Healthy diets
from sustainable food systems:
New research, metrics and measures

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UNIVERSITY OF WASHINGTON
uwcphn
CENTER FOR PUBLIC HEALTH NUTRITION

Disclosures

AD has received grants, gifts, contracts, and honoraria from entities, both public and private, with an interest in nutrient profiling models and nutrient density of foods.
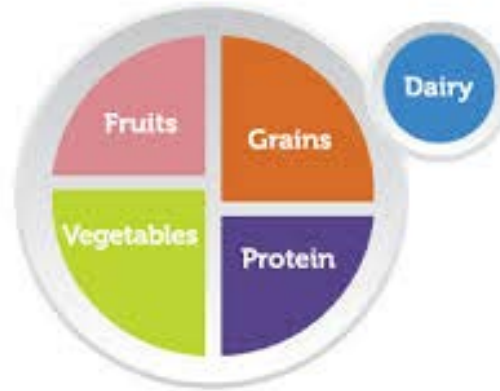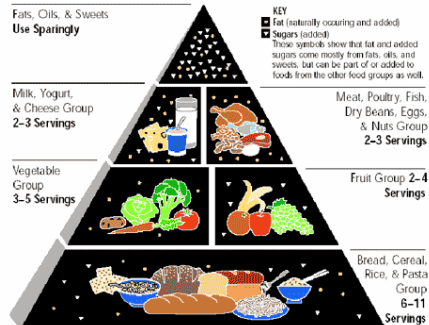
Some of the present analyses of protein quality were supported by Dairy Management Inc. in the US

The choice of words matters

- Sustainable diets.

- Sustainable *and* healthy diets.

- Healthy diets from sustainable food *systems.*

- Healthy diets with low impact on the *environment*.

FAO: 2010 definition of sustainable diets

- Sustainable diets are nutritionally adequate, safe and healthy; affordable; culturally acceptable; accessible; protective and respectful of biodiversity and ecosystems, while optimizing natural and human resources.

- Definition developed by the FAO Biodiversity and Sustainable Diets symposium, November 2010, Rome.

Barilla Center: healthy *and* sustainable diets

Health   Environment
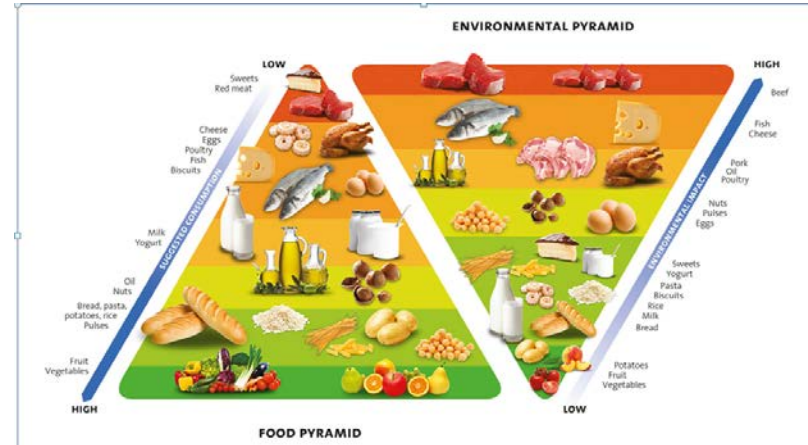
The Lancet: healthy diets from sustainable food *systems*

THE LANCET

January, 2019

www.thelancet.com

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

"Food in the Anthropocene represents one of the greatest health and environmental challenges of the 21st century."

