Report Environmental Impact of Belgian Food Consumption

Frederick M-J Duan, Sander Biesbroek, Pieter van ’t Veer

Department of Human Nutrition & Health

WAGENINGEN
UNIVERSITY & RESEARCH

01-10-2023

Duan, F M-J; Biesbroek, S; Van ’t Veer, P; 2023. Report Environmental Impact of Belgian Food Consumption.

Chair Group Global Nutrition, Department of Human Nutrition & Health, Wageningen University & Research

DOI: https://doi.org/10.18174/642877

Table of Contents

Synopsis

This research analyzed data from the Belgian National Food Consumption Survey, conducted between 2014 and 2015 by Sciensano. The average meat consumption was 182.2 grams/day in this representative population sample of Belgian adults. The daily diets when individuals who consumed meat resulted in approximately twice the greenhouse gas emissions than those who did not consume meat: 5.99 kg CO2-eq/day and 3.02 kg CO2-eq/day for meat days and meat-free days, respectively. Similar patterns have been observed for land use, with 7.95 and 3.25 m^2·year/day for meat days and meat-free days, respectively. If individuals were to replace meat by meat replacers (such as vegetarian or vegan meat imitates, eggs, legumes, and nuts/seeds) in their daily diets, it could potentially lead to a reduction in greenhouse gas emissions of 2.62 kg CO2-eq/day and land use of 3.64 m^2·year/day, representing a decrease of 37.8% and 36.4%, respectively. Therefore, limiting meat consumption has the potential to substantially reduce the environmental impact of food consumption in Belgium.

Background

Globally, current patterns of food production and consumption have a significant environmental impact, accounting for approximately 25% of total greenhouse gas emissions. Notably, meat and dairy products are the major contributors to this impact, responsible for up to 50% of greenhouse gas emissions and 80% of total farmland use (Biesbroek, 2014). Particularly in Western countries, the consumption of meat and dairy products is high. Shifting dietary patterns towards fewer animal- and more plant-based foods has substantial potential for reducing environmental impact (Willett, 2019).

Based on data from the Belgian National Food Consumption Survey (2014-2015), this report calculated the greenhouse gas emissions and land use resulting from daily diets of Belgian adults on days they consumed meat. These numbers were compared with the greenhouse gas emissions and land use of daily diets without meat. Additionally, the calculation was made for the potential reduction in environmental impact if an individual replaced meat by meat replacers in their diets for both a day and a week.

Research Results and Interpretation

Meat Consumption Level

In this representative population sample of Belgian adults (18-65 years), a total of 1304 participants recorded detailed information on food consumption on a total of 2537 days. Of all consumption days, the average total meat consumption was 182.2 grams/day, with breakdowns for red meat of 69.4 grams/day, processed meat of 49.7 grams/day, white meat of 35.4 grams/day, and seafood of 27.7 grams/day (**Figure 1**). In total, 145 (11.1%) individuals had at least one day in their daily dietary records when they did not consume meat, accounting for 170 (6.7%) days without meat consumption among the total 2537 days of records (**Table 1**).

Figure 1 – Average meat consumption (grams/day) of the study population

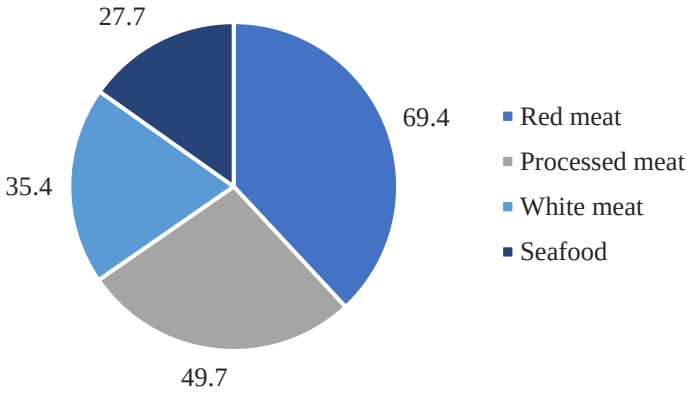


Table 1 – Numbers of participants and days of meat consumption

	Participants, n (%)	Days of dietary records, n (%)
Consumed meat	1159 (88.9)	2367 (93.3)
Did not consume meat	145 (11.1)[a]	170 (6.7)
Total	1304	2537

[a] Participants had at least one day when they did not consume meat.

