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# Decreasing the **environmental footprint** of our diet

Following a healthy and sustainable diet is not as easy as it might seem. The principle of eating less animal-based products and more plant-based products does not, by definition, impact the environment any less. This article uses calculations from the Optimeal® program to identify sustainability principles for our diets that do make a difference.

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ur food's journey from the farm to our plate costs energy and affects the environment. Over the last decade, attention has grown for more environmentally-friendly food production. However, consumer food choices also significantly influence the total environmental impact of our diet. Excessive food consumption and diets that entail large quantities of processed foods have a higher environmental footprint than, for instance, diets which include water as the only beverage or which involve no meat. The total environmental footprint of our diet, therefore, is a mix between production methods and consumer choices. Politicians, policymakers, scientists and nutrition authorities like the Netherlands Nutrition Centre agree on one important condition for transitioning towards a more environmentally-friendly diet: it must be healthy. The human body requires a great deal of nutrients, and these nutrients come from a large variety of foods. Variation in the diet is essential for good health, and a more sustainable diet must provide everything the body needs.

#### **Environmental impact**

Transitioning towards a more sustainable diet generally follows the following five principles:

- 1. Eat less animal-based and more plant-based products
- 2. Eat more locally-produced food
- 3. Decrease your carbon footprint
- 4. Reduce food waste
- 5. Eat less processed food

This article addresses the first, third, and fifth principles and calculates the environmental impact of different types of diets. If not stated otherwise, all diets provide all nutrients required by official dietary guidelines and are within normal ranges of saturated fat, salt, etc. Several calculation models are available to determine the environmental impact of food. One such method is Optimeal<sup>®</sup>, a quadratic calculation model developed by Blonk Consultants (Netherlands) and the Netherlands Nutrition Centre. Optimeal<sup>®</sup> has gathered data on the nutritional content and environmental effects (carbon emissions, land and water use) of 208 products regularly consumed in the Netherlands. Life-cycle assessments (LCAs) are used to calculate the environmental impact of each product, from production to consumption.

#### **Climate change**

Most sustainability recommendations focus on lowering carbon emissions. Human carbon emissions are the major cause of climate change. According to the Dutch semi-governmental environmental agency Milieu Centraal, a household produces 23 tons of carbon emissions every year. Figure 1 breaks down the household activities that cause emissions and to what extent. These figures reveal that about a quarter of our total emissions come from food.

### **Carbon emissions from food**

According to Milieu Centraal, every household (averaging 2.18 people in the Netherlands) is responsible for 5.6 tons of emissions from food. This number does not include the energy used to conserve (i.e. refrigerate or freeze) or prepare food, and can be broken down into the following four food groups:

1. Meat and fish	$1.8 \text{ tons CO}_2$
2. Dairy and eggs	$1.1 \text{ tons CO}_2$
3. Vegetables and fruits	$0.5 \text{ tons CO}_2$
4. All other products	$2.2 \text{ tons CO}_2$

These figures show that 2,9 tons  $CO_2$  come from animal-based products – in other words, 52% of a household diet and 12.6% of total annual household emissions. For perspective, a return flight from the Netherlands to Thailand releases 5.4 tons of carbon emissions.

#### Theory vs. reality

Theoretically, carbon emissions from the human diet could be reduced by 2.9 tons by eating vegan. But in actuality, the calories and nutrients lost by avoiding animal products must be compensated by other, plant-based products – and these have an environmental footprint as well. If an individual decides not to eat certain animal products based on environmental concerns, they must make sure that their new diet still lowers their environmental footprint. According to the Dutch environ.

Figure 1. Total carbon emissions from the average household (2.2 people). Source: Milieu Centraal website





Figure 2. Carbon emissions by kilogram of product produced, based on Optimeal® calculations



Figure 3. Land use by kilogram of product produced, based on Optimeal® calculations



mental agency Natuur en Milieu, an individual can decrease their carbon emissions by 1 ton per year by switching to a vegetarian diet.

#### **Carbon emissions products**

In general, animal products have higher carbon emissions than plant-based products. Figure 2 provides an overview of carbon emissions per kilogram of product. The big outlier here is beef (red meat), mainly from beef cattle. Beef's high carbon emissions are caused by several factors; the calculations used by Optimeal® are the sum of all emissions from meat consumed in the Netherlands, whether from imported meat or meat produced in the Netherlands from beef or dairy cattle.

