Technical report 2023

Sustainable Diets for Central and Eastern Europe

Modelling nutritionally optimal sustainable diets for adults in Czech Republic, Hungary, and Slovakia

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Detailed Methodology

In order to create sustainable diets for adults in Central and Eastern Europe for 2030, we used diet optimization software Optimeal®, a tool that applies mathematical diet optimization techniques to simultaneously reduce the environmental impact of the diet and meet all nutritional and price requirements while staying as close to the current diet as possible. Diet optimization tackles the challenge of identifying the optimal combination of foods under a set of predefined constraints (e.g., nutritional recommendations, climate target, total diet cost), while minimizing changes made to the diet. Below describes the references diets, data, constraints, and modelling approach taken in this study.

1. Reference diets

Creating nutritionally optimal sustainable diets requires data on the current average diet of the population of interest. The basis for the current diets in this study comes from dietary survey data that was compiled by the European Food Safety Authority (EFSA) in the EFSA Comprehensive European Food Consumption Database (1). Summary statistics of food consumption data reported in grams/day were retrieved for the adult population (aged 18-64 years) from the most recent survey available in Czech Republic, Slovakia, and Hungary. The most recent surveys available in the database include the Czech National Food Consumption Survey 2003 (SISP04), the National Nutrition Survey in Slovakia (SK MON 2008), and Hungarian National Food Consumption Survey 2018. In Czech Republic and Hungary, food consumption data were collected by means of 24-hour dietary recalls conducted on two non-consecutive days from a representative sample of the population (n=1,666 Czech adults & 529 Hungarian adults) (2,3). Data were collected during the whole year to reduce influence of seasonality in food consumption and covered all days of the week. The survey in Slovakia was carried out using one 24-hour dietary recall among 2,761 adults. In Slovakia, the study population cannot be considered representative of the general population since subjects were only selected among employees of confectionary and bakery manufactures (3).

The FoodEx2 food classification and description system (4) developed by EFSA, was used for all three countries. This system contains seven levels of detail, L1 to L7, with L1 being the most aggregated level (food group level). The starting point for composing the reference diets is the L3 level, differentiating between 224 different food products. We omitted level 1 (L1) food category 'Food products for young population' and L2 food category 'Foods for particular diets.' Some descriptions of L3 products are not very precise. An example is 'Cereal grains (and cereal-like grains).' A more specific product was selected to represent it in terms of nutritional composition and environmental impact; for this example, an L4 category 'Rice and similar-' was chosen as it makes up 95% of cereal grains reported across all three countries. There are also products that are represented by a mix of L4 products in that product group. The food category 'Tree nuts' for instance is represented by a mix of almonds, cashews, hazelnuts, and walnuts. For some L3 categories we chose to use L4 food products to get more diversity in nutritionally and environmentally relevant food items. For instance, the L3 category 'Mammals meat' was deemed too vague and therefore we went for L4 categories 'Poultry fresh meat', 'Bovine fresh meat', Pig fresh meat', etc.

Manual adaptations were required to get to a diet that comprises 153 products. A pragmatic approach was taken by combining the three surveys together when making the selection of food products. The following requirements were set for the individual food products and the diet as a whole.

Each individual product should:

- Sufficiently specify the product to define its environmental and nutritional properties.
- Not represent more than 50% of the food group (L1) if possible.
- Represent >1% of average total intake (gram/day) of the food group.

The defined products as a group should:

- Represent a regular, varied diet.
- Represent a variety of products in each food group.
- Provide sufficient options for healthy and sustainable diets (e.g., plant-based alternatives for dairy and meat products). Supplements are excluded from the study.

In case products did not meet these requirements, the product was entirely excluded from the diet and all other products belonging to the same L1 group were scaled up to compensate for the excluded quantity. Raw to cooked factors were applied to foods that were reported raw, so the final datasets contained foods as consumed.

Starting from the reduced list of 153 products, we modelled reference diets for adults in Czech Republic (n=127 food products), Hungary (n=130 food products), and Slovakia (n=137 food products) using the mean consumption reported in the country-specific surveys. The reference diets were linked to food composition datasets to obtain nutrient composition data for the food products. Nutritional properties of all food products are required to obtain an estimate of the nutrient composition of the overall diet, and to compare the reference diets and the optimised diets to nutrient reference values. Using country-specific nutrient data is preferred as each country has its own consumption pattern, resulting in country-specific foods, recipes, and commercial foods with varying composition due to different taste or fortification regulations across borders.

