ENVIRONMENTAL IMPACTS OF LUNCHES SERVED IN THE US NATIONAL SCHOOL LUNCH PROGRAM

ALEXANDRA STERN, PHD

AUGUST 30, 2022

NICE TO MEET YOU!

Postdoctoral fellow at US Environmental Protection Agency

Focus: Healthy diets from sustainable food systems


sustainability

MDPI

Review

Data Integration for Diet Sustainability Analyses

Zach Conrad [1,2,*], Alexandra Stern [3], David C. Love [4,5], Meredith Salesses [6], Ashley Cyril [6], Acree McDowell [6] and Nicole Tichenor Blackstone [3]


communications earth & environment

ARTICLE

https://doi.org/10.1038/s43247-022-00452-3 OPEN

Less animal protein and more whole grain in US school lunches could greatly reduce environmental impacts

Alexandra L. Stern [1✉], Nicole Tichenor Blackstone [1], Christina D. Economos[1] & Timothy S. Griffin [1]

DISCLOSURES

- This work was supported by the National Needs Fellowship grant number 2019-38420-29021 from the USDA National Institute of Food and Agriculture

- The views expressed herein at those of the authors and **do not necessarily represent the *opinion*** or policy of the agency
- This work is not associated with research at the US Environmental Protection Agency

The global food system is **driving climate change** and **environmental degradation** while contributing to unprecedented levels of **malnutrition**, and **economic inequalities**.

ARTICLE

https://doi.org/10.1038/s41586-018-0594-0

Options for keeping the food system within environmental limits

Marco Springmann[1,2*], Michael Clark[3], Daniel Mason-D'Croz[4,5], Keith Wiebe[4], Benjamin Leon Bodirsky[6], Luis Lassaletta[7], Wim de Vries[8], Sonja J. Vermeulen[9,10], Mario Herrero[5], Kimberly M. Carlson[11], Malin Jonell[12], Max Troell[12,13], Fabrice DeClerck[14,15], Line J. Gordon[12], Rami Zurayk[16], Peter Scarborough[2], Mike Rayner[2], Brent Loken[12,14], Jess Fanzo[17,18], H. Charles J. Godfray[1,19], David Tilman[20,21], Johan Rockström[6,12] & Walter Willett[22]

The Lancet Commissions

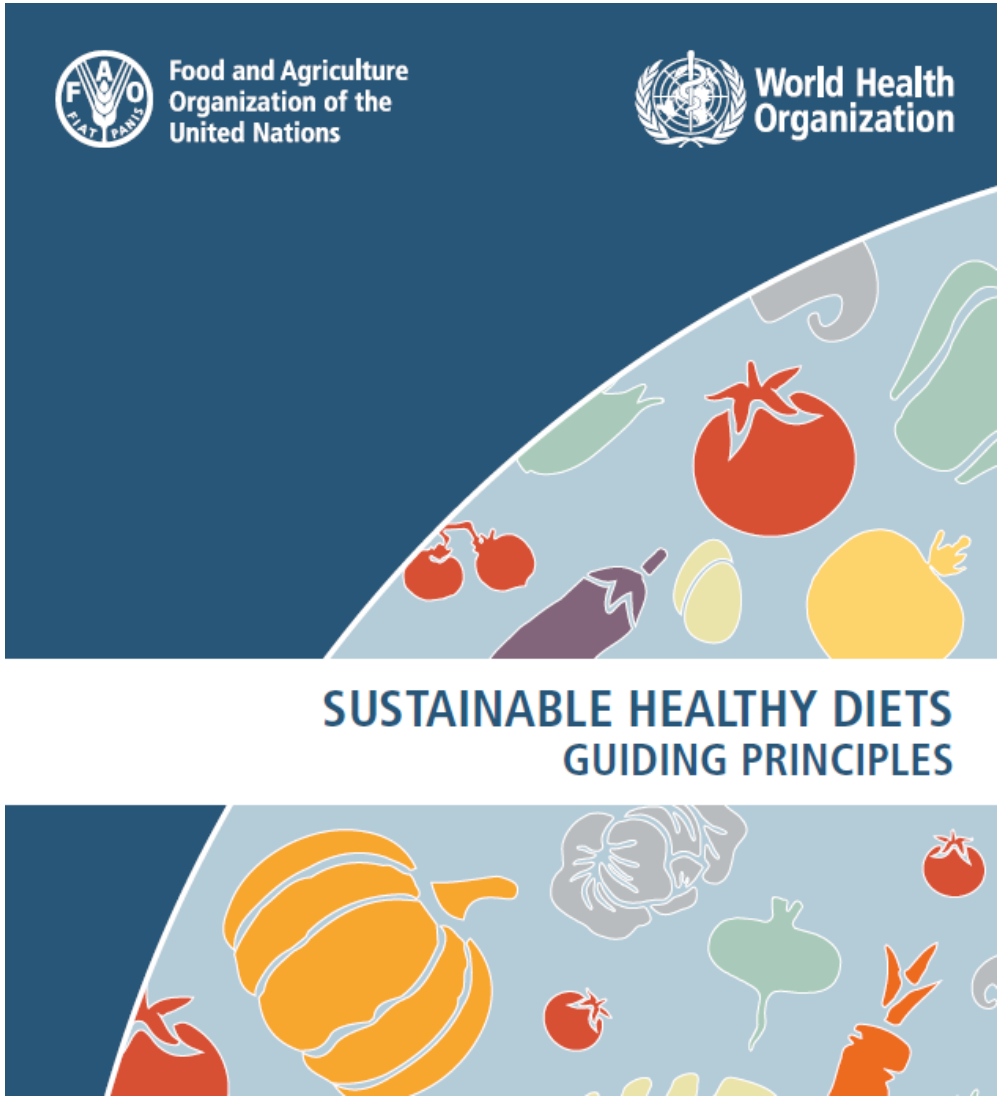
Food in the Anthropocene: the EAT–*Lancet* Commission on healthy diets from sustainable food systems