Figure 3 provides an overview of land use per kilogram of product. The production

of beef is also the biggest culprit here. Pangasius, a tropical fish, takes a surprising third place on the list. Pangasius is farmed, not wild, and is produced mainly in Vietnam and Thailand. In the LCA of pangasius, it is its feed that places it high on the list of land users.

#### Health

The apparent consensus to reduce our diet's environmental footprint is to eat less meat and fish and more plant-based products. Indeed, figures 2 and 3 seem to support this. However, our diet should not become unhealthy in the process. The alternative foods must still provide the essential nutrients our bodies need. Furthermore, not every food from animal origins has the same environmental footprint; the same holds for fruits and vegetables. For example, a banana imported from South America has a bigger environmental footprint than a Dutch apple, simply thanks to transport. When considering replacing certain diets with others, it is important to look closely at the environmental footprint of individual products.

#### **Product replacement**

Optimeal® has calculated the effects of product replacement on the environmental footprint of a diet. As a starting point, Optimeal<sup>®</sup> looks at the average Dutch diet based on the Dutch National Food Consumption Survey (VCP). Subsequently, food groups are changed in the diet with steps of 20 grams. For every 20 grams, Optimeal® has calculated a similar but alternative diet that complies with all dietary reference values for nutrients and then calculated its environmental impact. This model reveals how replacing certain parts of a diet affects the diet's footprint. Now, for each food group, it is possible to see its carbon footprint and land use (figures 4 and 5) in increments of 20 grams.

#### **Replacing dairy**

These figures clearly reveal the striking impact of beef consumption on the environment - the more beef is consumed, the higher carbon emissions and land use become. Like beef, dairy also comes from animals, but, unlike beef, increasing amounts of dairy consumption have negligible added effect on the environment. Why is this? When omitting dairy, which is very nutrient rich, the nutrients have to be provided by other products. For example, calcium can come from eating more vegetables like spinach or broccoli, protein from more eggs or legumes. To get the nutrients provided by dairy, an individual must consume much more fruit and vegetables than the recommended daily portions. When you add up the environmental effects of these replacements, the same carbon emissions and land use are the result. Increasing the amount of fruit and vegetables in the diet does not result in a lower environmental impact. This is surprising given the widely accepted principle that plant-based products should replace meat in the diet. However, most vegetables are relatively poor in nutrients.





You need a lot more of them to replace the daily nutrients you can get from dairy. As a result, Optimeal® has to increase vegetable intake by considerable amounts in order to reach the calcium recommendations. This is why these higher amounts of vegetables have the same environmental impact as that of nutrient-rich dairy. Obviously, since Optimeal® is only a nutrient calculation model, the health effects of vegetables, dairy and other products on e.g. non-communicable diseases are not taken into account.

#### **Optimeal® conclusions**

Fruit and vegetables are healthy, but not necessarily because of their nutritional content. Actually, fruit and vegetables are quite low in nutrients. When increasing consumption amounts of fruit and vegetables in Optimeal®, the program has to turn to nutrient-dense products to reach a healthy diet that complies with dietary recommendations. In our approach, Optimeal® uses animal products, since these are the most nutrient-dense. As seen in figures 4 and 5, there are two plant-based food groups that do have a desirable effect on the environmental footprint: bread and nuts and seeds. These two food groups contain relatively high amounts of nutrients and their environmental impact declines as consumption increases. However, for nuts and seeds as well as cheese, Optimeal® does not go further than 140 and 240 grams respectively. This is due to the fact that when these products are increased to higher consumption amounts, Optimeal® cannot calculate an alternative diet because the upper amount for saturated fat (10 en%) is reached.

Optimeal<sup>®</sup> concludes that the sustainable principle to eat less animal-based products

and more plant-based products does not automatically result in a more environmentally-friendly diet. Shifting between basic food groups to obtain a more sustainable diet gives disappointing results. We can only conclude that consuming more nuts, seeds, and bread, and eating less beef, will improve a diet's environmental footprint.