A Commission by The Lancet

Nutrition and food systems

A report by The High Level Panel of Experts on Food Security and Nutrition

September 2017

INTRODUCTION TO THE U.S. FOOD SYSTEM
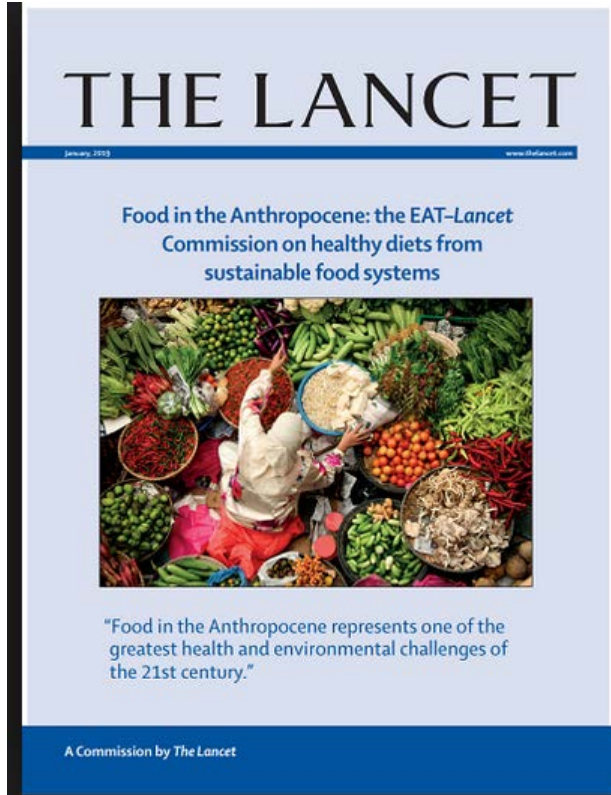
PUBLIC HEALTH, ENVIRONMENT, AND EQUITY
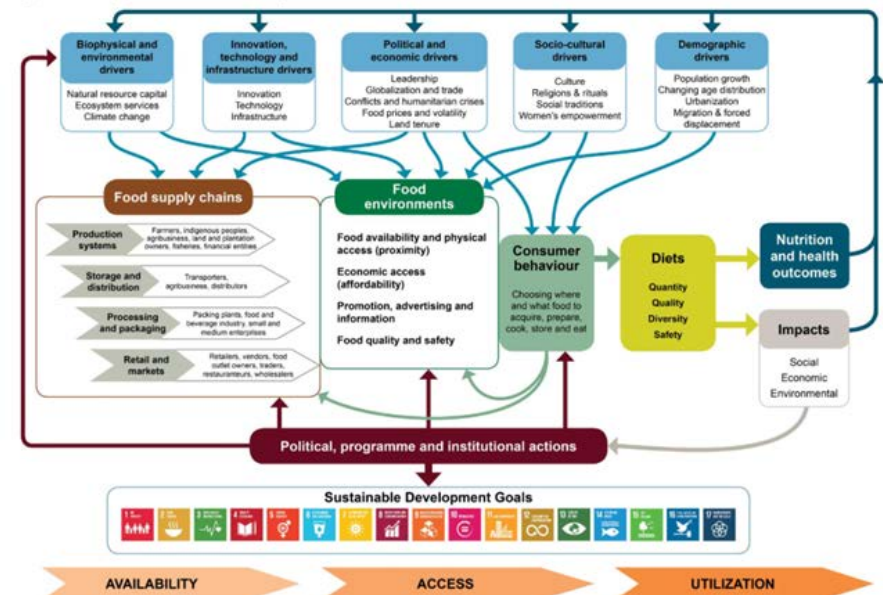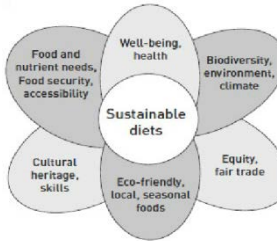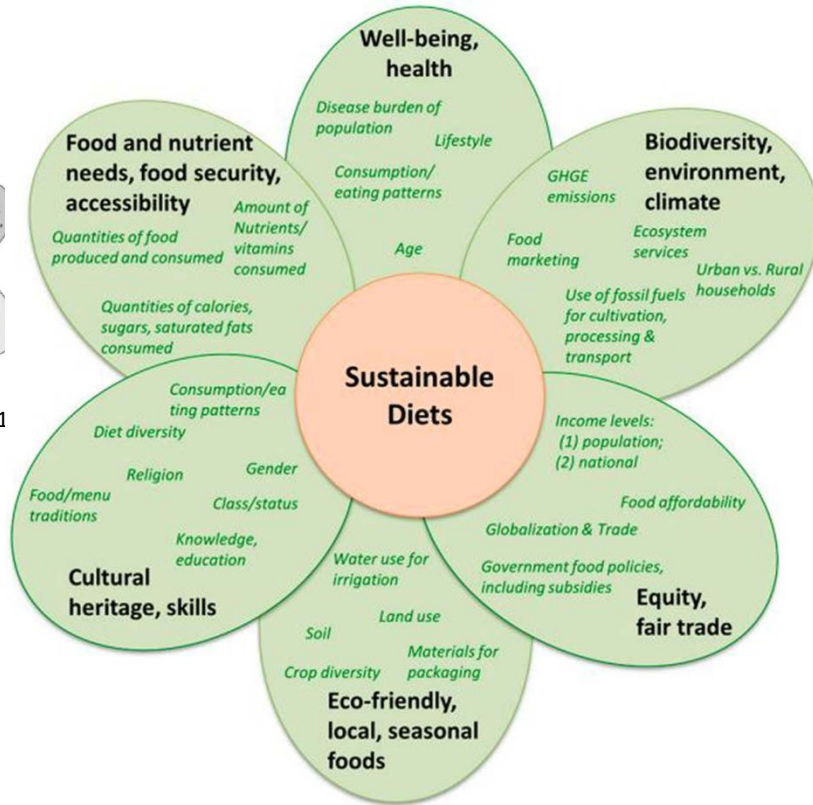

