Supporting information

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Table S 1. Food categories and corresponding sub-categories including the proportional split for the different environmental inventory matches. Inventory matches were from ecoinvent (Weidema et al., 2013) unless otherwise specified. Proportions are based on USDA's Economic Research Service (ERS, USDA, 2012) unless otherwise specified. When the match of the food item was not direct for the database, the matched name is listed in parentheses.

Food groups and sub-categories	Grouped as	Inventory matched
Dairy		
Milks and milk drinks	Fluid dairy	Cow milk, GLO
Cream and cream substitutes	Fluid dairy	
Milk desserts, sauces, gravies	Fluid dairy	
Cheeses	Cheese	Cheese, from cow milk, fresh, unripened, GLO
Meats		
Beef	Beef	beef cattle, for slaughter, at beef farm/IE Economic (Blonk, 2014)
Pork	Pork	Pigs to slaughter, pig fattening, at farm/adapted US, Economic (Blonk, 2014)
Poultry	Chicken	Broilers, for slaughter, at farm US, Economic (Blonk, 2014)
Fish and shellfish	Fish	50% Fish and seafood, high value species, wildcaught, per kg edible, RER (Blonk, 2014) 50% Large trout, 2-4 kg, conventional, at farm gate, FR (Blonk, 2014)
Meat, type not specified	Meat mixture	25.1% 'beef ' 21.5% 'pork' 46.6% 'poultry' 6.8% 'fish' *(NMFS, NOAA, 2012; NOAA, 2014; USDA, 2015)*
Lamb, veal, game, other carcass meat	Meat mixture	
Organ, sausages, lunchmeats, spreads	Meat mixture	
Meat, poultry, fish with nonmeat items	Mixture of meat and vegetables	50% see 'meat, type not specified' 50% see 'vegetable mixture'
Vegetables with meat, poultry, fish	Mixture of meat and vegetables	
Frozen, shelf-stable plate meals, w/meat	Mixture of meat, vegetables and grains	33.3% see 'meat, type not specified' (see above) 33.3% see 'vegetable' (see below) 33.3% see 'grain' (see below)
Vegetables		
White potatoes, Puerto Rican starch veg.	Starchy vegetables	Potato, US

Food groups and sub-categories	Grouped as	Inventory matched
Dark-green vegetables	Dark green vegetables	Spinach, GLO
Deep-yellow vegetables	orange/yellow vegetables	Carrot, GLO
Tomatoes and tomato mixtures	Vegetable mixture	4% cauliflower, white, GLO (cruciferous vegetables)
Other vegetables	Vegetable mixture	3% broccoli, GLO
Mixtures mostly vegetables w/o meat	Vegetable mixture	2% barrots, GLO 1% celery, GLO 5% maize grain, US 1% cucumber, GLO 5% spinach, GLO (leafy vegetables) 4% lettuce, GLO 3% onions, GLO 2% protein peas, GLO (peas) 2% green bell pepper, GLO (peppers) 23% sugar beet, CH (root vegetables) 22% potato, US 1% zucchini (string beans) 22% tomato, GLO
Eggs		
Eggs	Eggs	Consumption eggs, laying hens > 17 weeks, at farm (Blonk, 2014)
Egg mixtures	Eggs	
Egg substitutes	Eggs	
Legumes, Nuts, and Seeds		
Legumes	Legumes	Fava bean, integrated production, GLO
Nuts, nut butters, and nut mixtures (with carob)	Nuts	Almond kernels, at huller and sheller (AU LCI, n.d.)
Seeds and seed mixtures	Nuts	
Grains		
Yeast breads, rolls	Grains	74% flour, wheat, from dry milling, at plant 11% maize flour, from dry milling, at plant 11% rice, US 4% oat grain, dried, at farm Percentages based on USDA's Economic Research Service (USDA 2015h, 2015i).
Crackers and salty snacks from grain	Grains	
Pasta, cooked cereals, rice	Grains	
Pasta, cooked cereals, rice	Grains	
Pasta, cooked cereals, rice	Grains	
Cereals, not cooked or NS as to cooked	Grains	