#### The "data gap"

A downside to working with models like Optimeal® is that such models contain environmental data on a limited number of products. Optimeal® includes 208 products, but Dutch supermarkets sell tens of

When you add up the environmental effects of products that replace dairy, the same carbon emissions and land use are the result



thousands. Furthermore, environmental data is usually related to single types of foods, and LCAs can be determined relatively easily from this information, developing a picture of a food's carbon emissions and land use. Optimeal® therefore mostly consists of the basic food groups and not of processed foods or foods made from many different ingredients. There is no data on ready-to-eat meals, candy, or snacks, and such products have a higher environmental impact than basic food products. Models like Optimeal® must therefore be used with caution: "you can only manage what you can measure".

#### Wheel of Five diet

The Dutch dietary guidelines are represented in the Wheel of Five (Schijf van Vijf) developed by the Netherlands Nutrition Centre. The new Wheel of Five launched in 2016 provides ten different daily menus as examples of how you can meet these guidelines in your daily diet. One would expect that more complex, processed foods have a higher environmental footprint than the basic food groups. If so, the rule of thumb for eating in a more sustainable way would be to eat less processed food and to follow the recommendations of the Wheel of Five, assuming it, too, is sustainable. To find out, we entered all ten Wheel of Five daily menus for a 35-year-old woman (2000 kcal per day, see www.voedingscentrum.nl) into Optimeal® and calculated their carbon emissions and land use. We then compared these daily menus to the average Dutch diet (according to RIVM's Dutch National Food Consumption Survey (VCP)), recalculating it to 2000 kcal a day for comparison. Results are shown in table 1, with the daily menus sorted from highest to lowest carbon emissions.



Food groups 10 6 Vegetables and use  $(m^2 * year / day)$ Fruit 6 Meat Fish 6 Dairy 6 Cheese Bread 5 Potatoes, past Beans/pulses Nuts/seeds 3 Non-specified 2-200 10 110 180 CO 60 CO 20,60 200 240 32 30 Food group (gram / day)

#### Footprints of daily menus

We often hear that we eat too few fruit and vegetables and too much meat and snacks. This conclusion is based on the Dutch National Food Consumption Survey (VCP). We therefore assumed that the environmental impact of the average Dutch diet would be higher than the healthier Wheel of Five daily menus. The menu 'No meat today' put together by the Netherlands Nutrition Centre is meant to encourage consumers to skip meat one day a week; 'Crazy about fruit and vegetables' and 'Taste the sun' menus are higher in exotic fruits. If eating less meat and more plant-based products is truly more sustainable, then these daily menus would have a lower environmental impact than the more Dutch 'I love Holland' diet of mostly meat, cheese and other dairy. However, table 1 reveals that half of the Wheel of Five daily menus have a higher environmental impact than the average Dutch diet, even 'No meat today'. Most striking is that the 'I love Holland' daily menu has the lowest carbon emissions and land use of all. This daily menu is based on what the Dutch most commonly eat: meat, dairy (350 grams), fruit and vegetables from Dutch farms. Even the Netherlands Nutrition Centre finds it difficult to make a more sustainable diet based on the principle of eating less animal-based and more plantbased products. How can these surprising results be explained? Without going into too much detail, the following examples can help illustrate. Daily menus that contain lots of exotic fruits entail more land use and carbon emissions. The LCAs of exotic fruits logically have more environmental impact because they must be transported, conserved, etc. A Dutch apple or

Figure 4 and figure 5. Environmental impact on carbon emissions and land-use when replacing certain parts of the diet. For every 20 grams, Optimeal® has calculated a similar but alternative diet that complies with all dietary reference values for nutrients. The environmental impact of these alternative diets is calculated and shown per food group in the coloured lines. Non-specified is the impact of foods that do not belong to basic foodstuffs. See text for further information.

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Figure 5



pear can, in theory, go directly from the tree to the supermarket. In conclusion, it is not as easy as it seems to follow a more sustainable diet just by living according to eating less meat and other animal products and more plant-based products.