Food composition databases are publicly available for Czech Republic (5) and Slovakia (6), but not for Hungary. The Slovak food composition database was used for Hungary because it had less data missing. The Czech and Slovak databases did not contain a value for every nutrient in scope or did not have data for several food items. These data gaps needed to be filled so that nutrient intakes would not be underestimated. The largest gaps existed for iodine, sugar, trans fat and other fatty acids, as well as nutrients that were not reported, including folate, vitamin B12, and selenium in the Czech dataset.

To fill data gaps, zeros were set to missing data for which expert knowledge was positive the value was zero. For example, animal-based foods do not have any fibre, unless it is combined with other foods containing fibre. Where the value was not expected to be zero, values were imputed based on proxy product selection.

Proxy product selection was most commonly used to fill gaps for nutrients or food products that were not reported. For data gaps in the Czech database, proxies were taken from the Slovak database. For data gaps in the Slovak database, proxies were taken from the Dutch Food Composition Database (7) , as the data is publicly available, extensive and contains information on the nutrients in scope. Missing values for fatty acids were scaled to total fat of the product. Values of zinc and selenium in drinking water from the Slovak database were set to 0, although in the database they were 1.88 mg and 16 mg, respectively, as it distorted the results. All the food products in the three reference diets were matched to (prepared) food products in the nutritional table.

2. Environmental impact of food products

Environmental impacts of all food products in the reference diet are determined using the life cycle assessment (LCA) methodology, according to ISO 14040/ 14044 standards (8,9) and calculated following the ReCiPe impact assessment method (10). This means that the full life cycle is considered in the calculation of the environmental impact of the food products: cultivation, processing, transport, assembly, packaging, distribution, retail, consumption and waste treatment. The final life cycle stages, from distribution to end-of-life, were modelled according to defaults provided by the Product Environmental Footprint (11) methodology.

To quantify the environmental impact of the (optimised) diets for Central and Eastern Europe, life cycle inventories (LCIs) from background databases are linked to the food products. As no dedicated LCA food database is available for the CEE region, the Optimeal EU database (12) was the main source of environmental data. This is a cradle-to-end of life database developed by Blonk Consultants (12). The database contains full lifecycle (from cultivation up until consumption) LCIs of nearly 160 food products representable for the average European market. The final database utilises most of the activity data from the Optimeal EU dataset (12). The dataset was adapted to make it more specific to the CEE region by creating a CEE 'market mix' and adapting other background processes (e.g., electricity, water, etc.). The market mix is established by using trade and production statistics to determine the source countries of raw and processed commodities consumed in Czech Republic, Hungary, and Slovakia. Considering significant trade and production fluctuations that occur year to year, 5-year averages are used (2014- 2018). Let's take cabbage as an example, 29% comes from Hungary, 25% from Czech Republic, and 8% from Slovakia, the remaining is imported from Poland (19%), Germany (8%), the Netherlands (5%), Italy (4%), and <1% from four other countries. Countries that have a share of less than 0.5% are not accounted in the final mix. This is then linked with available country-specific cultivation data. Say, for instance, we do not have cultivation data from Slovakia, then the final market mix was rescaled based on the relative shares of the other countries to get full coverage (100%).

Since we optimise the diets for the year 2030, it is necessary to forecast the environmental impact of the diets for 2030. This is needed as there are ongoing technological changes that are expected to lead to a higher efficiency of food production as well as expected reductions in food loss and waste in 2030.

Such changes include, amongst other things, improved cultivation techniques, more efficient processing, the use of cleaner energy sources, and reductions in food loss and waste. The climate impact trend analysis of the Menu for Tomorrow study (13) formed the basis for projections of the environmental impact of food products in 2030. A summary of the implementation projections have been published in previous reports (14,15).