Figure 1   Conceptual framework of food systems for diets and nutrition

More complex visualizations

Burlingame, Dernini FAO 201

Johnston, Fanzo, Cogill 2014
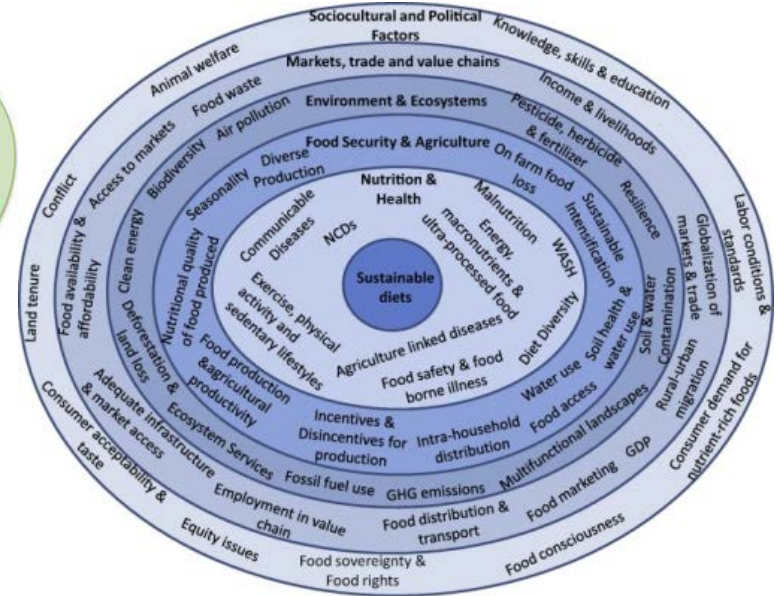
Downs Payne Fanzo 2017

The simple petal model: University of Cambridge and Chanel

Dimensions of sustainable nutrition (Koerber et al.)