#### **Fewer animal products**

In all its calculations up to now, Optimeal® has considered an alternative diet that looks most like the one consumers are used to. This is what the principle of quadratic modeling is about. We also used Optimeal® to calculate the environmental effects of omitting entire animal food groups. The results are shown in table 2. When the animal food groups in the left column are omitted, Optimeal® calculates an alternative diet that meets all nutrient requirements. Avoiding all dairy products hardly changes the environmental footprint; this corresponds with our earlier calculations. Avoiding meat, on the other hand, could potentially impact the footprint a great

Table 1. Carbon emissions and land use of Netherlands Nutrition Centre daily menus and the average Dutch diet (Avg. 35-year-old woman (VCP)), recalculated for 2000 kcal

Example daily menus	Carbon emissions (kg CO2 eq/dag)	Land use (m2*year/dag)
Taste the sun	5,10	4,54
Crazy about fruit and vegetables	5,04	4,02
Power food	3,89	3,54
Colors of Marrakesh	3,82	3,48
No meat today	3,66	2,74
Avg. 35-year-old woman (VCP)	3,62	3,98
Fiber boost	3,48	2,98
Fresh from the market	3,32	3,16
No fat!	3,29	2,81
Take your time	3,19	3,70
l love Holland	3,13	2,75
No meat today Avg. 35-year-old woman (VCP) Fiber boost Fresh from the market No fat! Take your time I love Holland	3,66 3,62 3,48 3,32 3,29 3,19 3,13	2,74 3,98 2,98 3,16 2,81 3,70 2,75

deal: approximately 25% fewer carbon emissions by omitting meat and more than 40% by going vegan. But such major dietary changes are not welcomed by most consumers, at least not yet.

Most striking is that the 'I love Holland' daily menu has the lowest carbon emissions and land use of all Wheel of Five menus



#### **Eating less**

The most logical advice for reducing environmental impact is to eat less. This is why carbon emissions of the VCP diet are calculated at different calorie intakes (P5, P25, P50, P75, and P95) for both men and women aged 31 to 50. These diets are optimized to meet the Wheel of Five guidelines. Results for women and men are presented in tables 3 and 4 respectively. For the P5 intake level in women, an optimal diet cannot be calculated because of Optimeal®'s minimum calorie consumption requirement. The tables demonstrate that for those who eat too much, eating less will reduce their environmental footprint. For example, a man who eats too much (P95) who switches to the recommended amount (P50) can reduce his carbon emissions by 36.3-47.5%.

#### Not too varied

As we saw in the Wheel of Five daily menus, even those with lots of fruit and vegetables can have a major impact on the environment. If you want to eat more plant-based products, it is best to choose products from the Netherlands. This is why, from an environmental standpoint, the 'I love Holland' daily menu is the most beneficial; it entails meat and dairy products that are made nearby. But if you eat lots of exotic fruit and vegetables, it is difficult to achieve a sustainable footprint. This is a dilemma in food nutrition. Eating a varied diet seems to be at odds with eating sus-



tainably. In short, with a varied diet you must also think in terms of excess.

#### **RIVM reports**

The results presented in this article are in line with RIVM's own research. In its 2016 report Milieubelasting van de voedselconsumptie in Nederland ("Environmental impact of food consumption in the Netherlands"), RIVM also found that sustainable eating requires a more nuanced approach. Using the Optimeal® calculations, RIVM concluded the following:

• Fruit and vegetables from the Netherlands have a lower environmental footprint than imported fruit and vegetables

# If you eat lots of exotic fruit and vegetables, it is difficult to achieve a sustainable footprint

- This does not apply to crops from Dutch greenhouses, which have a higher impact on the environment
- Eating less red meat (beef) reduces environmental impact

The more recent 2017 RIVM report *Wat ligt er op ons bord* ("What's on our plate")

Table 2. Effects on climate change (in percentages) from limiting animal-based food groups

	Carbon emissions (kg CO <sub>2</sub> eq/dag)	Land use (m²*year/dag)
Optimal average diet	3,67 (100%)	4,00 (100%)
No dairy	3,53 (96,2%)	3,64 (91%)
No meat, fish, or eggs	2,90 (79%)	3,24 (81%)
No meat or dairy	2,84 (77,4%)	2,63 (65,7%)
No meat, eggs, or dairy	2,78 (75,7%)	2,51 (62,7%)
No meat or fish	2,74 (74,7%)	3,20 (80%)
No meat	2,73 (74,4%)	2,81 (70,25%)
No meat, fish, eggs, or dairy	2,37 (64,6%)	2,47 (61,7%)
No meat, fish, or dairy	2,27 (61,8%)	2,55 (63,7%)