Walter Willett, Johan Rockström, Brent Loken, Marco Springmann, Tim Lang, Sonja Vermeulen, Tara Garnett, David Tilman, Fabrice DeClerck, Amanda Wood, Malin Jonell, Michael Clark, Line J Gordon, Jessica Fanzo, Corinna Hawkes, Rami Zurayk, Juan A Rivera, Wim De Vries, Lindiwe Majele Sibanda, Ashkan Afshin, Abhishek Chaudhary, Mario Herrero, Rina Agustina, Francesco Branca, Anna Lartey, Shenggen Fan, Beatrice Crona, Elizabeth Fox, Victoria Bignet, Max Troell, Therese Lindahl, Sudhvir Singh, Sarah E Cornell, K Srinath Reddy, Sunita Narain, Sania Nishtar, Christopher J L Murray

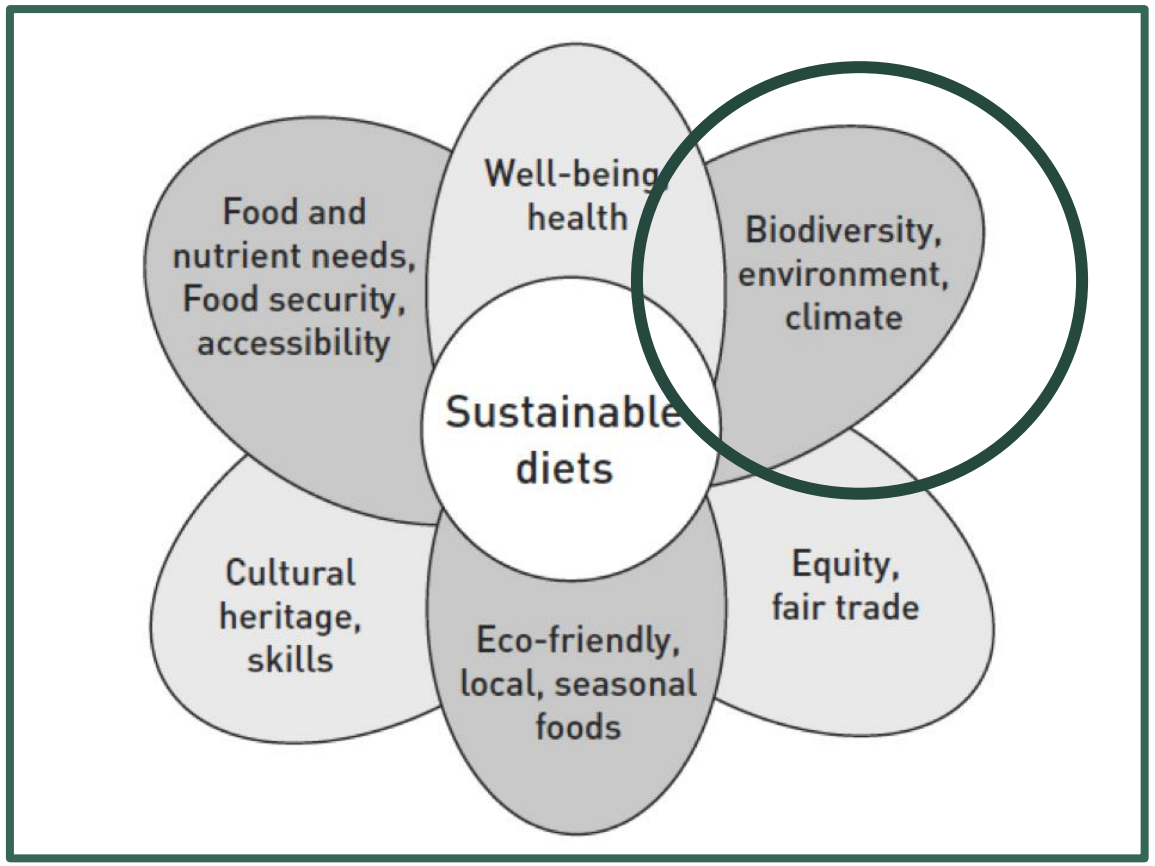
ARTICLES
PUBLISHED ONLINE: 31 AUGUST 2014 | DOI: 10.1038/NCLIMATE2353
nature climate change