FAO: Four domains of sustainability

Energy density
Nutrient density

Food affordability
Kcal/$ and Nutrients/$

Environmental cost
GHGEs

Nutrition and health	Economics
Environment	Society

Sustainable diets
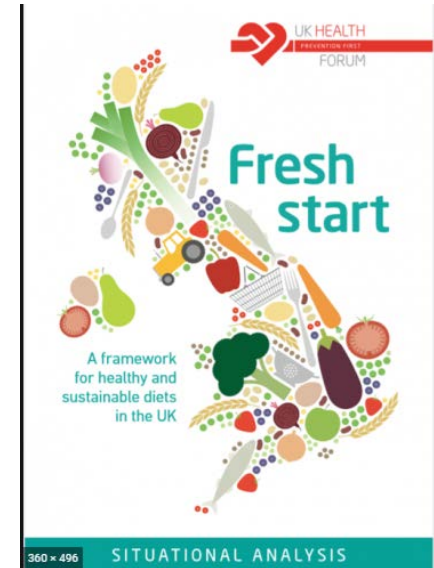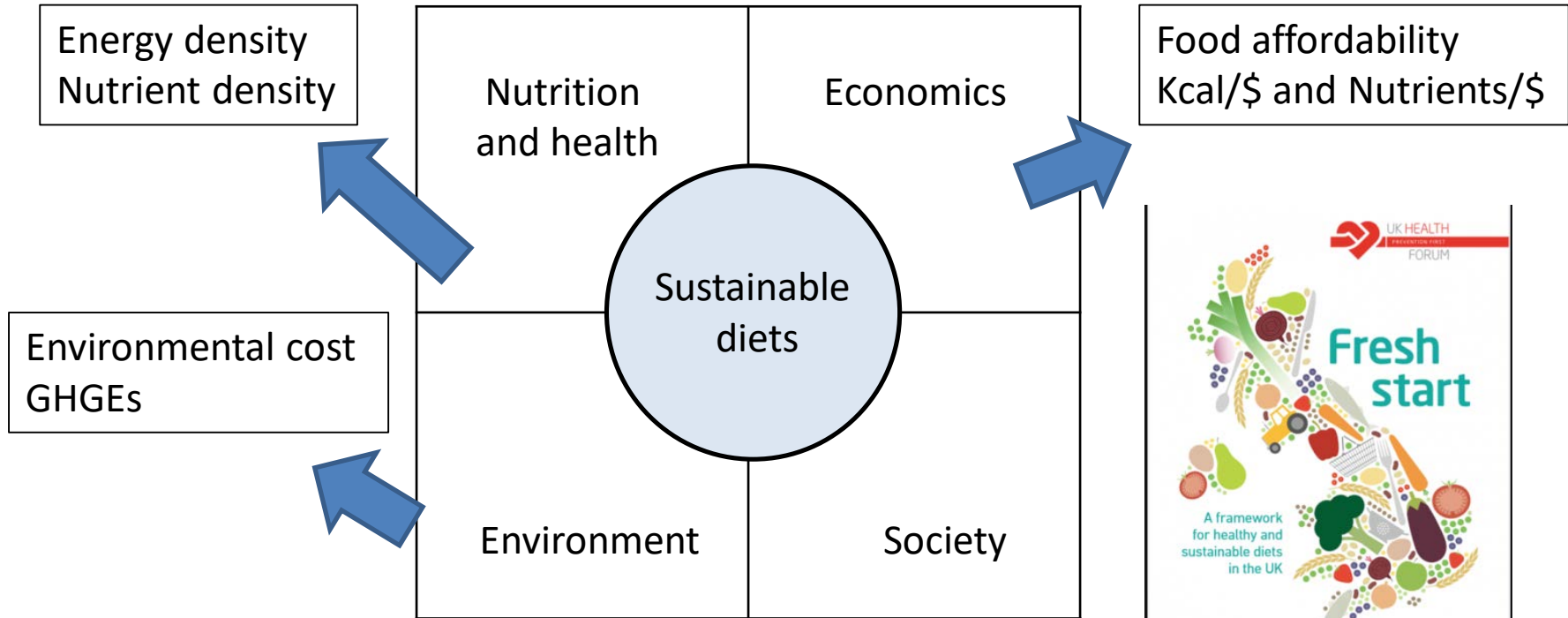
AD techie tesseract (hypercube) model
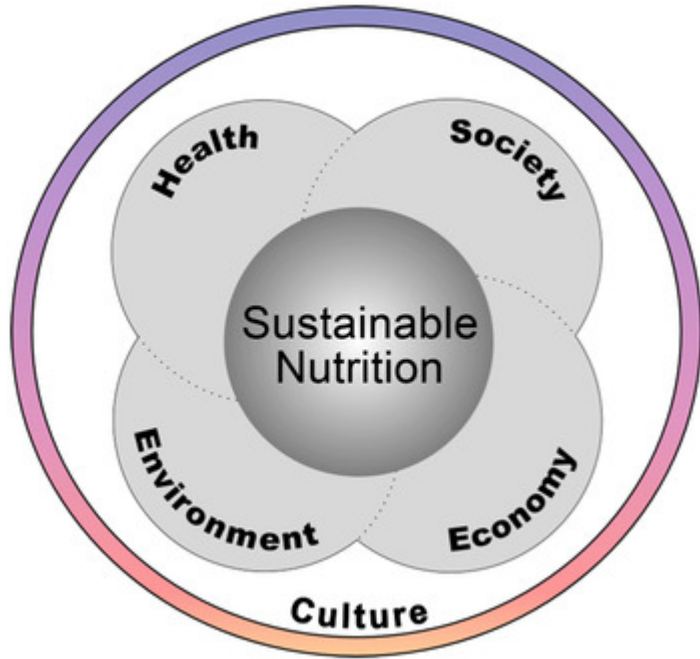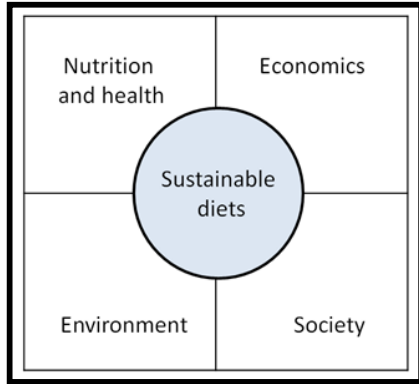