3. Constraints

Diet optimization aims to find an optimal combination of food items that meet certain requirements that define a healthy and sustainable diet. These requirements are called constraints or boundaries, which can have an upper limit (maximum), lower limit (minimum), or both. The environmental target for example, concerns an upper boundary that represents the maximum amount of carbon dioxide equivalents associated with the diet. Many of the nutrients, on the other hand, have a lower boundary associated with recommended daily intakes. Below describes the constraints used in this study.

3.1.1 Nutritional constraints

The nutrient constraints applied are derived from a combination of country-specific nutrition recommendations (16,17) and EFSA dietary reference values and tolerable upper intake levels for vitamins and minerals (18,19). Population reference intakes were taken, and when not available, average requirement or adequate intake was used. Whenever separate values were given for females and males or different age groups, an average was taken. The required energy intake depends on how active a person is and were based on low to moderate physical activity level (PAL 1.4-1.6). **Table 1** summarizes the entire set of nutrient recommendations applied to every country-specific model.

Next to guidelines for individual nutrients, countries translate the recommendations into understandable guidelines for food groups, which are called food-based dietary guidelines (FBDGs). Semi-quantitative country-specific FBDGs were used to establish boundaries for several food groups (20–23). When no quantity for a food group was provided, a constraint was estimated with assumptions on portion size or established only when the optimized diet contradicted the recommendations. For instance, if the optimized diet led to an increase in total sugar, a maximum intake was placed on total sugar equal to current intake. For the food group ‘Animal and vegetable fats and oils and primary derivatives thereof’, a cross-cutting recommendation is to prefer fats with low content of saturated fatty acids. We therefore put a maximum constraint of 0 on butter, animal fats (i.e., lard) and margarine.

3.1.2 Environmental constraints

The following environmental impacts were included as constraints in the optimization process:

- Greenhouse gas emissions excluding land-use change or carbon footprint (kg CO_2-eq/d) [1]
- Total land occupation (in m^2*y/d)
- Water use (m^3/d)
- Terrestrial acidification (kg SO_2-eq/d)
- Freshwater eutrophication (kg P-eq/d)
- Marine eutrophication (kg N-eq/d)
- Biodiversity loss (species*year/d)

A maximum constraint equal to the baseline impact was established so that environmental impact of the current diet would not increase. For greenhouse gas (GHG) emissions, a constraint has been set to 2.04 kg CO_2-eq/d, which represents the maximum allowable carbon footprint of the daily food consumption per person to meet the

[1] Land use change emissions are excluded because they are backward looking over the past 20 years, and therefore less informative of a future looking study. The method to calculate emissions due to direct land use change requires data on the past 20 years, whereas in our optimisation scenarios we look forward to 2030. This means that the required data for the scenarios is not yet available and because land use change can hardly be forecasted it is omitted.

1.5-degree target as set by the Paris Agreement. This reduction target is based on the IPCC's 1.5 degree assessment study (24) and is explained in more detail in the paper of Broekema et al. (15).

These environmental indicators are midpoint impacts except for biodiversity loss, which is an endpoint impact. Midpoint indicators measure single environmental problems (e.g., climate change), whereas endpoint indicators combine multiple environmental impacts into a final measure or outcome of environmental change. Biodiversity loss is measured as damage to ecosystems and is influenced by global warming, water consumption, ecotoxicity, eutrophication, acidification, and land use. The unit species*year refers to the number of terrestrial and aquatic[2] species lost integrated over time, so *not* species lost per year, but species lost over the duration of a year. This is related to certain midpoint impacts that are temporary, like land occupation (m^2*year), which also means 'land occupation for the duration of a year'. It is thus not expressed in permanent species extinctions, but a combination of the number of potentially lost species and duration during which they are potentially lost. The indicator 'damage to ecosystems' is based on the potentially disappeared fraction (PDF) of species, which is a measure of the local species loss. It thus is based on species, and not on abundance of animals, or population sizes. The most important contributor to biodiversity loss related to our diets is land use. For land use, the ReCiPe method accounts for the local relative species loss on specific types of land. These locally 'lost' species can still live outside the impacted area of land. As relaxation of the land is also considered (i.e., land no longer being used for food production), the concept of reversibility (and thus not permanent extinctions) is clear. Another important contributor is GHG emissions. For GHG emissions, ReCiPe accounts for PDF of species based on extinction rates predicted for certain global temperature increases. In this case, the loss of species seems permanent. More research would be required to investigate if there is any correction for this permanency.