Importance of food-demand management for climate mitigation

Bojana Bajželj[1]*, Keith S. Richards[2], Julian M. Allwood[1], Pete Smith[3], John S. Dennis[4], Elizabeth Curmi[1] and Christopher A. Gilligan[5]


Food and Agriculture
Organization of the
United Nations
World Health
Organization
SUSTAINABLE HEALTHY DIETS
GUIDING PRINCIPLES

SUSTAINABLE DIETS



- **Low environmental impacts**
- **Protective of biodiversity and ecosystems**
- **Promote food and nutrition security**
- **Nutritionally adequate**
- **Economically fair and affordable**
- **Culturally acceptable**

14 BILLION USD

40% OF CHILDREN

19% FREE MEALS

SCHOOL FOOD OPPORTUNITY

OBJECTIVE AND RESEARCH AIMS

The **overall objectives** of this research were to **evaluate the sustainability** of **school lunches** in the U.S. and **create realistic alternative menus** for schools which balance tradeoffs across sustainability indicators to guide recommendations for improvement.

SPECIFIC AIMS

- Collate life cycle inventories (LCIs) for foods served in the NSLP;
- Estimate the environmental impacts from the agricultural production of lunches;
- Explore the distribution of impacts across lunches and identify the contribution of impacts from quintiles and food groups; and
- Examine the composition of lunches by quintile to focus policy recommendations.