Food groups and sub-categories	Grouped as	Inventory matched
Grain mixtures, frozen plate meals, soup	Grains	
Quick breads	Cakes	33.3% wheat flour, from dry milling, at plant 33.3% butter, from cow milk 33.3% sugar, from sugar beet
Cakes, cookies, pies, pastries	Cakes	
Pancakes, waffles, French toast, other	Cakes	
Fruits		
Citrus fruits, juices	Fruit mixture	17% Apples, GLO 8% bananas, GLO 3% strawberries, GLO
Dried fruits	Fruit mixture	
Other fruits	Fruit mixture	
Fruit juices and nectars excl. citrus	Fruit mixture	7% grape, GLO 8% melon, GLO 49% citrus, GLO 3% peaches, GLO (stone fruit) 5% pineapple, GLO (tropical fruit)
Fats, Oils, and Salad Dressings		
Fats		3% Tallow, unrefined (animal fats) 20% Vegetable oil, refined (margarine) 51% as 33.3% "cottonseed oil, 33.3% soybean oil, 33.3% rape oil (cooking oil) 20% as 50% soybean oil 50% palm oil (shortening) 6% Refined coconut oil, at plant (other oils)
Oils	Fats and oils	
Salad dressings		
Sugars and Sweets		
Sugars and sweets	Sugar	30% Sugar, from beet 22% Sugar, from cane 35% Glucose syrup (High fructose corn syrup) 9% Glucose syrup 2% Glucose syrup (Dextrose) 1% Glucose syrup (Edible Syrup) *Honey is omitted*

Table S 2. Percentage of food waste at retail and consumer levels for various food groups, adapted from Buzby et al., 2014.

Food group	Retail (%)	Consumer (%)	Total waste (%)
Grains (and grain products)	12	19	28.7
Fruit	9	19	26.3
Vegetables	8	22	28.2
Fluid milk	12	20	29.6
Other diary	10	19	27.1
Red meat, pork, other non-fish and non-poultry meats	4	23	26.1
Poultry	4	18	21.3
Fish and seafood	8	31	36.5
Eggs	7	21	26.5
Nuts, legumes	6	9	14.5
Sugars, sweeteners	11	30	37.7
Fats, oils	21	17	34.4

Table S 3. Assumptions used to account for food preparation and clean-up. The same assumptions were used for all meals, scaled to the meal weight.

Activity	Parameter	Expert assumption
Thawing of frozen products	Device used	1.1 kWh (max) microwave
	Life time of microwave	8 years
	Thawing time	1 min (50% power)
	Energy use	0.15 kWh/kg
	Frequency of use	5 times/week
Cooking on skillet	Skillet weight	2.2 kg
	Life time	8 years
	Cooking time	0.13 hour
	Energy use	2.1 kWh/kg
	Times skillet used	500 times
Oven cooking	Skillet weight	2.2 kg
	Cooking time	0.3 hour
	Cooking temperature	180 °C
	Energy use	12 kWh/kg
	Servings cooked in lifetime of oven	146,000
Dish washing	Washing method	Residential dishwasher
	Usage rate	Each serving occupies 1/10th of a dishwasher load

Table S 4. Average Consumption weight (grams) of meals and the production weight required for the environmental impact assessment, which has been weight-adjusted and waste-adjusted for meatless and meat-containing meals (based on NHANES 2011-12, USDA 2015b, Buzby et al. 2014).

