronary heart disease and strokes. Randomised and controlled intervention studies show that such diets lower blood pressure, while cohort studies reveal that they are associated with a lower risk of coronary heart disease and strokes. Furthermore, these diets are associated with a lower risk of diabetes, bowel cancer and death without regard to the cause of death. Vegetarian diets have been convincingly shown to reduce the risk of coronary heart disease. Intervention studies show that vegetarian diets lower blood pressure and cohort studies show a correlation with a lower risk of coronary heart disease (Gezondheidsraad 2015).



2. What is the current protein intake in the Netherlands?

Protein consumption varies by sex and age group. In the Netherlands, we eat 78 grams of protein per day on average. The daily intake is higher for boys and men (88 grams) than for girls and women (68 grams). On average, 61% of this protein is of animal origin (58-65%).

These figures are taken from the 2012–2016 Dutch National Food Consumption Survey (DNFCS) of the National Institute for Public Health and the Environment (RIVM), involving people between the ages of 1 and 79 (RIVM 2019a) and additional RIVM (2019b) tables). Table 1 provides an overview (P50 is the median).

Table 1: Protein intake (P50) of the Dutch based on the 2012–2016 DNFCS

	1-3 year		4-8 year		9-13 year		14-18 year		19-30 year		31-50 year		51-70 year		71-79 year	
	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl	Men	Women	Men	Women	Men	Women	Men	Women
Consumption in g/day (P50)	41	40	58	50	72	57	80	62	91	68	97	72	92	72	84	69
Plant protein in g/day	18	16	25	22	31	25	34	26	37	28	38	28	35	26	30	25
Animal protein in g/day	25	25	35	30	43	34	48	37	54	40	60	44	59	46	55	46
Percentage of animal protein (in %)*	58	61	58	58	58	58	59	59	59	59	61	61	63	64	65	65
Estimated Average Requirement (EAR)	11	10	17	16	28	28	43	38	47	40	45	39	46	40	46	39
Percentage failing to meet the EAR									2%	1%					1%	1%
Energy intake from protein (in %)	13.4	13.0	13.1	13.2	13.5	13.5	13.8	13.8	14.4	14.6	15.1	15.9	15.6	16.6	15.9	16.2

* calculated on the basis of the RIVM figures

3. Do the Dutch consume enough and/or too much protein?

Almost all Dutch people consume enough protein. On average, the intake for adults is around 70% higher than the average protein requirement. For people over the age of 70, this percentage is slightly lower. The fact that the intake is higher than the requirement does not automatically mean that the protein intake can be reduced.

The RIVM also states the Estimated Average Requirement (EAR) for each age group. This figure derives from the Health Council (2001). The Council distinguishes between the average requirement (= EAR) and the recommended amount. Both are expressed in grams per kilogram of body weight. For adults, the average requirement has been set at 0.6 grams per kg of body weight and the recommended amount

at 0.8 grams per kg of body weight. The recommended daily amount is the amount of a nutrient that is sufficient to meet the needs of almost an entire population group. This recommended amount turns out to be approximately 50 to 60 grams of protein per day (for an average weight of 62 to 75 kg). For children, the recommended amounts of protein per kg of body weight are higher (Health Council 2001).

Almost all Dutch people consume enough protein (RIVM 2019a). The average requirement should be used to assess the intake figures for healthy populations (EAR, Health Council 2001). Intake figures are given as the median, which is the amount of protein consumed by half of a population group. This median is then compared with the EAR, the amount of a nutrient that is sufficient to meet the needs of half the population group. Only 2% of women aged 14–18, 1% of women aged 19–30 and 71–79, and 1% of men aged 71–79 have an intake that is lower than the EAR (see Table 1). According to a previous food consumption survey among older people (2010–2012), this percentage was slightly higher for people over the age of 70: 3% of men and 5% of women had a protein intake below the EAR. Older people over the age of 80 were also taken into account here and a higher average requirement for this age group was assumed. However, most of the respondents in this study were relatively vigorous (Ocké, Buurma-Rethans et al. 2013). Another study by Hengeveld et al. concluded that 15% of community-dwelling older adults (those aged 70 and older) had a protein intake below the recommended amount of 0.8 grams per kg of body weight (Hengeveld, Pelgröm et al. 2019). Since the group of older people over the age of 80 is growing, the group of vulnerable older people is expected to increase as well. In particular for vulnerable older people, it is important to consume sufficient protein of good quality.

The median consumption level is far (at least 50%) above the average protein requirement (RIVM 2019b). Table 1 also shows the energy percentage of protein in the diet. On average, this figure is between 13.0 and 16.6 energy percent (en%; the recommendation is at least 10 en%). In other words, the median intake is 70% to 115% above the average requirement for adults. For older people (those aged 71–79), this figure is around 80%.

The fact that the intake is higher than the average requirement does not automatically mean that the protein intake can be reduced. Protein-rich foods can help to reduce the risk of chronic diseases (Health Council 2015). They also provide other essential nutrients such as iron, B vitamins, calcium and fibre. Potential consequences of lowering total protein consumption by 10–15% per person in 2050, as suggested in different reports (Transitieteam Biomassa en Voedsel 2018, Rijksoverheid 2019), is not yet sufficiently clear. First, we recommend looking in more detail at the foods that should replace protein-rich products and the consequences of this substitution for the nutrient intake on a population level. Moreover, more insight is required into protein quality and intake among vulnerable groups when reducing their total protein intake.

In addition, there has recently been a lot of discussion about the protein requirements of older people. Currently, the Health Council of the Netherlands, WHO and EFSA recommend 0.8 g of protein per kg of body weight, also for older people (Gezondheidsraad 2001, WHO 2007, EFSA 2012). However, ESPEN and PROT-AGE expert groups recommend a higher protein intake for older people: 1.0 kg/kg body weight for healthy older people and 1.2–1.5 g/kg body weight for older people with a chronic/acute illness or in recovery (Bauer, Biolo et al. 2013, Deutz, Bauer et al. 2014). In addition to an adequate total intake, the distribution of protein intake during the day may be relevant and some recommend 25–30 g of protein per meal (Paddon-Jones and Rasmussen 2009, Paddon-Jones and Leidy 2014, Yanai 2015).