Environmental Impact of Daily Diets

Table 2 shows the greenhouse gas emissions and land use of diets for Belgian adults on any given day, separated into meat days and meat-free days. A meat day refers to an individual who ate meat and/or fish on a record day; while a meat-free day refers to an individual who did not ate meat and/or fish on a record day. Individuals who consumed meat had approximately twice the greenhouse gas emissions than those who did not consume meat: 5.99 kg CO2-eq/day and 3.02 kg CO2-eq/day for meat days and meat-free days, respectively. The absolute difference between them was 2.97 kg CO2-eq/day. The difference is more pronounced for land use, with 7.95 m^2·year/day for meat days, which was 2.4 times higher than the 3.25 m^2·year/day for meat-free days. This resulted in an absolute difference of 4.70 m^2·year/day.

Considering the difference in energy intake between meat days (1932 kcal/day on average) and meat-free days (1654 kcal/day on average), the observed greenhouse gas emissions and land use of daily diets for each individual were scaled to diets of 2000 kcal/day energy intake (**Table 2**). This procedure allows the environmental impact between meat days and meat-free days to be more comparable to each other, as the consumption of larger quantities of food and calories may result in higher environmental impact, irrespective of the types of food consumed. For both environmental indicators, the impacts for diets of 2000 kcal/day were higher than the observed values, and the differences between meat days and meat-free days became slightly smaller. Nevertheless, the patterns of the differences in environmental impact between the two groups remained consistent. These findings indicate that the differences in greenhouse gas emissions and land use resulted from meat consumption are partially due to the differences in energy intake between meat days and meat-free days; however, the overall effect of this adjustment for energy is limited. It is worth noting that underreporting of food consumption and energy intake might be possible in this survey data used. Nevertheless, by scaling the environmental impact indicators to diets of 2000 kcal/day energy intake, the potential influence of such underreporting on the environmental impact is likely mitigated.

In addition to energy intake, age and gender may also influence the environmental impact of diets. It is, therefore, important to obtain more accurate insights into the extent to which meat consumption contributed to dietary greenhouse gas emissions and land use, irrespective of the influence of these factors. To calculate this, regression models were applied. Results from the regression models show that meat consumption was estimated to contribute to 2.63 kg CO2-eq/day for greenhouse gas emissions and 3.96 m^2·year/day for land use of daily diets in this representative sample of Belgian adults (details see section **Methodology and Explanation** and **Table 5**).

Table 2 – Environmental impact and energy intake of daily diets for meat days and meat-free days[a]

	Meat days	Meat-free days	Total
Energy intake, kcal	1932 (802)	1654 (928)	1913 (814)
Greenhouse gas emissions, kg CO2-eq/day			
Observed	5.99 (3.59)	3.02 (1.74)	5.79 (3.57)
Per 2000 kcal	6.46 (3.21)	3.79 (1.42)	6.28 (3.19)
Land use, m^2·year/day			
Observed	7.95 (5.55)	3.25 (1.85)	7.63 (5.51)
Per 2000 kcal	8.46 (5.19)	3.97 (1.24)	8.16 (5.15)

[a] Data are presented as mean (standard deviation).