3.1.3 Cost of diets

For each of the food products in the reference diet, the average supermarket price was obtained. This was done by collecting prices of >8300 food items on sale in the Tesco online supermarket[3] for each country in February and March 2023 using automated data collection techniques in Python code. For composite foods that may be homemade, like sandwiches, we assigned the price of equivalent ready-made foods that can be purchased. For seasonal produce that were not available, we assigned the price of a canned/jarred or dried version (e.g., dried cherries were only available for Czech Republic). The prices of organic foods were excluded. We applied transformations to convert the price data from € per 100 g sold to € per 100 g consumed. Prices per unit of consumption were determined by making corrections for unavoidable waste (e.g., banana peels) and weight reduction and increase from cooking (e.g., shrinking for meat and swelling for rice and pasta). A constraint on the cost of the diet was set to the cost of the baseline diet so that it would not increase.

3.1.4 Acceptability

Food product constraints help to ensure that the optimised diet is acceptable to the general consumer. Maximum product constraints ensure that the optimised diet does not contain large amounts of individual products which are generally not consumed in large quantities. A maximum constraint was applied to food products equal to the 99th percentile of consumption. When the 99th percentile could not be determined, a maximum constraint was set equal the 99th percentile of consumption similar food(s) (e.g., a weighted average of the 99th percentile of cow milks was used as a maximum constraint of plant-based milks). Food groups were limited to 33-150% of current consumption to allow for reasonable dietary changes in the light of healthy, sustainable and adoptable diets and to take into account the asymmetric distribution of the data. In cases that this contradicted the FBDG, constraints on nutrient/FBDG took priority. Exceptions are for meat, milk products, and sugar and confectionary for which a minimum constraint of 5% current consumption was placed to achieve the nutrient recommendations and climate target for 2030.

3.2 Optimization algorithm and strategy

In this study we used quadratic programming as our optimisation technique, which results in smaller changes across more products compared to linear programming, which results in larger changes for fewer numbers of products.

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[2] Does not take into account overfishing.

[3] While Tesco was identified as one of the top supermarkets for each country, prices from Tesco alone may not be representative for each country. The original approach was to take an average of the prices from the top three most representative supermarket websites from each country. The websites of the other supermarkets either did not have prices of food products on sale and/or were not in English.

The goal of the optimization is to find a diet as similar as possible to the reference diet while satisfying the nutritional, environmental, cost and acceptability constraints. For each country, four diet scenarios are presented:

Reference diet: This is the reference diet, representing the current average diet based on the food consumption surveys described in section 1. No constraints are in place.

Optimized diet – Nutrient adequate: This diet is optimised for nutritional guidelines (both nutrient intake and food-based dietary guidelines). An upper constraint was established for the cost equal to that of the reference diet. No constraints were placed on environmental impacts.

Optimized diet – Acceptability balance. This scenario identifies the lowest possible GHG emission reduction that best balances cultural acceptability, while meeting the nutritional, environmental and affordability constraints. This was done by introducing a constraint on GHG emissions and reducing it step by step, calculating a new optimised diet after each step until no solution was possible within the constraints. Nutritional, environmental, and price constraints described earlier were also applied in these steps. Changes to the reference diet were translated into a penalty score (calculated as the Euclidean distance), which is a weighted sum of quantity changes from each product. The penalty score is a way to measure the distance of the optimised diets from the current diet, which is a common proxy to measure the acceptability and feasibility of the modelled diets (25). We then identified the 'critical point' where a further GHG reduction requires proportionally more changes to the diet, making it less acceptable for the average consumer. This point is identified applying the concept of elasticity, borrowed from economics science. Before this 'critical point' the changes in the diet are more effective in reducing GHG emissions. The 'critical point' determined the diet presented for this scenario. The diet at this 'critical point' is taken for this scenario.

Optimized diet – Climate target: This diet is optimised for nutritional guidelines and climate change target for 2030. Additionally, this scenario limits land occupation, terrestrial acidification, freshwater and marine eutrophication, blue water use, damage to ecosystems, and the cost of the optimised diet to that of the reference diet (if it was not yet achieved).