With regard to the intake, replacing 30% of animal foods with plant-based foods need not pose any problems in respect of the recommendations for both children and adults (Temme et al. 2015, Seves et al. 2017).

The recommendations of the Health Council (Gezondheidsraad 2001) for meeting the energy requirements are as follows:

- Protein: 10–25 en%
- Fat: 20–40 en%, or 20–35 en% for overweight people
- The rest of the energy requirement comes from carbohydrates (40–70%)

In the Wheel of Five, the health benefits of foods are combined with the provision of sufficient nutrients and energy. On average, the calculated Wheel of Five reference diet provides 85% of the energy in the ratio 17–22 en% protein, 32–36 en% fat and 46–50 en% carbohydrates (Brink, Postma - Smeets et al. 2018).

Lowering the total energy intake can help to reduce the protein intake. Reducing the protein intake while maintaining the same supply of energy will result in an increased fat and/or carbohydrate intake. This exchange can only be done to a limited extent. More than 40% of Dutch people are overweight (Statistics Netherlands 2018). For this group, it is not desirable to consume much more than 35 en% fat. The carbohydrate intake cannot be increased without limitation either, as the diet must remain viable. More carbohydrates in the form of wholegrain products and legumes also provide more protein, which contributes to the protein transition. Proteins have a satiating effect as well (Yang, Liu et al. 2014, Kristensen, Bendtsen et al. 2016).

A diet without meat in accordance with the Wheel of Five, in which meat has mainly been replaced by legumes and nuts, yields sufficient protein (Brink, Postma - Smeets et al. 2018). On average, the calculated reference diet without meat provides 85% of the energy in the ratio 15–19 en% protein, 32–35 en% fat and 46–51 en% carbohydrates. On average, this diet contains over 70 grams of protein per day for adult women and over 80 grams per day for adult men.

The tolerable upper limit for proteins is 25 en% (Gezondheidsraad 2001). Dutch people barely exceed the acceptable upper limit of 25 en% (additional RIVM (2019b) tables).

4. What is the protein requirement?

For adults, the average requirement has been set at 0.6 grams per kg of body weight and the recommended amount at 0.8 grams per kg of body weight.

For people following a lacto-ovo vegetarian or a vegan diet, the recommended amounts of protein are 1.2 and 1.3 times higher, respectively, than the values derived from the recommendation. The reason is that the quality of the protein in these diets is slightly lower than in a diet containing meat and meat products (Gezondheidsraad 2001). The protein requirements of older people have been much discussed in recent years. Currently, the Health Council of the Netherlands, WHO and EFSA recommend 0.8 g of protein per kg of body weight, also for older people (Gezondheidsraad 2001, WHO 2007, EFSA 2012). However, ESPEN and PROT-AGE expert groups recommend a higher protein intake for older people: 1.0 kg/kg body weight for healthy older people and 1.2–1.5 g/kg body weight for older people with a chronic/acute illness or in recovery (Bauer, Biolo et al. 2013, Deutz, Bauer et al. 2014). In addition to an adequate total intake, the distribution of protein intake during the day may be relevant and some recommend 25–30 g of protein per meal (Paddon-Jones and Rasmussen 2009, Paddon-Jones and Leidy 2014, Yanai 2015). The Health Council is currently reviewing the standards for protein.

As almost all Dutch people consume sufficient protein and the average intake for adults exceeds the requirement by over 70%, few adult vegetarians and vegans will have a protein deficiency in practice. However, this fact may not be true for children or older people.

5. Which product groups contribute to protein intake?

Meat, milk products and cereal products are important sources of protein in the Netherlands.

The Dutch National Food Consumption Survey (DNFCS) also provides information on which product groups contribute to the current food intake. Meat (28%), milk products (24%) and cereal products (23%) made the main contribution to the protein intake of Dutch people aged 1 to 79 in the period 2012–2016 (see Figure 1). The animal protein groups together account for 58%. Plant protein groups account for 37%. The other group, which accounts for 5%, may consist of both plant and animal proteins. Fish (4%) and eggs (2%) make a small contribution to protein intake. Pulses (<1%) and nuts (fruit and nuts 4%) hardly made any contribution to protein intake (RIVM 2019c).