Four domains
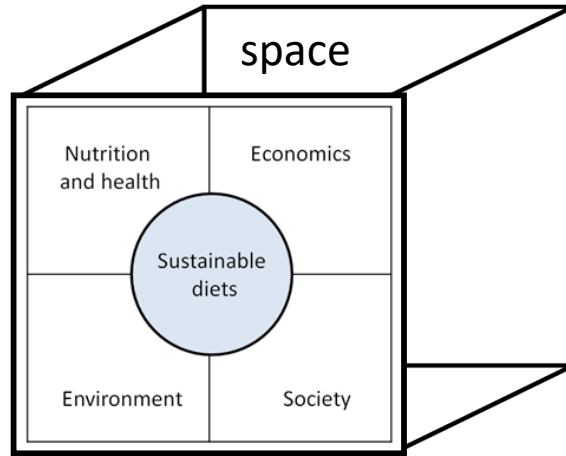
Four domains in space (across different geographies)
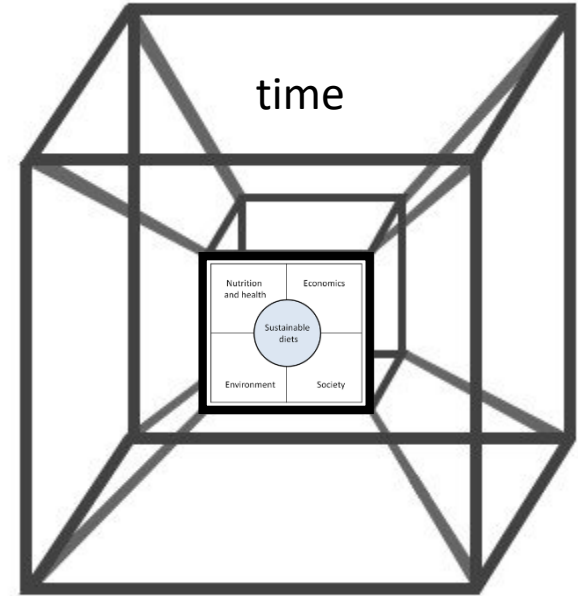
Four domains in space and *time* (Food production systems evolve with time; so do diets)