4. Limitations

We would like to acknowledge some limitations to the data and approach taken. First, while we focused on three optimised diets for each country, more solutions are possible (e.g., it is possible to reach similar goals being vegetarian, but we did not study any particular eating pattern). Second, the food consumption survey data that was used differed in terms of timeframe and methodology, making it difficult for straightforward comparison between the countries. For instance, the survey from Slovakia only accounted for one day of food consumption, which reduces the variability of individual eating patterns. The most recent food consumption data comes from the survey from Hungary, which was conducted according to the EU Menu Methodology (26). This is evident in the (non) reporting of composite dishes, as composite dishes were recorded disaggregated to ingredients. The food consumption data from Czech Republic and Slovakia are older and followed different methodologies, hence the larger reporting of composite dishes. For these two countries, the quantities of food groups may be underestimated given the number of composite foods reported, having implications in the modelling and interpretation of the results. For instance, out of the three countries, the Slovakian optimized diets had the lowest carbon footprints and the highest quantities of composite dishes, one third being meat based. The environmental impact of meat-based composite dishes is based on a recipe used in the Optimeal EU database (12), reflecting an average dish made up of 79% beef, pork, chicken, veal and turkey. The environmental impact of specific composite dishes can be lower or higher depending on the type and quantity of meat and other ingredients added. Moreover, the Slovakian survey cannot be considered representative of the general population since subjects were only selected among employees of confectionary and bakery manufactures.

The environmental data is used has also its limitations. Optimeal EU database (12) was used as base and adapted to each country. The set of environmental data is of enough quality to assess the total diet and its optimizations but is not meant to indicate with high accuracy the environmental impact of any specific food item. Furthermore, we applied forecasted emissions and improvements in food wastages and losses to project environmental impacts for 2030. As any forecast, these values have limitations in how precise they are. The changes are all relative to the reference consumption. It is certainly possible that over the next six years, food preferences will evolve which might make certain changes more culturally acceptable than they might seem today.

The analysis here is static as we used attributional LCA and not consequential LCA. An attributional LCA describes the environmentally relevant flows to and from a life cycle and the systems, while a consequential LCA describes how such flows will change in response to possible changes (27). With further changes in the food system, at scale, other connections are at play which we cannot fully capture such as beef and dairy, broilers and eggs, feed/food of crops. Interlinkages within food production (e.g., dairy and ruminant meat) is difficult to consider as they are relevant on an aggregated population level but less so on an individual level, and therefore it is not accounted for. Lastly, the cost of the diets reflects the current relative prices between products, but these relations can change based on supply, demand and preferences of future consumers.

Table 1 Daily nutrient and food group recommendations considered during the optimization of diets for adults in Czech Republic, Hungary and Slovakia

	Czech Republic		Hungary		Slovakia	
	Lower	Upper	Lower	Upper	Lower	Upper
Daily nutrient requirements[a]						
Energy (kcal)[b]	2018	2305	2018	2305	2313	2563
Protein total (E%)[c]	10.5	15.5	10.5	15.5	10.5	15.5
Fat total (E%)	20	30	20	35	20	30
Saturated fatty acids (E%)	-	10	-	As low as possible	-	As low as possible
Trans fatty acids (E%)	-	1	-	As low as possible	-	As low as possible
Fatty acids n-3 (a-linoleic acid) (E%)	0.5	-	0.5	-	0.5	-
Fatty acids n-6 (linoleic acid) (E%)	4	-	4	-	4	-
Carbohydrates (E%)	45	60	45	60	45	60
Fibre (g)[d]	30	-	30	-	30	-
Water (g)	2250	-	2250	-	2250	-
Alcohol (g)[e]	-	15	-	15	-	15
Vitamin A (retinol eq, mcg)	700	3000	700	3000	700	3000
Vitamin B1 (mg/g)	0.85	-	0.85	-	1.2	-
Niacin (mg NE)	13.52	35	13.52	35	14.8	35
Vitamin B2 (mg)	1.6	-	1.6	-	1.4	-
Vitamin B6 (mg)	1.7	25	1.7	25	1.3	25
Folate (dietary folate equivalents) (mcg)	330	1000	330	1000	400	1000
Vitamin B12 (mcg)	4	-	4	-	2.5	-
Vitamin C (mg)	102.5	-	102.5	-	98.8	-
Vitamin D (mcg)[f]	3.5	75	3.5	75	3.5	75
Vitamin E (mg)	12	300	12	300	14.5	300
Calcium (mg)	957.45	2500	957.45	2500	1000	2500
Iodine (mcg)	150	600	150	600	150	600
Potassium (mg)	3500	-	3500	-	3500	-
Copper (mg)	1.45	5	1.45	5	1.13	5
Magnesium (mg)	325	-	325	-	325.5	-
Sodium (mg)	-	2000	-	2000	-	2000
Selenium (mcg)	70	300	70	300	63.8	300
Zinc (mg)	11.49	25	11.49	25	9	25
Phosphorus (mg)	550	-	550	-	700	-
Iron (mg)	12.7	25	12.7	25	12.3	25
Food-based dietary guidelines						
Fruits and vegetables (g)	400		400		400	
Vegetables (g)	300		300		300	
Fruit and fruit products (g)		150		150		150
Legumes, nuts, oilseeds and spices (g)	10		10		10	
Fish and seafood (g)	28.57	57	21	42.86	14.29	28.57
Sugar and confectionary (g)		Mean intake		Mean intake		Mean intake
Alcoholic beverages (g)		196				
Water (g)	1500		1000		2250	