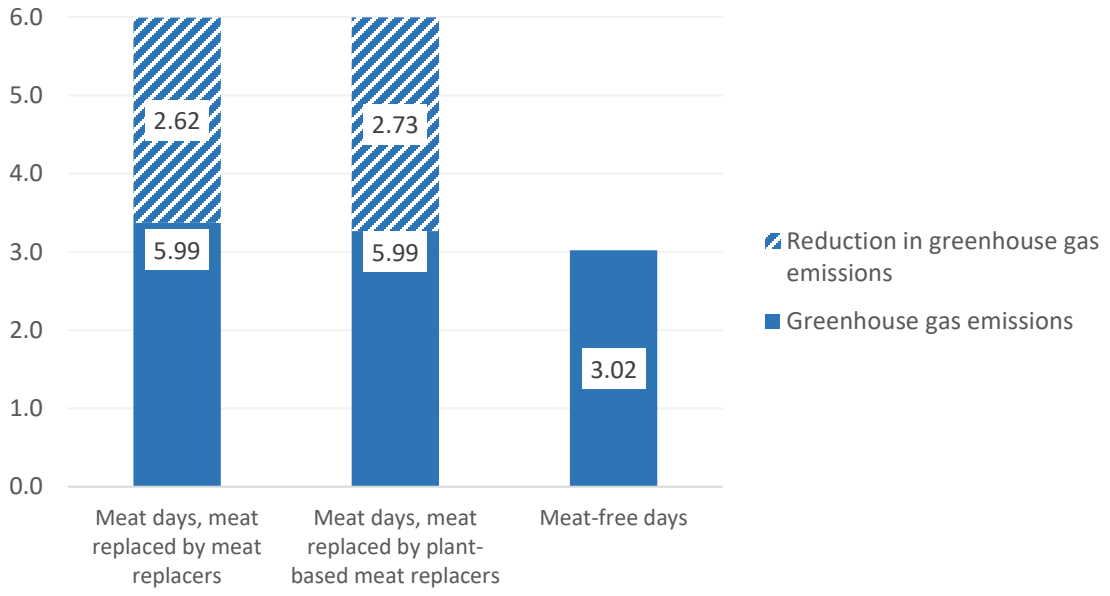
Reduction in Environmental Impact: Substituting Meat with Meat Replacers

Given the substantial contribution of meat consumption on dietary environmental impact, substitution analyses were performed to calculate the potential reduction in greenhouse gas emissions and land use if individuals replaced meat by meat replacers in their daily diets. Meat replacers include vegetarian or vegan meat imitates, eggs, legumes, and nuts/seeds; plant-based meat replacers include vegan meat imitates, legumes, and nuts/seeds. The difference between vegetarian meat imitates and vegan meat imitates is that vegetarian meat imitates may still contain dairy products, such as cheese burgers, while plant-based meat imitates do not contain any animal-based products.

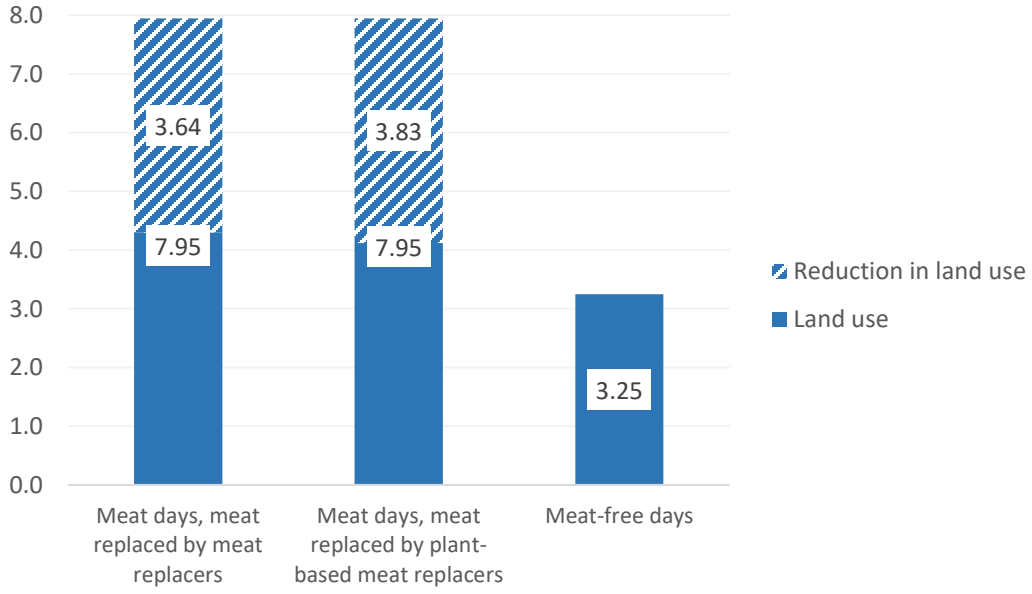
If individuals replaced meat by vegetarian meat replacers in their daily diets, it could lead to a reduction in greenhouse gas emissions of 2.62 kg CO2-eq/day (18.34 kg CO2-eq/week) per person on average, representing a 37.8% decrease. This reduction would further increase to 2.73 kg CO2-eq/day (19.08 kg CO2-eq/week) per person on average by 39.6%, if individuals replaced meat by plant-based meat replacers only. Concerning land use, similar patterns of reduction were observed. Individuals could achieve a reduction in land use of 3.64 m^2·year/day (25.51 m^2·year/week) per person on average, if they replaced meat by meat replacers in their daily diets, representing a 36.4% decrease. This reduction would further increase to 3.83 m^2·year/day (26.80 m^2·year/week) per person on average by 38.7%, if individuals replaced meat by plant-based meat replacers (**Figure 2** and **Table 3**).