Table 3

	kcal (% compared to current diet P50)	Current diet	Optimized diet
P5	1,361 (69,6%)	2,52 (69,6%)	Niet genoeg Kcal
P25	1,700 (86,9%)	3,15 (86,9%)	3,38 (92,3%)
P50	1,956 (100%)	3,62 (100%)	3.66 (100%)
P75	2,227 (113,8%)	4,12 (113,8%)	3,99 (109%)
P95	2,644 (135,2%)	4,89 (135,2%)	3,54 (96,7%)

#### Table 4

	kcal (% compared to current diet P50)	Current diet	Optimized diet
P5	1848 (69,8%)	3,15 (69,8%)	2,86 (74,7%)
P25	2299 (86,8%)	3,92 (86,8%)	3,36 (87,7%)
P50	2647 (100%)	4,52 (100%)	3,83 (100%)
P75	3022 (114,2%)	5,16 (114,2%)	4,36 (113,8%)
P95	3611 (136,4%)	6,16 (136,4%)	5,65 (147,5%)

Tables 3 (women) and 4 (men). Carbon emissions at several calorie intake levels (P5, P25, P50, P75 and P95) corresponding to the VCP quantities (RIVM 2011). See text for explanations

reinforces these conclusions. In this report, RIVM recommends for the first time that eating less is the first major step towards a sustainable diet. Once this step is taken, we can examine other ways to reduce our environmental footprint by making changes in our staple foods.

#### **Points for discussion**

For the purposes of this article, we worked with Optimeal<sup>®</sup>, a quadratic programming model used to calculate the environmental impact of food and dietary changes. No steps were taken to validate the calculations, but we used the same version of Optimeal® that was used by the Netherlands Nutrition Centre and RIVM. Such models always come with their shortcomings and limitations, as do the starting points with which they work. In replacing products, we always looked for an alternative diet that came as close as possible to the consumer's experience, thus making it more acceptable. One major downside to this type of calculation model is the limited number of foods for which environmental data is available - the "data gap" discussed above. Data is especially lacking for more unhealthy and non-staple foods. For this reason, models like Optimeal® are not actually equipped to base robust recommendations upon. However, the Optimeal® model is used by organizations like the Netherlands Nutrition Centre and RIVM to calculate the values of daily menus. The model was apparently not used to establish the new Wheel of Five daily menus which accompanied the Wheel of Five last year. Half of these daily menus have a higher environmental impact than the average VCP diet. This illustrates that the principle to eat less animal-based products and more plant-based products is not necessarily the way towards a more sustainable diet.





# The principle to eat less animal-based and more plant-based products is not necessarily the way towards a more sustainable diet

## Conclusions

This article provides us with a number of simple conclusions. A sustainable diet entails the following:

- Eating less
- Eating less red and processed meat
- Drinking less soda and fewer alcoholic beverages
- Eating less candy and fewer snacks (recommendation from the authors)

- Eating less processed food (recommendation from the authors)
- Eating more bread
- Eating more fruits and vegetables from Dutch farms
- Keeping dairy consumption at its current level

This study and RIVM's reports also make another important conclusion: The science behind sustainable and healthy diets is still very much in development. This means that any advice from such research must be examined with a critical eye. Finally, it is important that the environmental footprint of our diet is seen in the right perspective. Other aspects of our lifestyle (see figure 1) have an even larger impact on the environment – a flight to South Africa for vacation can undo an entire year's worth of environmental benefits from a vegetarian diet. ≮

## References

1 Milieubelasting van de voedselconsumptie in Nederland (2016). RIVM report 2016-0074.

2 Wat ligt er op ons bord (2017). RIVM report 2016-0200

The calculations in this article were made by Nutricon, a nutrition consultancy focused on the food industry. In addition to its nutritional support, Nutricon offers a combination of nutritional expertise and ICT.