The FAO four dimensions approach

- The four dimensions of sustainability
  - Health, Economics, Society, and the Environment.
- Each dimension has its metrics and measures.
  - Nutrient density, Affordability, Societal value, Environmental impact.
- The Lancet forgot about economics and society.

The health and nutrition dimension

What are nutrient-rich foods?

Nutrient density as basis for Front-of-Pack
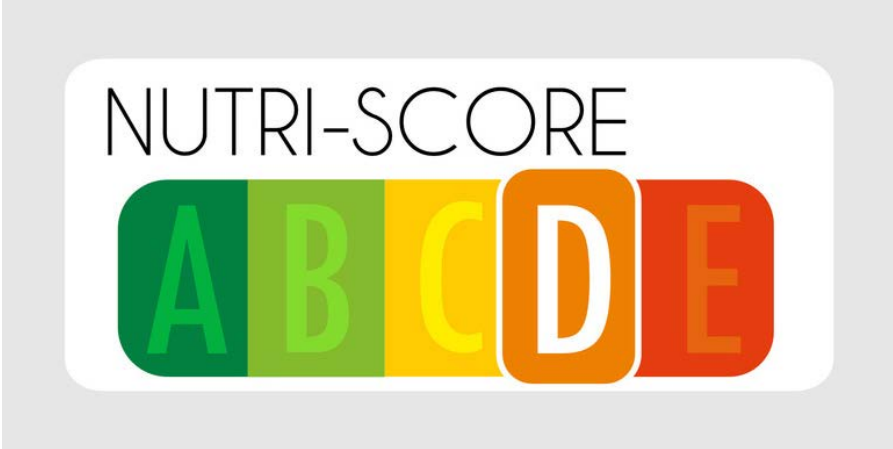
The origin of nutrient density concept

NATURALLY NUTRIENT RICH
...Putting More Power on Americans' Plates

BEEF

National Cattlemen's Beef Association on behalf of The Beef Checkoff

NATIONAL DAIRY COUNCIL

CALIFORNIA KIWIFRUIT

CALIFORNIA TOMATOES

The Other White Meat.

Wheat Foods

enc egg nutrition center

California

Commentary

Concept of a nutritious food: toward a nutrient density score[1–3]

Adam Drewnowski

ABSTRACT
The American diet is said to be increasingly energy-rich but nutrient-poor. To help improve the nutrient-to-energy ratio, the 2005 *Dietary Guidelines for Americans* recommend that consumers replace some foods in their diets with more nutrient-dense options. Such dietary guidance presupposes the existence of a nutrient density standard. However, a review of the literature shows that the concept of a nutritious food is not based on any consistent standards or criteria. In many cases, healthful foods are defined by the absence of problematic ingredients—fat, sugar, and sodium—rather than by the presence of any beneficial nutrients they might contain. Past attempts to quantify the nutrient density of foods have been based on a variety of calories-to-nutrient scores, nutrients-per-calorie indexes, and nutrient-to-nutrient ratios. The naturally nutrient rich (NNR) score, which is based on mean percentage daily values (DVs) for 14 nutrients in 2000 kcal food, can be used to assign nutrient density values to foods within and across food groups. Use of the NNR score allows consumers to identify and select nutrient-dense foods while permitting some flexibility where the discretionary calories are concerned.