474
TO OPEN
1% Lowfat Milk
Vitamin A & D • 1% Milkfat
GARELICK
SELL BY

METHODS

AIM1 DATA

Lunch data

→School Nutrition and Meal Cost Study

Environmental data

→ecoinvent 3.6

Recipe data

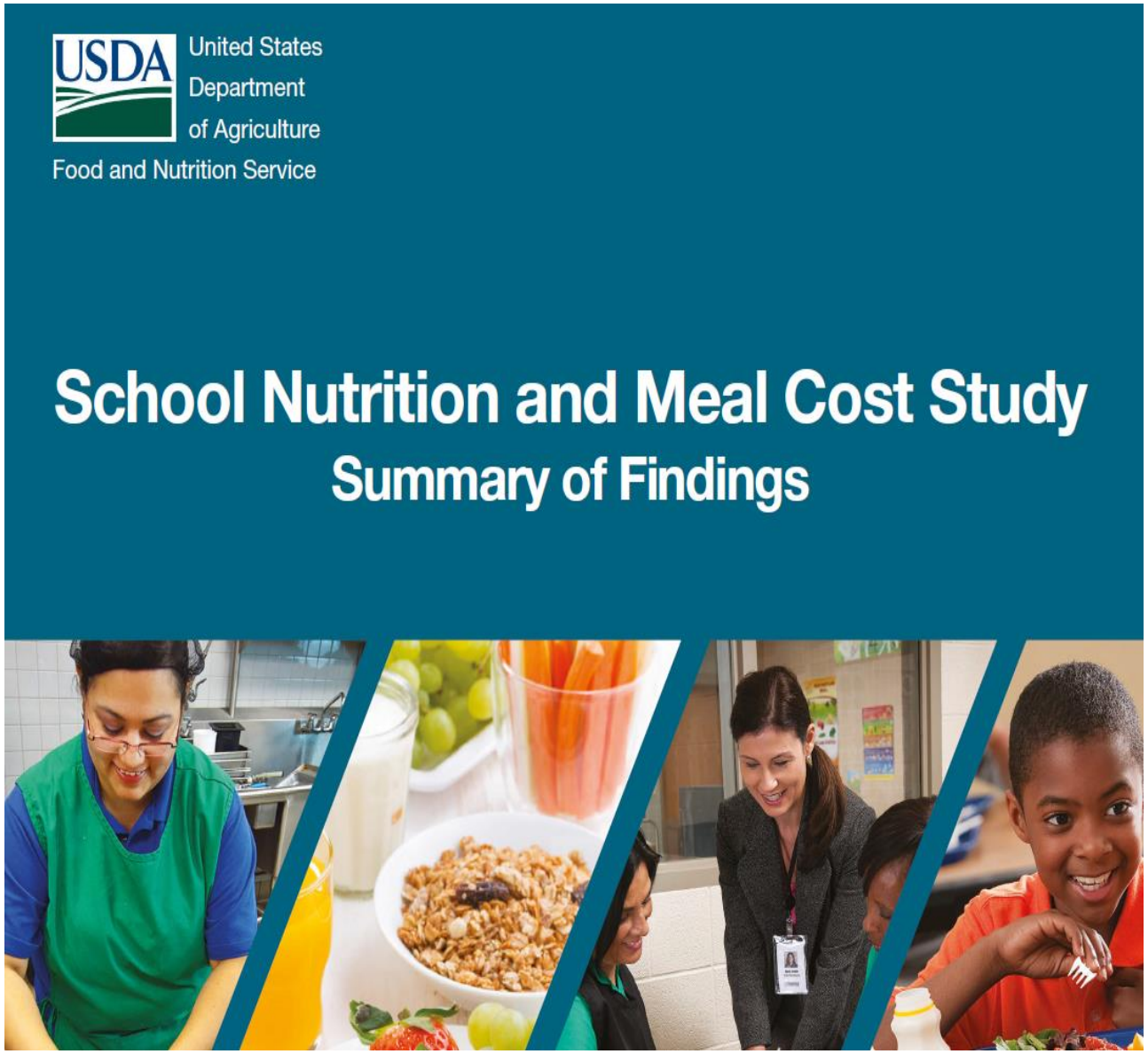
→Food Commodity Intake Database

Conversion data

→Food Intakes Converted to Retail Commodities

LUNCH DATA

- USDA periodic assessment of the school meals program
- Nationally representative sample of 1,207 schools
- 2.2 million lunches served
- Over 1,300 unique food items
- Web based survey of week of lunch served

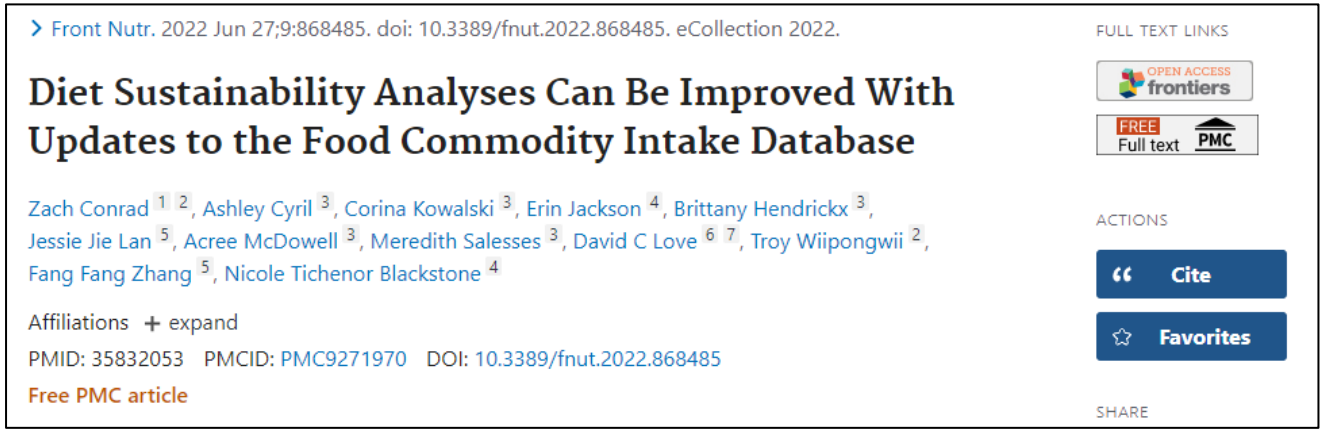


EXAMPLE LUNCHES

- Whole wheat pasta with meat sauce, a whole wheat roll, tossed salad with creamy dressing, canned peaches, and 1% milk
- Fajita with chicken and vegetables, corn chips, and apple juice
- Beef patty, whole wheat roll, and mashed white potatoes, and 1% milk
- Peanut butter and jelly sandwich, apple, and carrots

RECIPE DATA

- Food Commodities Intake Database (FCID)
- 500 commodities linked to 5,000 Food and Nutrient Database for Dietary Studies (FNDDS) Codes
- Standard forms and cooked status
  - Dried, juice, flour



> Front Nutr. 2022 Jun 27;9:868485. doi: 10.3389/fnut.2022.868485. eCollection 2022.