Food sub-categories	Meat-containing meals						Meatless meals								
	Consumption quantity (NHANES)			Produced quantity (consumption quantity adjusted for waste and cooking losses/gains)			Consumption quantity			Scaled to equal meat-containing meal weight			Produced quantity (consumption quantity adjusted for waste and cooking losses/gains)		
	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)
Milks and milk drinks	41.63	15.92	21.12	61.21	23.42	31.05	88.13	34.02	37.72	119.13	41.05	43.32	175.19	60.37	63.71
Cream and cream substitutes	3.47	0.63	0.77	4.89	0.88	1.08	4.35	0.76	1.42	5.88	0.92	1.63	8.28	1.30	2.30
Milk desserts, sauces, gravies	0.49	3.68	5.79	0.69	5.18	8.16	0.50	4.18	6.19	0.68	5.04	7.11	0.96	7.10	10.02
Cheeses	4.57	6.39	5.34	6.44	9.00	7.52	1.52	3.99	6.25	2.05	4.81	7.17	2.89	6.77	10.10
Meat, not specified	0.00	0.02	0.17	0.00	0.03	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beef	4.05	11.07	20.43	5.54	15.17	27.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pork	8.31	5.88	8.56	11.39	8.05	11.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lamb, veal, game, other carcass meat	0.22	0.36	1.34	0.30	0.49	1.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Poultry	6.76	25.97	31.21	8.67	33.30	40.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Organ, sausages, lunchmeats, spreads	21.63	15.72	7.61	29.64	21.54	10.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fish and shellfish	3.36	8.65	19.36	5.51	14.18	31.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Meat, poultry, fish with nonmeat items	25.49	74.93	78.46	34.91	102.64	107.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Frozen, shelf-stable plate meals, w/ meat	10.74	19.20	22.54	14.72	26.30	30.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Food sub-categories	Meat-containing meals						Meatless meals								
	Consumption quantity (NHANES)			Produced quantity (consumption quantity adjusted for waste and cooking losses/gains)			Consumption quantity			Scaled to equal meat-containing meal weight			Produced quantity (consumption quantity adjusted for waste and cooking losses/gains)		
	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)
Vegetables with meat, poultry, fish	0.00	0.95	0.35	0.00	1.36	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eggs	13.56	1.43	1.00	18.83	1.98	1.39	3.95	2.29	1.63	5.34	2.76	1.87	7.41	3.84	2.60
Egg mixtures	29.57	2.38	1.62	41.07	3.31	2.24	11.65	7.94	5.81	15.75	9.58	6.67	21.88	13.31	9.27
Egg substitutes	0.45	0.10	0.00	0.63	0.14	0.00	0.19	0.07	0.00	0.25	0.08	0.00	0.35	0.11	0.00
Legumes*	4.29	8.49	12.32	1.83	3.62	5.25	1.75	15.88	19.40	2.36	19.17	22.28	1.01	8.16	9.49
Nuts, nut butters, and nut mixtures (with carob)	0.31	0.95	0.63	0.36	1.12	0.74	1.83	3.11	1.71	2.47	3.75	1.97	2.91	4.42	2.32
Seeds and seed mixtures	0.06	0.04	0.10	0.07	0.05	0.12	0.09	0.07	0.14	0.12	0.09	0.16	0.14	0.10	0.19
Yeast breads, rolls	25.19	22.65	16.34	36.51	32.83	23.68	16.42	13.56	12.60	22.20	16.37	14.47	32.17	23.72	20.97
Quick breads	8.54	4.00	7.29	12.37	5.79	10.56	2.97	2.82	4.16	4.01	3.40	4.78	5.81	4.93	6.93
Cakes, cookies, pies, pastries	3.91	7.16	9.26	5.66	10.38	13.42	6.63	6.01	6.30	8.97	7.25	7.23	13.00	10.51	10.48
Crackers and salty snacks from grain	0.27	2.08	1.67	0.39	3.01	2.43	0.77	3.84	3.06	1.04	4.63	3.52	1.51	6.71	5.10
Pancakes, waffles, French toast, other	9.30	0.78	0.57	13.48	1.13	0.83	3.78	1.26	1.11	5.11	1.52	1.27	7.41	2.20	1.84
Pasta, cooked cereals, rice*	30.64	24.03	30.30	18.91	14.83	18.70	26.68	14.17	17.01	36.06	17.10	19.53	22.26	10.56	12.05
Cereals, not cooked or not specified*	1.09	0.06	0.14	0.56	0.03	0.07	11.40	1.83	1.82	15.41	2.21	2.09	7.95	1.14	1.08