[a] The constraints are based on a combination of country-specific nutrition recommendations (16,17) and EFSA dietary reference values and tolerable upper intake levels for vitamins and minerals (18,19). Population reference intakes were taken, and when not available, average requirement or adequate intake was used. Whenever separate values were given for females and males or different age groups, an average was taken.

[b] Constraints on energy are based on average requirements for persons exerting low to moderate physical activity level (PAL 1.4-1.6).

[c] The lower protein constraint is taken Slovakian recommendations (17), whereas the upper protein constraint is taken from a diet optimization study of the Eatwell Guide (28).

[d] The lower constraint on fibre is based on the Slovakian recommendation that fibre should present up to half of the daily plate.

[e] The upper constraint on alcohol is based on the Czech recommendation to not exceed the daily intake of alcohol for men of 20 g and for women half the amount.

[f] While the recommendation is 15 mcg/d, we placed an upper constraint of 3.5 mcg on vitamin D assuming that the rest of the required vitamin D is synthesized in the skin or obtained by dietary supplements.

Table 2 Composition of the reference (REF) and optimized diets – nutrient adequate (NA), acceptability balance (AB), and climate target (CT) scenarios – for Czech Republic, Hungary, and Slovakia

	Czech Republic				Hungary				Slovakia			
Food group	REF diet (g/d)	NA diet (g/d)	AB diet (g/d)	CT diet (g/d)	REF diet (g/d)	NA diet (g/d)	AB diet (g/d)	CT diet (g/d)	REF diet (g/d)	NA diet (g/d)	AB diet (g/d)	CT diet (g/d)
Vegetables and vegetable products	114.8	300.0	300.0	300.0	224.3	300.0	300.0	300.0	83.1	300.0	300.0	300.0
Fruit and fruit products	126.6	150.0	141.7	116.4	149.0	150.0	150.0	111.3	116.9	100.0	100.0	100.0
Grains and grain-based products	257.3	218.9	248.8	242.4	277.4	250.3	259.5	286.7	248.9	328.6	328.0	325.9
Legumes, nuts, oilseeds and spices	14.2	61.4	75.7	114.5	21.5	44.8	45.5	65.6	13.5	121.2	81.7	79.3
Starchy roots or tubers and products thereof, sugar plants	87.1	92.3	93.3	98.6	80.3	79.2	80.3	81.9	70.7	59.8	67.5	67.4
Meat and meat products	182.1	118.7	79.7	32.3	177.0	136.8	117.6	61.7	99.2	68.9	20.0	15.8
Milk and dairy products	176.4	206.4	170.2	129.6	247.5	239.5	226.2	149.1	133.0	141.3	55.8	45.4
Fish, seafood, amphibians, reptiles and invertebrates	16.4	25.9	40.0	55.4	11.6	27.4	26.7	21.4	6.9	14.3	28.6	28.6