Diet Sustainability Analyses Can Be Improved With Updates to the Food Commodity Intake Database

Zach Conrad [1 2], Ashley Cyril [3], Corina Kowalski [3], Erin Jackson [4], Brittany Hendrickx [3], Jessie Jie Lan [5], Acree McDowell [3], Meredith Salesses [3], David C Love [6 7], Troy Wiipongwii [2], Fang Fang Zhang [5], Nicole Tichenor Blackstone [4]

Affiliations + expand

PMID: 35832053 PMCID: PMC9271970 DOI: 10.3389/fnut.2022.868485

Free PMC article

FULL TEXT LINKS

OPEN ACCESS frontiers

FREE Full text PMC

ACTIONS

Cite

Favorites

SHARE

RECIPE DATA

FNDDS Code	FNDDS Description	FCID Code	FCID Description	Commodity proportion	Cooked Status
51300110	bread, whole wheat	1500402000	wheat flour	42.25	9
51300110	bread, whole wheat	1500401000	wheat grain	18.576	2
51300110	bread, whole wheat	1500124000	corn, field, syrup	3.629	2
51300110	bread, whole wheat	600350000	soybean, oil	2.677	2
51300110	bread, whole wheat	1500404000	wheat, bran	1.163	2
51300110	bread, whole wheat	600348000	soybean, flour	0.587	9
51300110	bread, whole wheat	3600223000	milk, nonfat solids	0.561	2
51300110	bread, whole wheat	2003128000	cottonseed, oil	0.233	2
51300110	bread, whole wheat	3600224000	milk, water	0.015	2
51300110	bread, whole wheat	3600222000	milk, fat	0.006	2

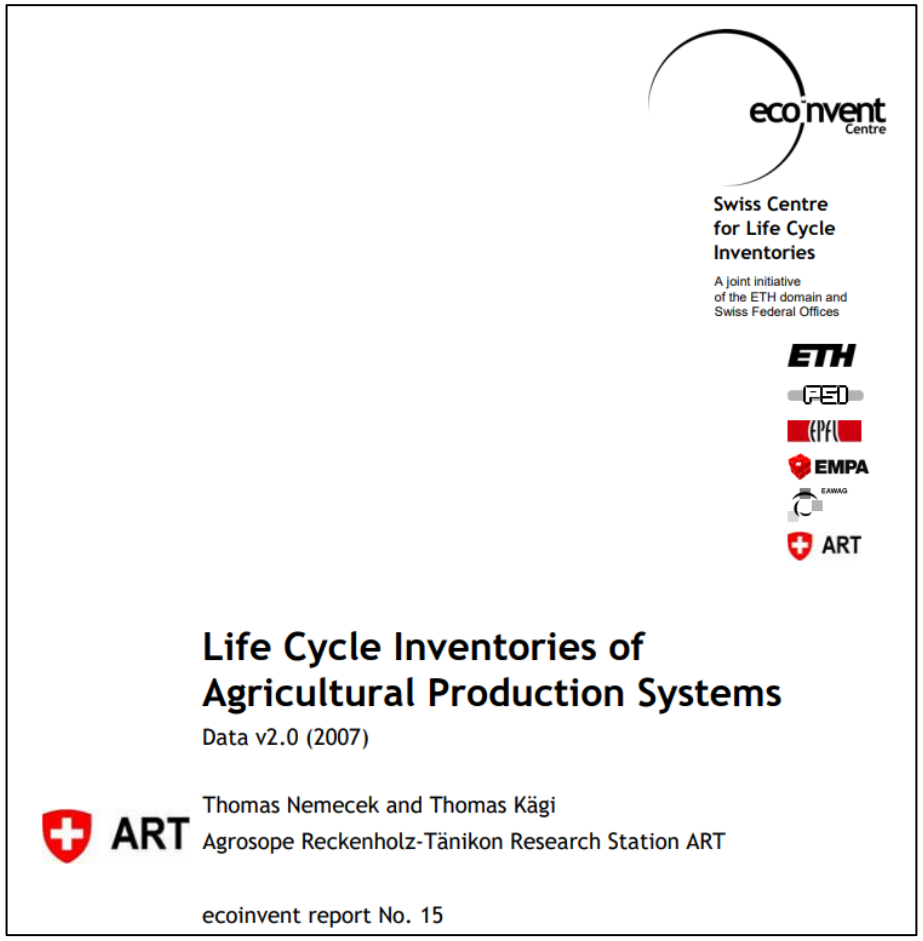
SELECTING ENVIRONMENTAL DATA

- Range of possible data sources
  - US Federal LCA Commons
  - World Food LCA Database
  - Ecoinvent 3.6
  - Literature
    - Mekonnen and Hoekstra
    - dataFIELD
    - Poore and Nemechek

ecoinvent

FEDERAL LCA COMMONS

SELECTING ENVIRONMENTAL DATA



- Ecoinvent
  - Consistent system boundaries and allocation methods
  - LCI over LCA results
    - Ability to manipulate inventory
    - Consistent LCIA methods
    - Uncertainty analyses
  - Wide range of agricultural products from around the world
  - Overlap with WFLDB