Food sub-categories	Meat-containing meals						Meatless meals								
	Consumption quantity (NHANES)			Produced quantity (consumption quantity adjusted for waste and cooking losses/gains)			Consumption quantity			Scaled to equal meat-containing meal weight			Produced quantity (consumption quantity adjusted for waste and cooking losses/gains)		
	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)
Grain mixtures, frozen plate meals, soup	9.60	35.29	43.99	13.91	51.14	63.75	14.43	125.40	194.72	19.51	151.33	223.62	28.27	219.32	324.09
Meat substitutes, mainly cereal protein	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.00	0.03	0.05	0.00	0.04	0.07	0.00
Citrus fruits, juices	36.40	7.68	8.96	51.27	10.82	12.63	25.05	9.02	7.10	33.87	10.89	8.15	47.70	15.34	11.48
Dried fruits*	0.09	0.11	0.09	0.58	0.71	0.58	0.72	0.21	0.27	0.97	0.25	0.31	6.08	1.56	1.97
Other fruits	11.63	13.65	11.28	16.37	19.23	15.89	22.02	20.64	20.13	29.76	24.91	23.12	41.92	35.08	32.56
Fruit juices and nectars excl. citrus	8.94	7.80	8.92	12.60	10.99	12.56	8.04	10.13	6.80	10.87	12.22	7.81	15.31	17.21	11.00
White potatoes, starch veg.	16.95	23.15	33.51	24.22	33.07	47.87	3.15	7.62	9.84	4.25	9.20	11.30	6.07	13.14	16.15
Dark-green vegetables	0.49	5.85	10.84	0.70	8.36	15.49	0.36	3.29	5.48	0.49	3.97	6.30	0.70	5.67	9.00
Deep-yellow vegetables	0.17	2.72	5.03	0.24	3.88	7.19	0.84	2.52	2.67	1.14	3.04	3.07	1.63	4.34	4.38
Tomatoes and tomato mixtures	6.53	12.39	13.07	9.33	17.70	18.66	2.35	10.55	13.82	3.18	12.73	15.87	4.54	18.19	22.67
Other vegetables	4.93	31.68	46.91	7.04	45.25	67.01	3.80	29.37	38.21	5.14	35.44	43.88	7.34	50.63	62.68
Mixtures mostly vegetables w/o meat	0.19	0.05	0.00	0.28	0.07	0.00	0.48	0.66	0.00	0.66	0.80	0.00	0.94	1.14	0.00
Fats	1.73	0.60	1.28	2.79	0.96	2.07	1.04	0.58	0.63	1.41	0.69	0.72	2.27	1.12	1.17
Oils	0.00	0.05	0.07	0.00	0.08	0.12	0.03	0.12	0.10	0.05	0.14	0.11	0.08	0.22	0.18
Salad dressings	1.10	4.61	4.75	1.77	7.44	7.66	0.13	1.67	1.93	0.18	2.02	2.21	0.28	3.25	3.57
Sugars and sweets	8.94	2.45	3.19	15.15	4.16	5.41	5.37	3.49	4.05	7.26	4.21	4.65	12.30	7.13	7.88
Total of all categories	366	412	496	491	554	667	270	341	432	366	412	496	487	559	677

	Meat-containing meals						Meatless meals								
	Consumption quantity (NHANES)			Produced quantity (consumption quantity adjusted for waste and cooking losses/gains)			Consumption quantity			Scaled to equal meat-containing meal weight			Produced quantity (consumption quantity adjusted for waste and cooking losses/gains)		
Food sub-categories	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)	Breakfast (g)	Lunch (g)	Dinner (g)

*Consumption is based on final cooked weight, production volume based on the form of the environmental data (e.g. dry weight for legumes). A factor of 2.76 was used to adjust for wet to dry weight of beans, 2.35 for wet to dry weight of pasta, 2.81 for wet to dry weight of grains, 4.46 for dray to wet wait of fruit, based on ratios of calories for different food states (i.e. dry, fresh, cooked) from USDA's nutrient database (USDA, 2015).

Table S 5. Absolute values for environmental impact indicators of meal occasions for meatless and meat-containing meals.