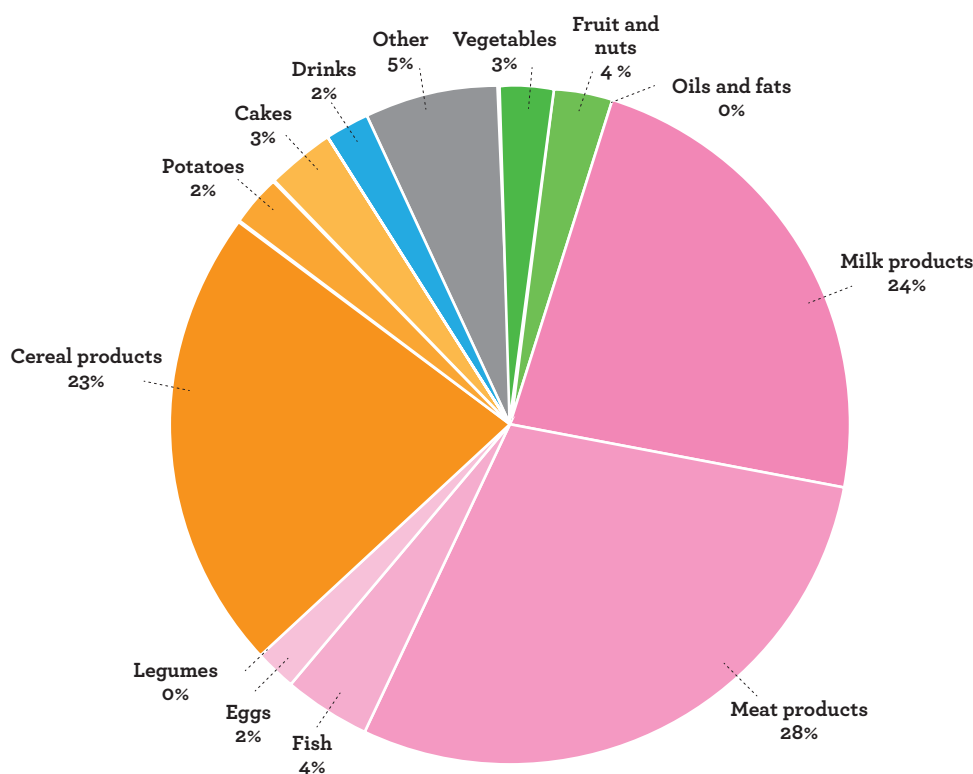


Figure 1: Contribution of different product groups to the average protein intake of Dutch people aged 1 to 79 (2012–2016DNFCS) (calculated on the basis of (RIVM 2019c))

The National Institute for Public Health and the Environment (RIVM) examined the consumption of people aged 9–69 in the Netherlands over the period 2012–2016 and whether food consumption had changed compared to 5 years earlier. During those five years, the consumption of alcoholic beverages, potatoes, fats and oils, dairy, sugar, confectionery and meat decreased (below the 0-line, Figure 2). The quantity of vegetables and cereal products, cakes and pastries has remained roughly the same. While adults and children show similar changes, we can see that children have started eating more fruit. The total consumption has remained stable (RIVM 2018).

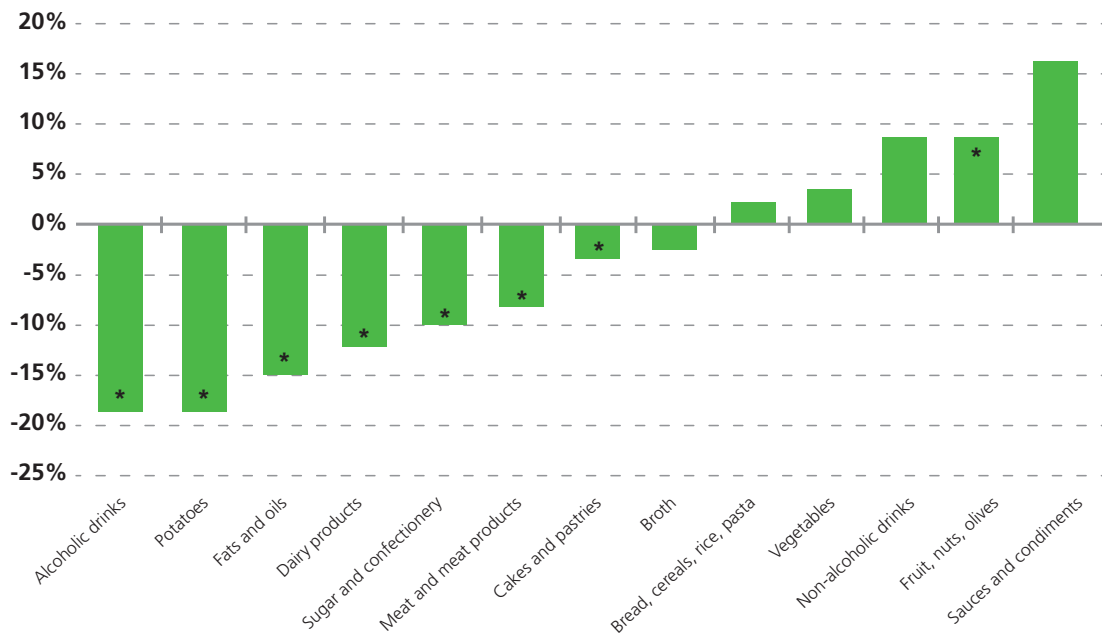


Figure 2: Change in food consumption (2012–2016 DNFCs compared to 2007–2010 DNFCs among people aged 9–69) (RIVM 2018) *Statistically significant

6. What is the environmental impact of different protein sources¹?

Although the environmental impact of different protein sources varies significantly, animal protein sources (especially red meat) generally have a higher environmental impact than plant-based sources.

The most recent environmental impact data of different protein sources date from 2019 (RIVM StatLine 2019). These figures are summarised in Figure 2a and 2b for foods and beverages, respectively. Commissioned by the National Institute for Public Health and the Environment (RIVM), Blonk Consultants has carried out various life cycle analyses (LCA) of food products as consumed in the Netherlands. These LCAs entail a cradle-to-end-of-life analysis, meaning from inputs to household consumption. Direct energy use and food losses by the consumer are included. Greenhouse gas emissions include all emissions during the life cycle of a product that contribute to climate change, such as nitrous oxide emissions released during the cultivation of crops, methane emissions released due to livestock production and emissions caused by land conversion (for example due to deforestation). Land use refers to the area of land used or transformed per year. Water use concerns fresh water usage throughout the supply chain. This concerns irrigation water during the cultivation of crops, mentioned as “blue water footprint”. Inevitably, the data for each product have some limitations, as there are variations within a single type of product as well as assumptions, uncertainties and limitations in LCA methods.

¹ For the definition of ‘protein source’, see question 10.

Table 2a: Environmental figures for protein providing foods per kg of product. These data entail a complete 'cradle-to-end-of-life' analysis from inputs to household consumption by Dutch consumers (RIVM StatLine 2019).