SELECTING ECOINVENT INVENTORIES/PROCESSES

LEVEL 1 Function

Exact product → Similar product → Proxy

LEVEL 2 Geography

US, Importing → Similar climate region → Global

LEVEL LCA Parameters

Allocation

System boundary

Functional unit

PROCESSES AND PROXIES

FCID	FCID Description	Process	Proxy (1,0)
1100007000	Apple, fruit with peel	apple production | apple | US	0
1100008000	Apple, peeled fruit	apple production | apple | US	0
103299000	Potato, tuber, w/peel	potato production | potato | US	0
402117000	Collards	brassica	1
500064000	Brussels sprouts	brassica	1
1003180000	Grapefruit	citrus	1

Proxy group	Process
brassica	broccoli production | broccoli | GLO
brassica	cabbage white production | cabbage white | RoW
brassica	cauliflower production | cauliflower | GLO
citrus	orange production, fresh grade | orange, fresh grade | US
citrus	mandarin production, sorted and graded | mandarin, fresh grade | RoW
citrus	lemon production | lemon | MX

ANALYSES

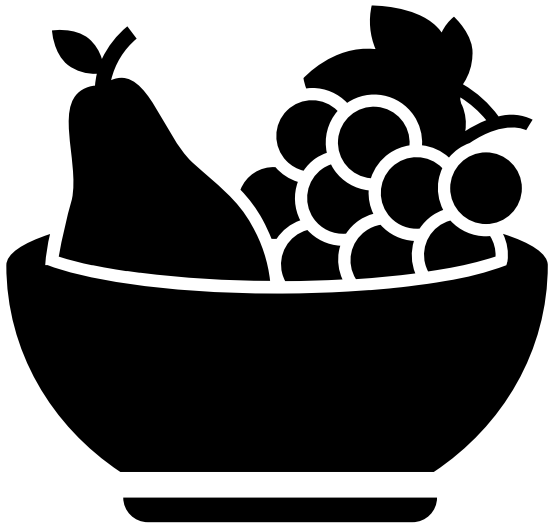
- Impact assessment methods
  - ILCD
  - ReCiPE Midpoint H
- Software
  - openLCA
  - Simapro as comparison

Database	Software	Impact Assessment Methods
Ecoinvent 3.6	ecoquery	ILCD 2.0
Ecoinvent 3.6	openLCA	ReCiPe 2016
WFLDB 3.1	Simapro	ILCD 2011
WFLDB 3.4	Simapro	ILCD 2011
WFLDB 3.5	Simapro	PEF

DATA LINKAGES – RECIPES, PROXIES, AND CONVERSIONS

Menu Item

Fruit cup



Recipe

Agricultural Commodities to Foods

Commodity
Pear
Apple w/o peel
Corn syrup

DATA LINKAGES – RECIPES, PROXIES, AND CONVERSIONS

Recipe
Agricultural Commodities to Foods

LCI ecoinvent 3.6
Direct, proxies, proxy groups

Commodity	LCI Assignment
Pear	Tree fruit group
Apple w/o peel	apple production | apple | Cutoff, U – US
Corn syrup	Corn, field, syrup - mod - beet sugar production | molasses, from sugar beet | Cutoff, U

DATA LINKAGES – RECIPES, PROXIES, AND CONVERSIONS

Impacts
Greenhouse gas

GHG Impact kg co2 eq kg-1
0.25
0.08
0.62

X

Recipe
Proportion 100g $^{-1}$

Proportion
0.50
0.48
0.02

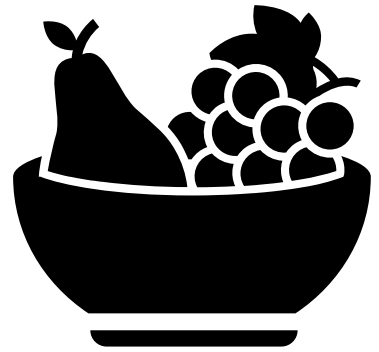
X

Conversion
Inedible, cooking loss

Stem and seeds
Stem, peel, seeds
None

=

Final Impact of fruit cup



RESULTS

Table 1-1. Environmental impacts of lunches served in the National School Lunch Program during the 2014-2015 SY.

	Mean (SE)				
	Global Warming Potential kg CO_2 eq.	Land Use m^2a crop eq.	Water Consumption m^3	Eutrophication Potential	
				Marine g N eq.	Freshwater g P eq.
Per Lunch	1.5 (2.7E-2)	1.8 (3.4E-2)	5.5E-2 (6.6E-4)	3.1 (4.9E-2)	0.24 (1.6E-3)
Per 1000 kcal	2.4 (4.3E-2)	2.9 (5.5E-2)	8.9E-2 (1.1E-3)	5.0 (8.0E-2)	0.39 (2.7E-3)

SY = School year; SE = standard error of the mean is the variability of lunches from School Nutrition Meal Cost Study.