Impact category	Meal type	Life cycle stage						
		Raw material	Manuf-acture	Packag-ing	Distrib-ution	Use	Waste manag-ement	Total
Carbon Footprint (kg CO_2-eq)	Breakfast with meat	2.1E+0	1.6E-1	5.1E-2	3.3E-2	1.2E-1	8.7E-2	2.6E+0
	Meatless breakfast	6.2E-1	1.6E-1	5.1E-2	3.3E-2	1.2E-1	9.1E-2	1.1E+0
	Lunch with meat	3.3E+0	1.6E-1	6.7E-2	3.3E-2	1.2E-1	9.4E-2	3.8E+0
	Meatless lunch	5.0E-1	1.6E-1	6.7E-2	3.3E-2	1.2E-1	9.9E-2	9.8E-1
	Dinner with meat	4.2E+0	1.6E-1	8.4E-2	3.3E-2	1.2E-1	1.2E-1	4.8E+0
	Meatless dinner	5.7E-1	1.6E-1	8.4E-2	3.3E-2	1.2E-1	1.2E-1	1.1E+0
Water Use (m³)	Breakfast with meat	4.1E-1	5.8E-4	2.0E-5	1.2E-4	4.7E-4	6.9E-5	4.1E-1
	Meatless breakfast	1.5E-1	5.8E-4	2.0E-5	1.2E-4	4.7E-4	7.2E-5	1.5E-1
	Lunch with meat	6.9E-1	5.8E-4	2.6E-5	1.2E-4	4.7E-4	7.5E-5	6.9E-1
	Meatless lunch	1.3E-1	5.8E-4	2.6E-5	1.2E-4	4.7E-4	7.9E-5	1.3E-1
	Dinner with meat	9.5E-1	5.8E-4	3.2E-5	1.2E-4	4.7E-4	9.1E-5	9.5E-1
	Meatless dinner	1.5E-1	5.8E-4	3.2E-5	1.2E-4	4.7E-4	9.6E-5	1.5E-1
Resource Consumption (MJ)	Breakfast with meat	1.3E+1	2.6E+0	1.2E+0	5.3E-1	1.9E+0	6.3E-2	1.9E+1
	Meatless breakfast	4.3E+0	2.6E+0	1.2E+0	5.3E-1	1.9E+0	6.6E-2	1.1E+1
	Lunch with meat	1.9E+1	2.6E+0	1.6E+0	5.3E-1	1.9E+0	6.8E-2	2.6E+1
	Meatless lunch	3.9E+0	2.6E+0	1.6E+0	5.3E-1	1.9E+0	7.2E-2	1.1E+1
	Dinner with meat	2.5E+1	2.6E+0	1.9E+0	5.3E-1	1.9E+0	8.3E-2	3.2E+1
	Meatless dinner	4.5E+0	2.6E+0	1.9E+0	5.3E-1	1.9E+0	8.7E-2	1.2E+1
Health Impact of Pollution (DALY)	Breakfast with meat	2.5E-6	9.9E-8	5.0E-8	2.0E-8	8.4E-8	4.0E-9	2.7E-6
	Meatless breakfast	7.7E-7	9.9E-8	5.0E-8	2.0E-8	8.4E-8	4.0E-9	1.0E-6
	Lunch with meat	3.7E-6	9.9E-8	6.5E-8	2.0E-8	8.4E-8	4.0E-9	3.9E-6

	Meatless lunch	5.8E-7	9.9E-8	6.5E-8	2.0E-8	8.4E-8	4.0E-9	8.5E-7
	Dinner with meat	4.6E-6	9.9E-8	8.1E-8	2.0E-8	8.4E-8	5.0E-9	4.9E-6
	Meatless dinner	6.3E-7	9.9E-8	8.1E-8	2.0E-8	8.4E-8	5.0E-9	9.2E-7
Ecosystem Quality (PDF-m²-yr)	Breakfast with meat	6.9E+0	5.2E-2	1.1E-2	1.0E-2	3.1E-2	1.0E-3	7.0E+0
	Meatless breakfast	2.0E+0	5.2E-2	1.1E-2	1.0E-2	3.1E-2	1.0E-3	2.1E+0
	Lunch with meat	1.0E+1	5.2E-2	1.4E-2	1.0E-2	3.1E-2	2.0E-3	1.1E+1
	Meatless lunch	1.5E+0	5.2E-2	1.4E-2	1.0E-2	3.1E-2	2.0E-3	1.6E+0
	Dinner with meat	1.3E+1	5.2E-2	1.8E-2	1.0E-2	3.1E-2	2.0E-3	1.3E+1
	Meatless dinner	1.4E+0	5.2E-2	1.8E-2	1.0E-2	3.1E-2	2.0E-3	1.5E+0

Table S 6. Sensitivity analysis of the influence of various meat types.