Product	Greenhouse gases kg CO ₂ eq	Land use m ² *year	Water use m ³
Lamb	86,64	30,65	0,96
Beef steak	31,34	15,45	0,25
Veal	31,00	16,25	0,35
Hamburger	30,68	15,05	0,25
Tilapia	22,86	6,73	0,10
Minced meat (half beef, half pork)	20,37	11,97	0,17
Sausage (pork)	15,68	9,56	0,14
Dutch shrimps	15,41	2,15	0,08
Tuna (canned)	14,55	0,02	0,06
Dutch cheese	13,09	5,35	0,10
Pork	12,42	10,05	0,12
Chicken	10,87	7,46	0,15
Peanuts	7,35	5,97	0,17
Cod	6,95	0,10	0,04
Salmon (farmed)	6,88	2,22	0,05
Vegetarian schnitzel	5,92	3,73	0,10
Almonds	4,87	7,45	4,38
Salmon (wild-caught)	4,49	0,09	0,03
Tofu	4,33	2,23	0,05
Egg (boiled)	4,32	3,79	0,11
Cashew nuts	4,26	13,94	2,00
Mealworms	4,00	4,52	0,13
Vegetarian hamburger	3,77	1,80	0,04
Chickpeas (soaked and boiled)	3,73	4,90	0,04
Walnuts	3,31	3,88	4,09
Salted herring	2,81	0,01	0,02
Mackerel (smoked)	2,17	0,01	0,02
Brown beans (canned)	1,88	2,11	0,07
Seaweed (kelp)	0,88	0,02	0,01

Table 2b: Environmental figures for protein providing beverages per kg of product. These data entail a complete 'cradle-to-end-of-life' analysis from inputs to household consumption by Dutch consumers (RIVM StatLine 2019).

Product	Greenhouse gases kg CO ₂ eq	Land use m ² *year	Water use m ³
Semi-skimmed milk	2,03	0,78	0,02
Soya drink natural	0,76	0,35	0,01

As yet, little information is available on the environmental impact of novel protein sources.² Novel protein sources, such as insects fed with residual flows, appear to make more efficient use of land. If produced using renewable energy, they could also lead to fewer greenhouse gas emissions than common animal protein sources (Parodi, Leip et al. 2018). Some data can be found in the Fact Sheet about novel protein sources as meat substitutes (in Dutch) (Van Dooren and Postma - Smeets 2015).

Based on the RIVM calculations for the environmental impact by the Wheel of Five (van de Kamp, van Dooren et al. 2018), it is known that meat, beverages and dairy together have the highest environmental impact in the current diet (Brink, Postma - Smeets et al. 2018). For men, these foods accounts for about two thirds of the impact, in which 31% of the environmental impact is due to the consumption of red meat (see Figure 3).

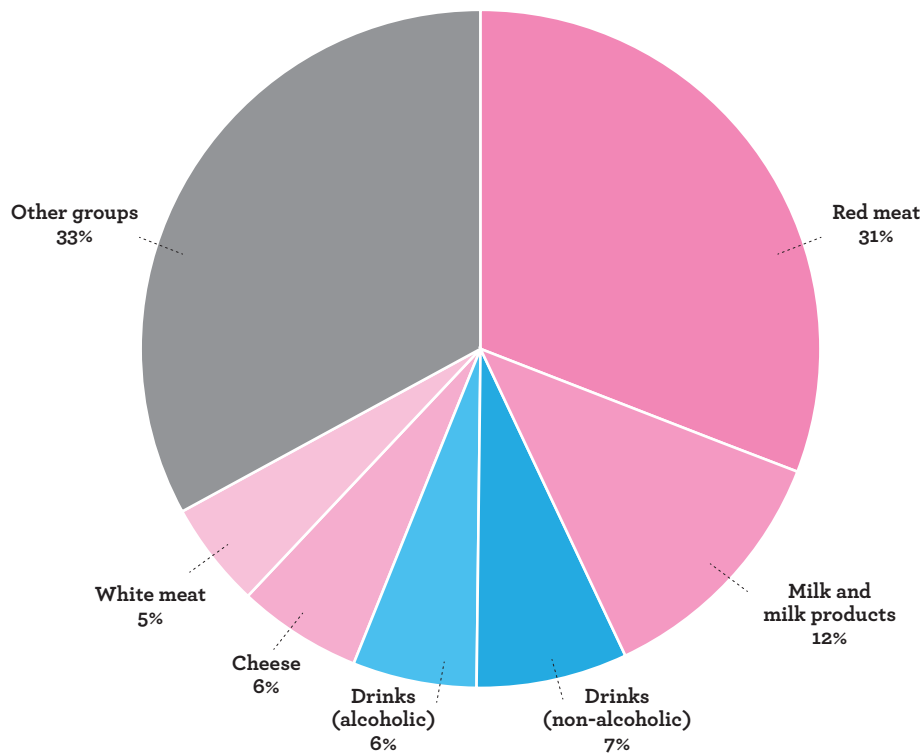


Figure 3: Contribution of products to the total greenhouse gas emissions of the Dutch diet (men aged 18–30) (Brink, Postma - Smeets et al. 2018)

² Novel protein sources according to the criteria of the Novel Foods Regulation 2015/2283.

7. What ratio of plant-animal protein is consumed in the Netherlands?

The ratio in the current intake is approximately 61% animal protein and 39% plant protein.

Table 1 also shows the usual intake of plant and animal proteins by age group (P50). If the amount of animal and plant protein listed in Table 1 is expressed in relation to the total intake, the average percentage of animal protein is 61% (ranging from 58% to 65%) and the average percentage of plant protein is 39% (see also the appendix).

8. What ratio of plant-animal protein is recommended in the Wheel of Five Guidelines?

The Wheel of Five Guidelines do not provide a direct recommendation for the plant-animal protein ratio. If the recommendations for protein-rich products are taken into account, it amounts to approximately 50% plant/50% animal protein given the maximum recommended meat consumption (500 grams per week), or approximately 60%/40% for a vegetarian diet.

The Wheel of Five Guidelines (in Dutch) (Brink, Postma - Smeets et al. 2018) do not provide a direct recommendation for the plant-animal protein ratio. However, they do provide six concrete recommendations that have a direct impact:

- 500 grams of meat per week as a maximum, of which not more than 300 grams should consist of red³ meat and as little as possible of processed meat⁴;
- fish, preferably oily fish, once a week;
- a few portions of dairy, including cheese, per day (quantity depending on age and sex);
- 2-3 eggs per week (3-4 eggs for vegetarians);
- legumes once a week (135 grams);
- a handful of nuts daily (25 grams);
- sufficient bread and wholegrain products (quantities depending on age and sex).