Figure 2 – Comparison of dietary environmental impact on meat days, meat-free days, and potential reduction on meat days by replacing meat with meat replacers[a]

(a) Greenhouse gas emissions (kg CO2-eq/day)



(b) Land use (m^2·year/day)



[a] Meat replacers include vegetarian or vegan meat imitates, eggs, legumes, and nuts/seeds; plant-based meat replacers include vegan meat imitates, legumes, and nuts/seeds.

Table 3 – Potential reduction in environmental impact if individuals replaced meat by meat replacers in their daily diets[a]

	Meat replacers[b]	Plant-based meat replacers[b]
Greenhouse gas emissions, kg CO2-eq		
With 1 day change	2.62 (2.96)	2.73 (3.02)
With 1 week change	18.34 (20.74)	19.08 (21.16)
Percentage reduction, %	37.8 (21.6)	39.6 (22.1)
Land use, m^2·year		
With 1 day change	3.64 (4.61)	3.83 (4.72)
With 1 week change	25.51 (32.27)	26.80 (33.03)
Percentage reduction, %	36.4 (24.5)	38.7 (25.0)

[a] Data are presented as mean (standard deviation).

[b] Meat replacers include vegetarian or vegan meat imitates, eggs, legumes, and nuts/seeds; plant-based meat replacers include vegan meat imitates, legumes, and nuts/seeds.

Methodology and Explanation

Study Population

Information on daily food and nutrition consumption was obtained from the Belgian National Food Consumption Survey, conducted between 2014 and 2015 by Sciensano. For this research, data from 1304 Belgian adults were used, with in total 2537 days of dietary records. Demographic characteristics of the study population are presented in **Table 4**. The overall survey methodology adhered to the guidelines established by the European Food Safety Authority (EFSA) in the context of the EU Menu project. Participants were selected using a multistage stratified sampling procedure, which included geographical stratification. Within each selected municipality, individuals were sampled from 10 age-gender strata in accordance with the EFSA age group cut-off recommendations. The selection of participants aimed to create a representative population sample of the Belgian population. Information on individual food consumption was collected using 24-hour dietary recalls on two non-consecutive days. Majority of the participants had dietary records on two non-consecutive days. These recalls were conducted in the form of interviews by trained and experienced dieticians, following a structured and standardized approach. All food items were classified according to the FoodEx2 food classification system developed by EFSA. In this research, meat is defined as including red meat, white meat, processed meat, fish, and other seafood. A more detailed description of the Belgian National Food Consumption Survey can be found elsewhere (Bel, 2016).

Table 4 – Demographic characteristics of the study population[a]

	Participants, n (%)
Participants, n	1304
Female, n (%)	677 (51.9)
Days of dietary records, n	2537
Age, years	40.4 (14.0)
Weight, kg	76.0 (16.9)
Height, cm	170.6 (9.6)
BMI, kg/m^2	26.1 (5.2)

[a] Data are presented as mean (standard deviation) if not specified.