Energy-dense sweets and fats have long been contrasted, unfavorably, to foods that contained substantial amounts of key nutrients per serving or per unit weight. The terms *energy-dense* and *nutrient-poor* are commonly used to characterize foods perceived as unhealthy and to distinguish them from more nutritious options (8). Disparaging terms such as *junk foods* (13) or *empty calories* (14) are commonly used in antithesis to such descriptors as *healthful, packed with nutrients, nutrient-dense,* or *nutrient-rich.*

The problem is that nutrient-dense foods lack a common definition (15, 16). A 1977 review of the literature (15) showed that there were only limited efforts to define the concept of a nutritious food. General statements that such a food should provide "significant amounts of essential nutrients" were not backed by any firm standards or criteria (15). Three decades later, in 2004, there was still no agreement as to the definition of a nutrient-dense food or a healthful beverage (16). The various attempts to define and quantify the nutrient density of foods over the past 30 y are the topic of this report.

The many uses of nutrient profiling (NP)

How to create a nutrient profile

- Select nutrients to encourage
  - Fiber, vitamins A, C, E, Ca, K, Mg, vit D
- Select nutrients to limit
  - Saturated fat, added (free) sugars, sodium, (total sugar, energy)
- Select base of calculation
  - 100 g, 100 kcal, or serving
- Select algorithm
  - Many options: arithmetic, ratio, weighted?
- Select method of validation
- Promote innovation
  - Animal protein versus plant protein?
  - Standards of identity (FDA)

Development and Validation of the Nutrient-Rich Foods Index: A Tool to Measure Nutritional Quality of Foods[1–3]

Victor L. Fulgoni III,[4]* Debra R. Keast,[5] and Adam Drewnowski[6]

[4]Nutrition Impact, LLC, Battle Creek, MI 49014; [5]Food and Nutrition Database Research Inc., Okemos, MI 48864; and [6]Center for Public Health Nutrition, School of Public Health, University of Washington, Seattle, WA 98195

Nutrient-rich scores: A family of NP models

NR index	Macronutrients	Vitamins	Minerals	Reference
NR5	Protein, fiber	Vit C	Ca, Fe	**AFSSA 2008**
NR6	Protein, fiber	Vit A, C	Ca, Fe	**Drewnowski et al 2008**
NR8	Protein, fiber	Vit A, C	Ca, Fe, Mg, K	
NR9	Protein, fiber	Vit A, C, E	Ca, Fe, Mg, K	**Drewnowski et al 2008**
NR11	Protein, fiber	Vit A, C, E, B_{12}	Ca, Fe, Zn, Mg,K	**Drewnowski et al 2008**
NR12	Protein, fiber	Vit A, C, E, thiamin, riboflavin, B_{12}	Ca, Fe, Zn, K	**Drewnowski et al 2008**
NR14	Protein, fiber	Vit C, D, E, thiamin, riboflavin, B_{12}, folate	Ca, Fe, Zn, K	**Drewnowski et al 2008**
NNR15	Pro, fiber, MUFA	Vit C, D, E, thiamin, riboflavin, B_{12}, folate	Ca, Fe, Zn, K	**Drewnowski 2005**
NDS16	Protein, fiber, linolenic, DHA	Vit C, D, E, thiamin, riboflavin, B_6, folate	Ca, Fe, Zn, Mg, K	**Darmon et al 2006**
NDS23	Protein, fiber, PUFAs, DHA	Vit A, C, D, E, B1, B2, B_6, B_{12}, niacin, folate	Ca, Fe, Zn, Mg, Cu, Se, K, I, (*Ph*)	**Maillot et al 2007**
LIM	Sat fat, add sugar		Na	**Drewnowski 2008, Darmon 2006**