If the recommendations are taken into account, they result into a ratio of 52% plant/48% animal protein for men (aged 19-50) and 46% plant/54% animal protein for women (aged 19-50) given the maximum recommended meat consumption of 500 grams per week. On average, the ratio is about 50/50. In the Wheel of Five's vegetarian variant, which replaces meat by legumes, nuts and eggs, the ratio is 38% plant/62% animal protein for men and 43%/57% for women (see the appendix for the calculations).

³ Red meat comes from cattle, sheep, goats and pigs. White meat comes from chicken and other poultry.

⁴ Processed meat is meat that has been modified through salting, smoking or other processes to enhance flavour or improve preservation. Processed meat could be red or white meat.

9. How would the environmental impact change if everyone's diet contained 50% animal and 50% plant protein?

If everyone had a diet containing 50% animal and 50% plant protein in line with the recommendations of the Wheel of Five, it could reduce the environmental impact of the diet by about 10% to 13%, expressed in terms of greenhouse gas emissions.

According to the 2007-2010 DNFCs, the environmental impact of food consumption (expressed in terms of greenhouse gas emissions) is higher for men than for women. The environmental impact of the current food consumption for men is 5.91 kg CO₂eq/day (aged 19-30) and 5.81 kg CO₂eq/day (aged 31-50), respectively. For women, these figures are 4.28 and 4.38 kg CO₂eq/day, respectively. Eating in accordance with the Wheel of Five Guidelines provides health benefits for everyone, including a reduction in environmental impact for men (-13%, an average of 0.78 kg CO₂eq less per day; see Figure 4) (Brink, Postma - Smeets et al. 2018, van de Kamp, van Dooren et al. 2018). The protein ratio is 48% animal, 52% plant. For women, the environmental impact remains roughly the same (0.02 kg CO₂eq less per day). In this case, the protein ratio would be 54% animal and 46% plant for women.

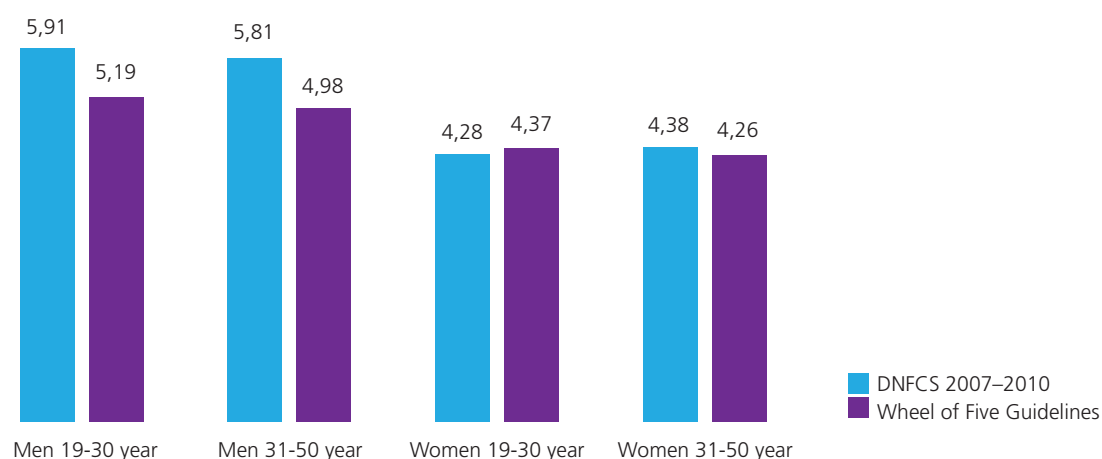


Figure 4: Greenhouse gas emissions (in kg CO₂eq/day) of the current food consumption compared to a diet in accordance with the Wheel of Five Guidelines, including food groups outside the Wheel of Five (with alcoholic beverages) (Brink, Postma - Smeets et al. 2018)

Environmental benefits can be achieved by making different choices within the Wheel of Five. The variant of the Wheel of Five with 400 grams of meat instead of 500 grams reduces greenhouse gas emissions by 9% for men and 10% for women (0.40 kg CO₂eq less per day; see Figure 5) (Brink, Postma - Smeets et al. 2018, van de Kamp, van Dooren et al. 2018). In this case, the ratio for women would be closer to 50/50: 52% animal and 48% plant protein.⁵

The Wheel of Five variant without meat reduces greenhouse gas emissions by 35% for men and 37% for women (1.47 kg CO₂eq less per day) (Brink, Postma - Smeets et al. 2018, van de Kamp, van Dooren et al. 2018). This meat is partly replaced by eggs, legumes and nuts in order to continue providing all nutrients. The proportion of animal protein then drops further to 38% for men and 42% for women, respectively.