Table 1-2. Average composition of lunches served in the National School Lunch Program exclusively in the 1st or 5th quintiles for all impact categories by food group. Results are energy (kcal) adjusted averages of lunches exclusively in the 1st (low impact; n=62,000) or 5th (high impact, n=38,000) quintiles for all impact categories.

Food Group	Low Impact	High Impact	p-value
Fruit (cup eq.)	0.62	0.72	0.04 *
Fruit juices	0.05	0.17	0.00 ***
Other fruit	0.57	0.55	0.03 *
Vegetables (cup eq.)	0.61	0.73	0.00 **
Red orange	0.23	0.19	0.07
Starchy	0.11	0.20	0.00 ***
Other fruit	0.13	0.17	0.05
Beans and peas	0.05	0.05	0.89
Dark green	0.10	0.12	0.24
Protein foods (oz. eq.)	0.69	1.72	0.00 ***
Beef and pork[1]	0.00	1.02	0.00 ***
Poultry[1]	0.18	0.32	0.00 **

Table 1-2. Average composition of lunches served in the National School Lunch Program exclusively in the 1st or 5th quintiles for all impact categories by food group. Results are energy (kcal) adjusted averages of lunches exclusively in the 1st (low impact; n=62,000) or 5th (high impact, n=38,000) quintiles for all impact categories.

Food Group	Low Impact	High Impact	p-value	
Protein foods (oz. eq.)	0.69	1.72	0.00	***
Cured luncheon meat[2]	0.20	0.23	0.54	
Seafood	0.04	0.01	0.04	*
Eggs	0.01	0.03	0.00	**
Legumes	0.01	0.04	0.13	
Nuts and seeds	0.19	0.01	0.00	***
Soy products	0.04	0.04	0.82	
Dairy (cup eq.)	1.58	1.03	0.00	***
Cheese	0.71	0.26	0.00	***
Milk	0.86	0.76	0.00	***
Grains (oz. eq.)	2.42	2.12	0.00	***
Refined grains	0.98	0.96	0.79	
Whole grains	1.43	1.16	0.00	**

Table 1-3. Total lunch composition and percent contribution of impacts from food groups for lunches served in the National School Lunch Program. Food group contribution to total impacts is a factor of commodity impacts from varying production practices and amount served. Mass of each food group is expressed as the percent of the total mass of all lunches served. Color ranges from light green and yellow to light and dark red to denote food groups' contribution intensity. Red cells represent the greatest contribution to lunch impacts, whereas light green represents the lowest contribution.

Food Groups	% Lunches by Mass	% Contribution to Total Environmental Impact				
		Global Warming Potential	Land Use	Water Consumption	Eutrophication	
					Marine	Freshwater
Fruits	**20.0**	**1.3**	**2.1**	**26.5**	**1.7**	**3.2**
Other fruit	15.0	0.8	1.3	16.5	1.1	2.0
Juice	5.0	0.5	0.8	10.0	0.6	1.2
Vegetables	**16.0**	**2.8**	**2.5**	**14.3**	**3.2**	**8.4**
Red orange	6.0	0.4	0.6	5.6	0.6	0.7
Starchy	4.0	0.7	0.8	6.1	1.1	4.1
Other	4.0	1.3	0.5	1.8	0.9	3.2
Beans and peas	1.0	0.2	0.6	0.5	0.3	0.3
Dark green	1.0	0.7	0.8	6.1	1.1	4.1
Meat	**8.0**	**67.3**	**65.6**	**28.0**	**60.2**	**39.5**
Poultry	3.0	9.3	6.1	19.2	9.3	18.4
Beef	2.0	52.5	56.0	4.6	47.3	13.6
Pork	1.0	5.2	3.5	4.2	3.6	7.5
Dairy	**36.0**	**21.7**	**17.0**	**7.0**	**24.3**	**28.5**
Grains	**8.0**	**2.7**	**6.2**	**4.3**	**7.7**	**10.5**
Other	**5.0**	**1.8**	**2.4**	**4.2**	**1.0**	**1.4**
Sweeteners	**3.0**	**0.3**	**0.7**	**0.8**	**0.8**	**0.6**
Oil	**2.0**	**0.9**	**2.9**	**5.3**	**0.8**	**7.1**
Egg	**0.3**	**0.3**	**0.4**	**8.6**	**0.3**	**0.4**
Seafood	**0.2**	**0.9**	**0.0**	**0.4**	**0.0**	**0.2**
Nuts and seeds	**0.2**	**0.0**	**0.2**	**0.5**	**0.1**	**0.1**