Meal types compared		Impact of A minus impact of B				
A	B	Carbon Footprint (kg CO2e)	Water Use (m3)	Resource Consumption (MJ)	Health Impact of Pollution (DALY)	Ecosystem Quality (PDF*m2*yr)
Beef-based breakfast	Meatless breakfast	4.663	0.214	13.88	0.0628890	17.14
Pork-based breakfast	Meatless breakfast	0.721	0.174	7.40	0.0628854	1.34
Chicken-based breakfast	Meatless breakfast	0.347	0.086	4.46	0.0628852	0.88
Fish-based breakfast	Meatless breakfast	0.878	1.171	14.82	0.0628862	0.58
Meat-based breakfast avg.	Meatless breakfast	1.490	0.264	8.30	0.0000017	4.92
Beef-based lunch	Meatless lunch	8.53	0.350	26.17	0.0683330	31.18
Pork-based lunch	Meatless lunch	1.220	0.275	14.16	0.0683262	1.87
Chicken-based lunch	Meatless lunch	0.529	0.112	8.71	0.0683258	1.02
Fish-based lunch	Meatless lunch	1.514	2.124	27.92	0.0683277	0.46
Meat-based lunch average	Meatless lunch	2.836	0.556	15.49	0.0000031	8.97
Beef-based dinner	Meatless dinner	10.25	0.395	31.57	0.0834016	37.83
Pork-based dinner	Meatless dinner	1.428	0.305	17.08	0.0833935	2.45
Chicken-based dinner	Meatless dinner	0.592	0.108	10.49	0.0833930	1.43
Fish-based dinner	Meatless dinner	1.781	2.537	33.69	0.0833952	0.75
Meat-based dinner average	Meatless dinner	3.669	0.801	20.36	0.0000040	11.57