Environmental Impact Indicators

Diet-related environmental impacts were calculated using the SHARP Indicators Database (SHARP-ID), which includes estimates of European average greenhouse gas emissions and land use of food items. The SHARP-ID was developed as part of the EU-funded SUSFANS project (H2020-SFS-2014-2, grant number 633692). In short, attributional life cycle assessment was applied to quantify the environmental impacts throughout the entire life cycle of a food product, including primary production, primary packaging, transport, food losses/waste, and food preparations at home. The life cycle assessment data were adjusted for consumption amount using available conversion factors for production, edible portion, cooking losses and gains, and food losses and waste. The life cycle assessment data were available for 957 FoodEx2 coded foods, based on 182 primary food products, and were extrapolated to European countries. In this study, the environmental impact for greenhouse gas emissions and land use was linked to the Belgian Food Consumption Survey data using the FoodEx2 food classification codes (Mertens, 2019). Other environmental impact indicators, such as water use and biodiversity loss are not available, therefore, not included in this study. It is important to investigate the environmental impact of these indicators when data become available.

Regression Models

Meat consumption contributes substantially to greenhouse gas emissions and land use from daily diets. In addition, factors such as energy intake, age, and gender may also influence the environmental impact of diets. It is, therefore, important to obtain more accurate insights into the extent to which meat consumption contributed to dietary greenhouse gas emissions and land use, irrespective of the influence of these other factors.

To calculate this, two linear regression models were applied for both environmental impact indicators. Taking greenhouse gas emissions as an example, in the first model, the log-transform values of emissions of daily diets were set as the dependent variable, and age, gender, energy intake, meat consumption (both amount and consuming meat on a record day or not) were set as the independent variables. The second model was identical but the variables for meat consumption were left out, i.e., it included age, gender, and energy intake as the independent variables. The difference of the greenhouse gas emissions predicted by these two models estimates the part of greenhouse gas emissions that can be attributed to meat consumption, for individuals of the same age, sex, and energy intake. For land use, the same approach was applied.

The comparison of the predicted values based on the aforementioned two regression models is shown in **Table 5**. For greenhouse gas emissions, when considering all relevant factors, the predicted values for meat days and meat-free days are 5.76 and 2.67 kg CO2-eq/day, respectively. When meat consumption is not considered, the predicted values change to 5.33 and 4.87 kg CO2-eq/day for meat days and meat-free days, respectively. This results in absolute differences of 0.43 and 2.20 kg CO2-eq/day between the two models for meat days and meat-free days, respectively. Summing up these absolute differences, it is estimated that meat consumption itself contributed to on average 2.63 kg CO2-eq/day in greenhouse gas emissions of daily diets among Belgian adults. For land use, when considering all relevant factors, the predicted values for meat days and meat-free days are 7.44 and 2.89 m^2·year/day, respectively. When meat consumption is not considered, the predicted values change to 6.75 and 6.17 m^2·year/day for meat days and meat-free days, respectively. This leads to absolute differences of 0.69 and 3.27 m^2·year/day between the two models for meat days and meat-free days, respectively. Summing up these absolute differences, it is estimated that meat consumption itself contributed to on average 3.96 m^2·year/day in land use of daily diets among Belgian adults.

However, it should be noted that there are other potential factors that could influence meat consumption and the environmental impact of daily diets, such as education and income. Unfortunately, these factors are not available in the current research data, and therefore, their influence could not be examined in this research.

Table 5 – Predicted environmental impact of daily diets for meat days and meat-free days[a]

	Meat days	Meat-free days	Summed differences
Greenhouse gas emissions, kg CO2-eq/day			
Model 1[b]	5.76 (3.65)	2.67 (0.94)	
Model 2[c]	5.33 (2.17)	4.87 (4.17)	
Difference[d]	0.43 (2.54)	2.20 (3.28)	2.63
Land use, m^2·year/day			
Model 1[b]	7.44 (5.68)	2.89 (1.19)	
Model 2[c]	6.75 (3.19)	6.17 (6.61)	
Difference[d]	0.69 (4.06)	3.27 (5.48)	3.96

[a] Data are presented as mean (standard deviation) except for the summed differences.

[b] Values predicted by meat consumption, age, sex, and energy intake.

[c] Values predicted by age, sex, and energy intake.