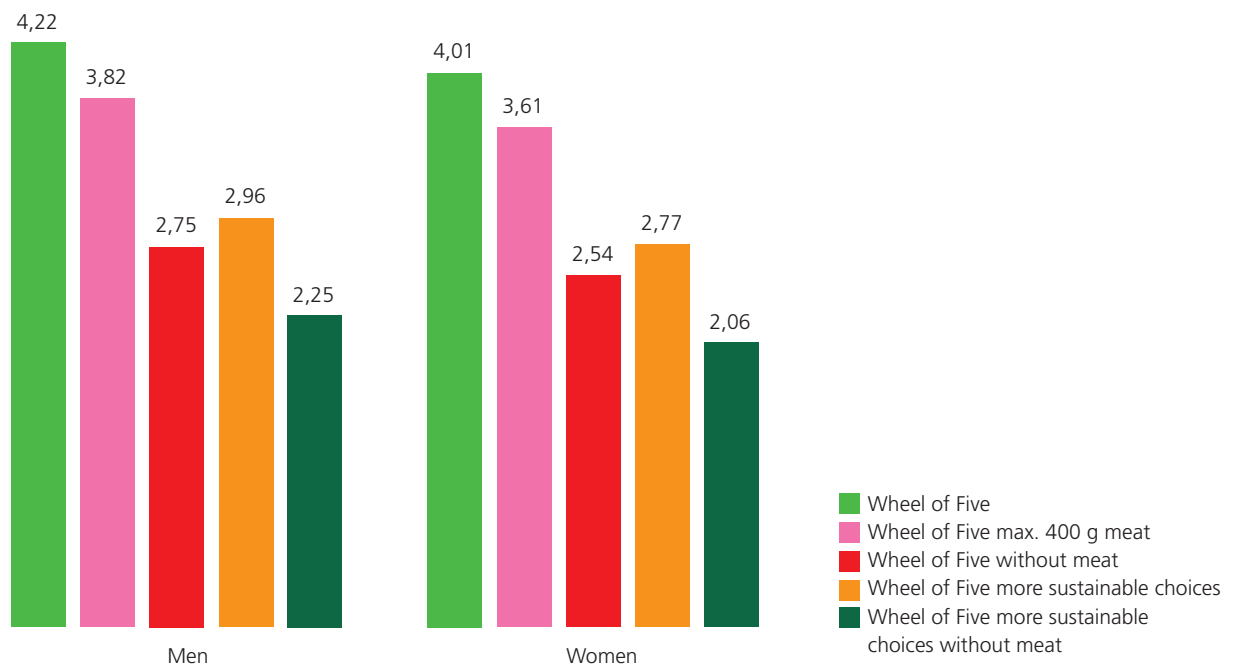


Figure 5: Greenhouse gas emissions (in kg CO₂eq/day) for the different Wheel of Five variants, containing only foods within the Wheel of Five (Brink, Postma - Smeets et al. 2018)

⁵ The examples in the appendix also make it clear that eating in accordance with the Wheel of Five (including meat) keeps the total amount of protein for men approximately the same (from 91–98 grams to 95 grams/day), while increasing it for women (from 68–72 grams to 85 grams). In the vegetarian variant, the total amount of protein is lower: 83 grams/day for men and 73 grams/day for women.

10. Which foods are sources of protein?

A product may be called a ‘source of protein’ if at least 12% of the energy in the food consists of protein. For example, legumes, nuts, seeds, bread, various cereal products and soya products are sources of protein. Products can be called ‘high protein’ if at least 20% of the energy in the food consists of protein. In order to fall within the Wheel of Five criteria, meat and dairy substitutes must be ‘high protein’.

‘Source of protein’ and ‘high protein’ are nutrition claims. The use of claims is regulated by European legislation (European Regulation No 1924/2006 on nutrition and health claims made on foods). Manufacturers may only use a claim if it appears on the European list of approved claims. A product may be called a ‘source of protein’ if at least 12% of the energy in the food consists of protein. Products can be called ‘high protein’ if at least 20% of the energy in the food consists of protein.

On the basis of this criterion, legumes, nuts, seeds, bread, various cereal products and soya products are sources of protein. Although vegetables and mushrooms contain a small percentage of protein in terms of grams, these products usually contain more than 12 en% protein and are therefore a source of protein in accordance with the legislation. Legumes and soya products are high in protein, as are meat, fish, eggs and dairy products.



11. What are alternatives to meat, dairy and fish?

The Netherlands Nutrition Centre has developed criteria for vegetarian products, cheese substitutes and plant-based protein drinks that are intended to replace meat and dairy in terms of nutritional value. There are no substitution criteria for fish.

The Netherlands Nutrition Centre has formulated criteria for vegetarian products, of which the last three are substitution criteria⁶ (Brink, Postma - Smeets et al. 2018):

- Saturated fatty acids: ≤ 2.5 g/100 g
- Trans-fatty acids: ≤ 0.1 g/100 g
- Sodium: ≤ 450 mg/100 g
- Added sugar: not added
- Iron: ≥ 0.8 mg/100 g
- Vitamin B12: ≥ 0.24 mcg/100 g and/or B1: ≥ 0.06 mg/100 g
- Protein: ≥ 20 en%

⁶ Due to European regulations, organic products must not be fortified and organic ready-to-eat meat substitutes therefore cannot meet the criteria (organic pulses and nuts can, however).

Products that meet these criteria are products which aim to match part or all of the nutritional value of lean meat and which fit within the Wheel of Five. The protein criterion for vegetarian products, as well as for cheese substitutes and plant-based protein drinks, was revised in 2018 from 12% of the energy to 20% of the energy in order to bring substitutes more into line with the protein level of the foods that they are replacing. Mushrooms, Quorn, various ready-to-eat vegetarian products (not always fortified, often too much salt) as well as various types of seaweed and insects do not meet these criteria. By way of comparison, the Wheel of Five criteria for unprocessed meat are as follows:

- Saturated fatty acids: ≤ 5.0 g/100 g
- Trans-fatty acids: not added
- Sodium: not added
- Added sugar: not added

Processed meat is not included in the Wheel of Five (the same applies to all types of processed meats, such as sliced cold meat, hamburgers, beef roulade, sausages or kebab).

As regards dairy substitutes, it should be noted that the Health Council attaches a specific health benefit to dairy consumption. It concludes that dairy consumption is likely to be associated with a lower risk of bowel cancer and the consumption of yoghurt with a lower risk of diabetes (Gezondheidsraad 2015). As a result, dairy is recommended in the Wheel of Five. The Health Council also examined the health effects of consuming soya and soya products, concluding that too little research has been carried out to form an opinion.

Some people cannot or do not want to eat or drink certain products from the Wheel of Five, such as 'animal-based' dairy products. They eat other products instead. On the basis of the studies examined, the same health effects cannot be attributed to these other products. However, they can contribute to the intake of several nutrients that are characteristic of the product group. Substitution criteria have been formulated for these nutrients. The following Wheel of Five substitution criteria have been formulated for plant-based protein drinks and desserts (Brink, Postma - Smeets et al. 2018):

- Saturated fatty acids: ≤ 1.1 g/100 g
- Trans-fatty acids: not added
- Sodium: ≤ 60 mg/100
- Total sugar: ≤ 6 g/100 g
- Calcium: ≥ 80 mg/100 g
- Vitamin B12: ≥ 0.24 mcg/100 g
- Protein: ≥ 20 en%.