Eggs and egg products	19.5	19.0	24.6	27.1	23.8	25.7	27.5	32.0	11.1	4.6	16.6	16.6
Products for non-standard diets, food imitates and food supplements	0.6	0.8	0.8	0.8	10.0	15.0	15.0	15.0	1.9	2.9	2.9	2.9
Composite dishes	60.5	42.3	47.8	19.9	2.2	0.7	0.7	0.7	268.2	88.5	88.5	88.5
Animal and vegetable fats and oils and primary derivatives thereof	41.2	15.4	13.6	13.6	32.1	18.9	16.5	10.58	17.9	26.6	25.2	24.1
Sugar and similar, confectionery and water-based sweet desserts	20.9	20.9	20.9	2.1	22.5	22.5	22.5	21.2	11.6	0.6	7.7	9.5
Seasoning, sauces and condiments	16.7	5.5	5.5	7.2	17.0	5.6	5.6	5.6	5.8	3.2	8.7	8.7
Alcoholic beverages	431.6	195.8	195.8	195.8	94.8	94.2	92.9	69.44	92.5	90.6	67.8	65.32
Coffee, cocoa, tea and infusions	206.8	208.0	207.6	206.6	290.3	290.6	290.5	287.8	452.0	449.6	444.0	442.9
Fruit and vegetable juices and nectars (including concentrates)	32.2	33.9	30.5	19.9	46.2	45.4	45.7	37.0	31.1	23.1	8.5	6.4
Water and water-based beverages	1426.7	1609.3	1607.2	1593.3	1708.3	1707.9	1707.5	1698.6	792.5	2348.0	2348.0	2347.8

Table 3 Environmental impacts and cost of the reference (REF) and optimized diets – nutrient adequate (NA), acceptability balance (AB), and climate target (CT) scenarios – for Czech Republic, Hungary, and Slovakia

	Czech Republic				Hungary				Slovakia			
	REF diet	NA diet	AB diet	CT diet	REF diet	NA diet	AB diet	CT diet	REF diet	NA diet	AB diet	CT diet
Individual carbon footprint (kg CO_2-eq/d)	5.29	4.32	2.65	2.04	4.23	3.78	3.02	2.04	4.51	3.71	2.10	2.04
Total land occupation (m^2*year/d)	6.17	4.87	4.03	3.62	5.18	4.53	4.07	3.61	4.97	4.92	3.57	3.57
Water use (m^3/d)	0.10	0.12	0.10	0.10	0.11	0.11	0.11	0.11	0.09	0.15	0.09	0.09
Acidification (kg SO_2-eq/d)	0.09	0.06	0.03	0.02	0.06	0.05	0.02	0.02	0.08	0.05	0.02	0.02
Freshwater eutrophication (kg P-eq/d)	$1.30*10^{-3}$	$9.71*10^{-4}$	$6.30*10^{-4}$	$5.14*10^{-4}$	$8.32*10^{-4}$	$7.24*10^{-4}$	$5.72*10^{-4}$	$4.12*10^{-4}$	$9.51*10^{-4}$	$7.53*10^{-4}$	$4.30*10^{-4}$	$4.15*10^{-4}$
Marine eutrophication (kg N-eq/d)	$1.03*10^{-2}$	$7.78*10^{-3}$	$4.26*10^{-3}$	$3.46*10^{-3}$	$7.74*10^{-3}$	$6.37*10^{-3}$	$4.75*10^{-3}$	$3.56*10^{-3}$	$8.75*10^{-3}$	$6.63*10^{-3}$	$3.44*10^{-3}$	$3.33*10^{-3}$
Biodiversity loss (species*year/d)	$9.14*10^{-8}$	$7.19*10^{-8}$	$5.17*10^{-8}$	$4.45*10^{-8}$	$7.38*10^{-8}$	$6.42*10^{-8}$	$5.44*10^{-8}$	$4.43*10^{-8}$	$7.55*10^{-8}$	$6.75*10^{-8}$	$4.36*10^{-8}$	$4.22*10^{-8}$
Cost (€/d)	9.16	8.82	8.36	7.16	8.23	8.23	7.94	6.84	8.06	8.06	7.38	7.31

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