Food groups	# FCID commodities	% FCID requiring proxies	% Total Impact from Proxies				
			Global Warming Potential	Land Use	Water Con.	Eutrophication Potential	
						Marine	Freshwater
Fruit	153	56	0.3	0.3	2.7	0.3	0.5
Vegetables	189	63	0.6	0.9	2.1	0.9	2.0
Grain	44	48	1.4	0.9	2.8	1.3	2.7
Meat	58	40	0.0	0.0	0.1	0.0	0.0
Fish and seafood	6	33	0.0	0.0	0.1	0.0	0.0
Nuts and seeds	29	55	0.0	0.0	0.0	0.0	0.0
Eggs	6	0	0.0	0.0	0.0	0.0	0.0
Dairy	7	0	0.0	0.0	0.0	0.0	0.0
Oils and fats	26	62	0.3	0.5	3.1	0.3	1.0
Sweeteners	15	60	0.1	0.2	0.2	0.2	0.2
Other	29	45	0.0	0.0	0.5	0.0	0.1
Total diet	**562**	**54**	**2.7**	**2.8**	**11.6**	**3.1**	**6.3**

USE OF PROXIES IN LINKAGES TO FCID AND PERCENT CONTRIBUTION OF PROXIES TO TOTAL IMPACTS, BY FOOD GROUP

RANKING OF IMPACTS BY IMPACT CATEGORY AND METHODS IN THE TEN MOST SERVED COMMODITIES IN NSLP.

Food	Process Name	Database	Software	LCIA Method	Climate Rank	Land Rank
apple	apple production | apple | US	ecoinvent 3.6	ecoquery	ILCD 2.0 2018 Mid no LT	2	2
apple	Apple, at farm (WFLDB 3.1)/US U	WFLDB 3.1	Simapro	ILCD 2011 Midpoint+ V1.06	3	2
apple	Apple, at farm (WFLDB 3.4)/US U (QLL18.1.0)	WFLDB 3.4	Simapro	ILCD 2011 Mid+	1	2
apple	Apple, at farm (WFLDB 3.5)/US	WFLDB 3.5	Simapro	PEF	2	3
apple	apple production | apple | Cutoff, U - US	ecoinvent 3.6	openLCA	ReCipe 2016 Mid (H)	2	1
beef	beef cattle production on pasture and feedlot | cattle for slaughtering, live weight | RoW	ecoinvent 3.6	ecoquery	ILCD 2.0 2018 Mid no LT	10	10
beef	Beef, fresh meat, at slaughterhouse (WFLDB 3.1)/US U	WFLDB 3.1	Simapro	ILCD 2011 Mid+ V1.06	10	10
beef	Beef, fresh meat, at slaughterhouse (WFLDB 3.4)/US U (QLL18.1.0)	WFLDB 3.4	Simapro	ILCD 2011 Mid+	10	10
beef	Beef, fresh meat, at slaughterhouse (WFLDB 3.5)/US	WFLDB 3.5	Simapro	PEF	10	10
beef	beef cattle production on pasture and feedlot | cattle for slaughtering, live weight | Cutoff, U - RoW	ecoinvent 3.6	openLCA	ReCipe 2016 Mid (H)	10	10
carrot	carrot production | carrot | CN	ecoinvent 3.6	ecoquery	ILCD 2.0 2018 Mid no LT	3	3
carrot	Carrot, at farm (WFLDB 3.1)/GLO U	WFLDB 3.1	Simapro	ILCD 2011 Mid+ V1.06	1	3


325
325
325
1% Lowfat
Milk
Vitamin A & D • 1% Milkfat
GARELICK
TO OPEN

DISCUSSION

FUTURE OF SCHOOL LUNCH

- Implications for policy, funding, and school meal programming
- New standards for lunch planning
  - Minimum requirements for legumes (including peanuts) and fish
  - Limits for beef and cheese
- Reduce the burden for schools in selecting suitable fish options
  - Federal and state agencies and nonprofits provide lists of acceptable options based on locality
- Funding through legislation and Farm to School
- Effective behavioral interventions for menu changes

UPDATED NUTRITION STANDARDS

	Preschool	Grades K-5	Grades 6-8	Grades 9-12
	Amount of Food Per Week (Minimum per day)			
Meat and Meat Alternative (oz. eq.)	7.5 (1.5)	8-10 (1)	9-10 (1)	10-12 (2)
Beans and Peas (Legumes)	1.5	2	2	2
	Amount of Food per Month			
Fish	1.5	4	4	4
Beef	< 4.5	< 6	< 6	< 6
Cheese	< 4.5	< 6	< 6	< 6

THANK YOU!

SPECIAL THANKS

- My committee
  - Timothy Griffin
  - Nicole Tichenor Blackstone
  - Christina Economos
- Boston Public Schools
  - Laura Benevidez
  - Nancy Fisher
  - Kelly Thompson and Caitlin Tenario
- Collaborators
  - Scott Richardson (photo credits)
  - Steve Levine
- Funding
  - USDA NIFA, Doctoral Fellowship in Childhood Obesity Prevention