Criteria for cheese substitutes containing plant-based ingredients are as follows:

- Saturated fatty acids: ≤ 14 g/100 g
- Trans-fatty acids: not added
- Sodium: ≤ 820 mg/100 g
- Added sugar: not added
- Calcium: ≥ 500 mg/100 g
- Vitamin B12: ≥ 0.24 mcg/100 g
- Protein: ≥ 20 en%.

No substitution criteria have been established for fish.

Proteins are of plant or animal origin. In addition to these categories, there is a third category of products that can supply proteins: the so-called novel protein sources. While these sources are new to the market and are often not yet permitted for use in human food, they are covered by the so-called Novel Food Legislation. These products are of both plant (e.g. duckweed, certain algae) and animal origin (e.g. certain insects and 'cultivated meat').

12. If you consume less animal protein, do you have to take protein quality into account?

A diet in accordance with the Wheel of Five in which meat has been completely replaced by nuts, legumes and eggs yields sufficient protein. With the partial replacement of animal protein sources and sufficient variation, no problem with protein quality is to be expected. In case of full replacement with plant-based proteins (a vegan diet), the Health Council recommends the consumption of additional protein due to protein quality.

The quality of a protein depends on its digestibility and the levels of essential amino acids in relation to the need for these amino acids. The essential amino acid present in the lowest concentration relative to the requirement is the so-called limiting amino acid (Gezondheidsraad 2001). Proteins that you consume in food and drink are broken down by your body into small building blocks of protein known as amino acids. Your body can then reuse them to build other body proteins. The body is able to produce some amino acids itself, but others must be ingested through food. They are known as the essential amino acids. Plant-based protein sources contain fewer essential amino acids or they are present in a different proportion than those found in meat and dairy. Moreover, some plant-based protein is sometimes harder to digest. Sufficient essential amino acids and good digestibility together determine protein quality (Gezondheidsraad 2001). Novel protein sources⁷, just as various common protein sources, often have one or more limiting amino acids. In addition, the digestibility of novel protein sources seems to be lower than that of meat and dairy (Seves, Verkaik-Kloosterman et al. 2016).

A diet without meat in accordance with the Wheel of Five, in which meat has mainly been replaced by legumes and nuts, yields sufficient protein (Brink, Postma - Smeets et al. 2018).



⁷ According to this study by the National Institute for Public Health and the Environment (RIVM), novel protein sources are understood to mean proteins such as soya, lupin, insects (mealworms and grasshoppers), seaweeds and algae.

One study by the National Institute for Public Health and the Environment (RIVM) shows that common protein sources such as meat, fish and eggs are rarely replaced completely by novel protein sources in practice. They are usually a partial replacement or form an addition to the menu. The total amount of protein that people consume on a daily basis does not seem to decrease as a result. According to this study, the quality of the protein from novel protein sources is sometimes slightly lower than that of common protein sources. The reason is that the new protein sources are often absorbed slightly less optimally by the body (they have a 'lower digestibility') and have a slightly less favourable amino acid composition (see Table 3). However, if we combine novel protein sources in products with common sources (plant and animal), the quality of the total amount of protein that we consume does not change substantially and remains high according to Seves et al. (Seves, Verkaik-Kloosterman et al. 2016).

Table 3: Protein quality and digestibility of a number of protein sources (Seves, Verkaik-Kloosterman et al. 2016)

	Plant-based		Insects		Algae	
	Soya	Lupin	Mealworms	Grasshoppers	Micro-algae	Seaweed
Protein quality						
<i>Limiting amino acids</i>	None; based on soya concentrate and isolate	Methionine + cysteine, valine, lysine; possibly also isoleucine, threonine, tryptophan	Possibly tryptophan	Leucine, valine and possibly tryptophan	Unknown	Tryptophan; depending on product, also histidine and isoleucine
<i>Digestibility</i>	86-95%	86-91%	91%	86%	75-94%	52-87%



13. What is the opinion of the Netherlands Nutrition Centre about a further shift towards a ratio of 40% animal and 60% plant protein?

By 2030, 60% of the protein that we eat should come from plant sources and 40% from animal sources. This recommendation is given by the Council for the Environment and Infrastructure (RLi 2018), among others. The Netherlands Nutrition Centre also believes that a more plant-based and less animal-based dietary pattern is important for our health as well as the environment. In the short term, we are aiming for a 50/50 ratio in accordance with the Wheel of Five. This aim already requires a huge change in behaviour for many people. In addition, more insights into the effects of a further shift on health and the environment are required.

By eating in line with the Wheel of Five, you will eat a more plant-based and less animal-based diet. The animal-plant protein ratio within the Wheel of Five is 50/50 if you eat the maximum recommended amount of 500 grams of meat per week. If you consume little or no meat within the Wheel of Five, but you do consume dairy, eggs and fish, you will arrive at a ratio of 40/60.

Eating in accordance with the 40/60 ratio is possible, provided that meat is replaced with high-quality protein sources. More insights are required to establish whether eating in accordance with this ratio is feasible for vulnerable groups and whether it will also enable them to consume sufficient amounts of all nutrients. The effects of a further shift on the protein intake of vulnerable groups, for example, are not yet sufficiently clear.

It is particularly important for vulnerable older people to consume sufficient protein of good quality. The protein quality of plant-based products is generally lower than that of animal-based products. In addition, the quality of plant-based protein sources may vary. The recommended amount of protein in a more plant-based diet is higher as a result. A good combination of plant-based protein sources is also important. Older people eat less. If they choose a plant-based protein source that contains little protein, or if they fail to vary and combine foods sufficiently, they may consume too little protein.