Figure S 1. Ranking of food items for the weight as consumed (averaged across meals) versus as produced in meat-containing meals.
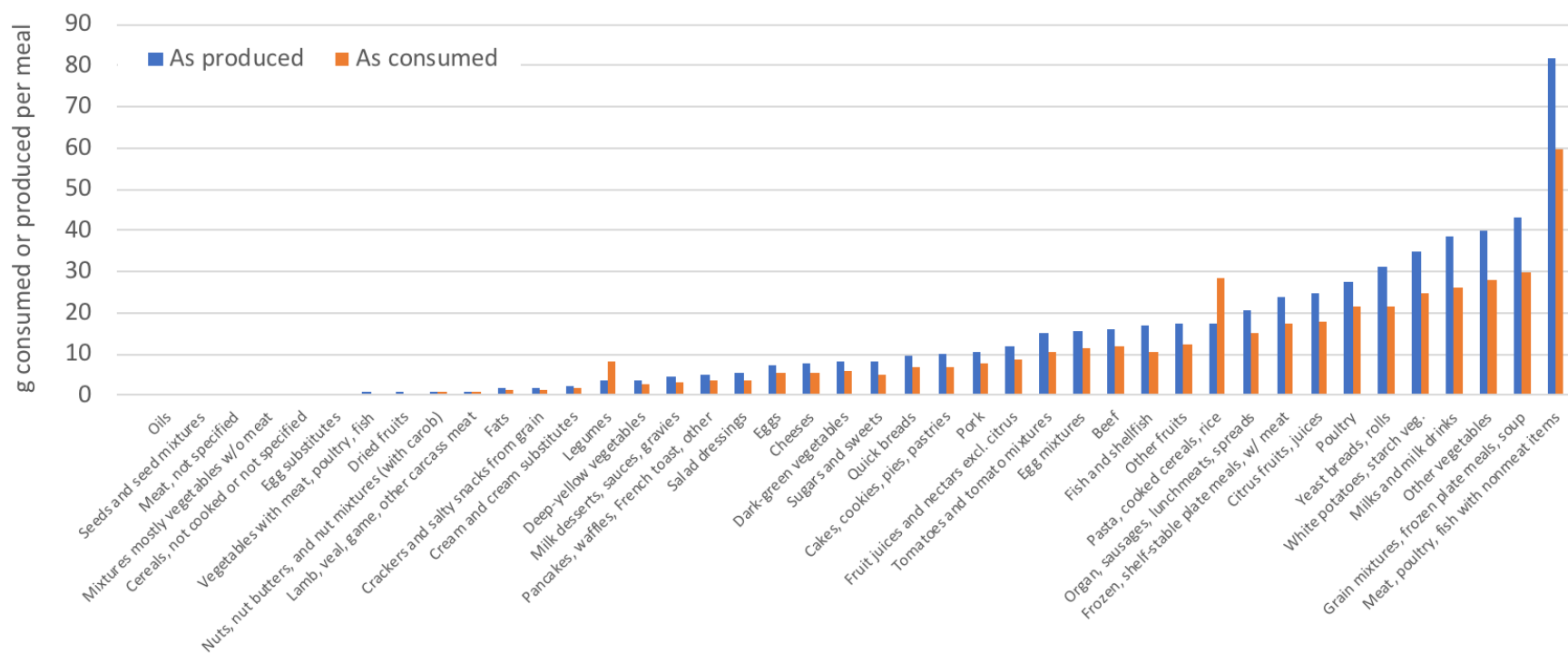
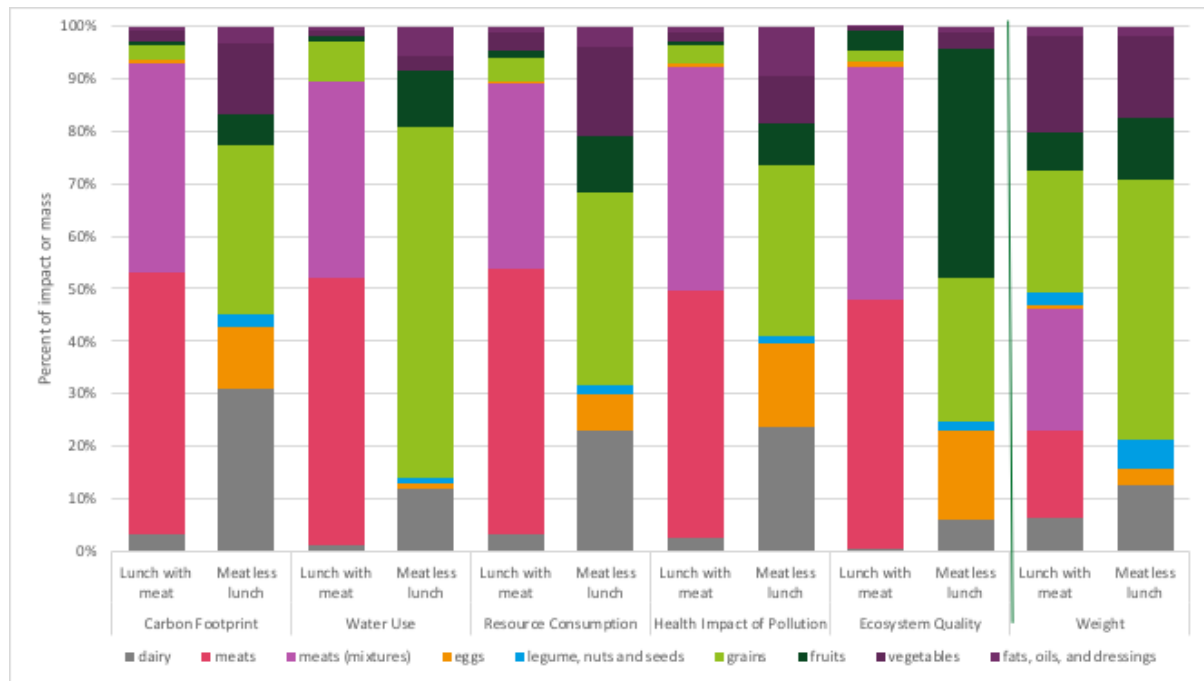*Figure S 2. Contribution of food categories to the environmental impact of lunches*

Figure S 3. Contribution of food categories to the environmental impact of dinners