[d] Difference in predicted values between the two models indicate the environmental impact attributed to meat consumption.

Reflection on Results

In this research, we estimated that 2.63 kg CO2-eq/day greenhouse gas emissions and 3.96 m^2·year/day land use were attributed to meat consumption of daily diets in Belgian adults. It should be noted that the predicted differences in environmental impact are not the real-life observations of people who actually changed their diet; nevertheless, the calculations provide a reasonable estimate on how much a meat-free day may help reduce greenhouse gas emissions and land use. When people having meat-free days in their usual dietary patterns, however, they may also change other aspects of the diet, which could not be accounted for in this research. It is important to recognize that changing meat consumption not only affects greenhouse gas emission and land use, but many other dietary factors as well. Sufficient nutrients intake should be guaranteed when switching to more plant-based diets. Animal-based foods are good dietary sources of iron, calcium, vitamin B1, vitamin B12, and vitamin D, while in plant-based foods these nutrients are in general limited (Tso, 2021). Additionally, the effects of long-term dietary adjustment on the environmental impact should be further studied. This research is based on a cross-sectional food consumption survey; hence, real-life changes in diets for individuals and associated changes in environmental impact of diets with longer period of time were not investigated (Biesbroek, 2019). In this research, we obtain insights into the potential reduction in greenhouse gas emissions and land use for a day and a week by replacing meat by meat replacers. Our results suggest substantial long-term benefits may be achieved in reducing the environmental impact of diets, if individuals switch to more plant-based dietary patterns for a longer period of time. Moreover, the environmental impact indicators used in this research are based on current estimates related to the current production systems. We used the average EU-data of greenhouse gas emissions and land use applied to the Belgian diets. Footprints of diets sourced in Belgium may differ from these EU-average values. Additionally, footprints will change when animal production systems become more environmentally sustainable.

Conclusions

Based on data of a representative population sample of Belgian adults, this research calculated the greenhouse gas emissions and land use resulting from daily diets, as well as the potential reduction in environmental impact if individuals replaced meat with meat replacers. Among all participants, the average meat consumption was 182.2 grams/day, with 11.1% of participants had at least one day when they did not consume meat. Meat days had approximately twice the greenhouse gas emissions and land use of daily diets compared with meat-free days. If individuals replaced meat with meat replacers, this change could lead to a reduction of 2.62 kg CO2-eq/day in greenhouse gas emissions and 3.64 m^2·year/day in land use on average. These findings suggest that limiting meat consumption in daily diets may have a substantial potential in reducing environmental footprints in this Belgian adult population.

References

Bel, S., Van den Abeele, S., Lebacq, T., et al. (2016). Protocol of the Belgian food consumption survey 2014: objectives, design and methods. Archives of Public Health, 74, 1-11.

Biesbroek, S., Bueno-de-Mesquita, H. B., Peeters, P. H., et al. (2014). Reducing our environmental footprint and improving our health: greenhouse gas emission and land use of usual diet and mortality in EPIC-NL: a prospective cohort study. Environmental Health, 13(1), 1-9.

Biesbroek, S., Verschuren, W. M., Boer, J. M., et al. (2019). Are our diets getting healthier and more sustainable? Insights from the European Prospective Investigation into Cancer and Nutrition–Netherlands (EPIC-NL) cohort. Public Health Nutrition, 22(16), 2931-2940.

Mertens, E., Kaptijn, G., Kuijsten, A., et al. (2019). SHARP-Indicators Database towards a public database for environmental sustainability. Data in Brief, 27, 104617.

Tso, R., & Forde, C. G. (2021). Unintended consequences: nutritional impact and potential pitfalls of switching from animal-to plant-based foods. Nutrients, 13(8), 2527.

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., ... & Murray, C. J. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. The Lancet, 393(10170), 447-492.

Acknowledgement

This research was conducted on behalf of the National Week Without Meat Foundation (Stichting Nationale Week Zonder Vlees). The foundation has no influence on the contents, methods, results, and conclusions in this report. We acknowledge Merel Daas and Samantha N Heerschop (Wageningen University & Research, Department of Human Nutrition & Health) for data collection, data preparation, and methodology.