For young children, more insights into the practical feasibility of eating in accordance with the 40/60 ratio are also required. In order to ensure an adequate intake of nutrients, it is important to replace meat with plant-based alternatives that provide largely the same nutrients, such as nuts, legumes or soya products. If young children fail to eat the recommended amount of plant-based substitutes, it may affect the nutritional adequacy of their diet.

For a further shift, the impact of specific protein sources on the environment also need to be examined in more detail. There are major differences in environmental impact between the various animal-based protein sources and the various plant-based protein sources. For example, beef has a much higher environmental impact than chicken, while cashew nuts are more harmful to the environment than peanuts (Brink, Postma - Smeets et al. 2018). Various environmental aspects such as land use, water use and CO₂ emissions can also be considered.

In general, less meat (especially red and processed meat) is beneficial to health and the environment. For the whole population, however, a diet without any meat (and dairy) is not automatically the most sustainable. The reason is that certain land in the Netherlands is only suitable for grazing animals and not for arable farming. For example, a diet that includes a little meat (about once a week) requires less agricultural land than a diet with no meat at all (Kernebeek, Oosting et al. 2014, Zanten, Herrero et al. 2018). Furthermore, livestock can play a role in circular farming. Livestock can be fed with residual streams such as peel and pulp, while animals provide fertilisers that can fertilise crops.

The Netherlands Nutrition Centre aims to achieve a good balance between animal-based and plant-based proteins in accordance with the recommendations of the Health Council. Both provide other useful nutrients in addition to protein. We consider it advisable to take a first step towards the 50/50 ratio before moving to a 40/60 ratio. Practical advice can be found in the Wheel of Five Guidelines.



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Appendix

Food group	Weighted protein composition in Wheel of Five products (RIVM)		
	Total protein	Plant protein	Animal protein
Vegetables	1,57	1,57	0
Fruit	0,63	0,63	0
Potatoes	1,87	1,87	0
Bread	10,8	10,8	0
Cereal products	6,45	6,45	0
Legumes	6,97	6,97	0
Nuts	18,34	18,34	0
White meat	22,04	0,13	21,91
Red meat	21,75	0	21,75
Fish	20,48	0,23	20,21
Eggs	12,32	0	12,32
Milk	3,53	0	3,53
Cheese	27,31	0,01	27,3
Fats	0,29	0,26	0,03
Drinks	0,06	0,06	0

Food group	Recommended amounts in Wheel of Five (Wheel of Five Guidelines, Table 4.5)			
	Men 19-50 jaar		Women 19-50 jaar	
	with meat	without meat	with meat	without meat
Vegetables	250	250	250	250
Fruit	200	200	200	200
Potatoes	158	158	158	158
Bread	245	245	158	158
Cereal products	113	113	113	113
Legumes	19	38	19	38
Nuts	25	32	25	32
White meat	29	0	29	0
Red meat	43	0	43	0
Fish	19	19	19	19
Eggs	18	25	18	25
Milk	375	375	375	375
Cheese	40	40	40	40
Fats	65	65	40	40
Drinks	1500	1500	1100	1100

Food group	Men 19-50 with meat			Men 19-50 without meat		
	Total protein	Plant protein	Animal protein	Total protein	Plant protein	Animal protein
Vegetables	3,92	3,92	0	3,92	3,92	0
Fruit	1,27	1,27	0	1,27	1,27	0
Potatoes	2,95	2,95	0	2,95	2,95	0
Bread	26,47	26,47	0	26,47	26,47	0
Cereal products	7,29	7,29	0	7,29	7,29	0
Legumes	1,32	1,32	0	2,65	2,65	0
Nuts	4,59	4,59	0	5,87	5,87	0
White meat	6,39	0,04	6,35	0	0	0
Red meat	9,35	0	9,35	0	0	0
Fish	3,89	0,04	3,84	3,89	0,04	3,84
Eggs	2,22	0	2,22	3,08	0	3,08
Milk	13,24	0	13,24	13,24	0	13,24
Cheese	10,92	0	10,92	10,92	0	10,92
Fats	0,19	0,17	0,02	0,19	0,17	0,02
Drinks	0,95	0,95	0	0,95	0,95	0
Total protein (in grams)	94,96	49,01	45,94	82,68	51,58	31,1
Percentage protein of total		51,61	48,38		62,38	37,61

	Men's current consumption (2012-2016 DNFCs)		
Total protein (in grams); 19-30 year	91,00	37,00	54,00
Total protein (in grams); 31-50 year	98,00	38,00	60,00
Percentage of total protein		39,72	60,28

Food group	Women 19-50 with meat			Women 19-50 without meat		
	Total protein	Plant protein	Animal protein	Total protein	Plant protein	Animal protein
Vegetables	3,92	3,92	0	3,92	3,92	0
Fruit	1,27	1,27	0	1,27	1,27	0
Potatoes	2,95	2,95	0	2,95	2,95	0
Bread	17,07	17,07	0	17,07	17,07	0
Cereal products	7,29	7,29	0	7,29	7,29	0
Legumes	1,32	1,32	0	2,65	2,65	0
Nuts	4,59	4,59	0	5,87	5,87	0
White meat	6,39	0,04	6,35	0	0	0
Red meat	9,35	0	9,35	0	0	0
Fish	3,89	0,04	3,84	3,89	0,04	3,84
Eggs	2,22	0	2,22	3,08	0	3,08
Milk	13,24	0	13,24	13,24	0	13,24
Cheese	10,92	0	10,92	10,92	0	10,92
Fats	0,12	0,11	0,01	0,12	0,11	0,01
Drinks	0,69	0,69	0	0,69	0,69	0
Total protein (in grams)	85,23	39,29	45,93	72,96	41,86	31,09
Percentage protein of total		46,1	53,89		57,38	42,61

Women's current consumption (2012-2016 DNFCs)			
Total protein (in grams); 19-30 year	68,00	28,00	40,00
Total protein (in grams); 31-50 year	72,00	28,00	44,00
Percentage of total protein		40,03	59,97