EFSA approach to NP modeling
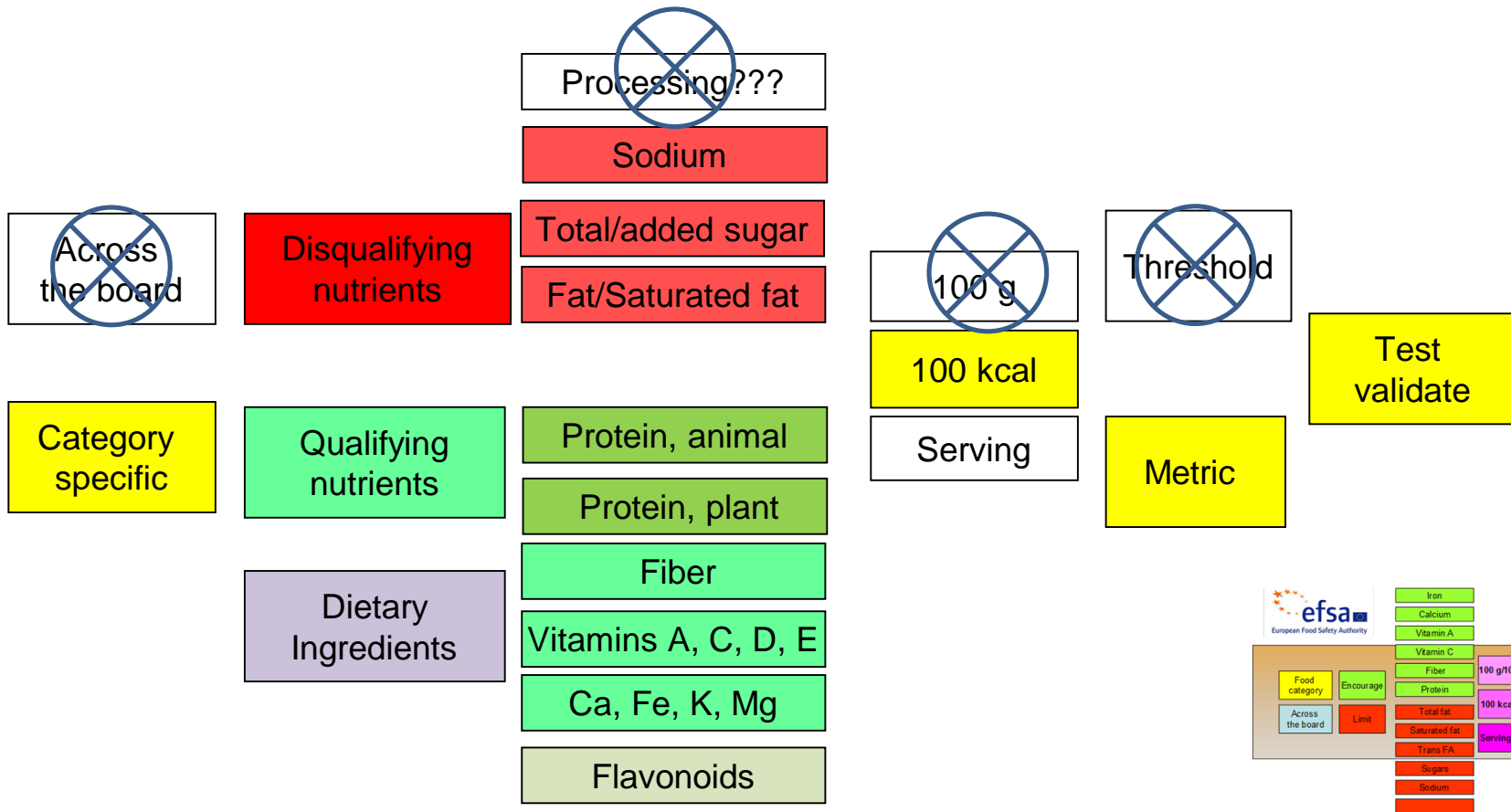
Energy density versus nutrient density
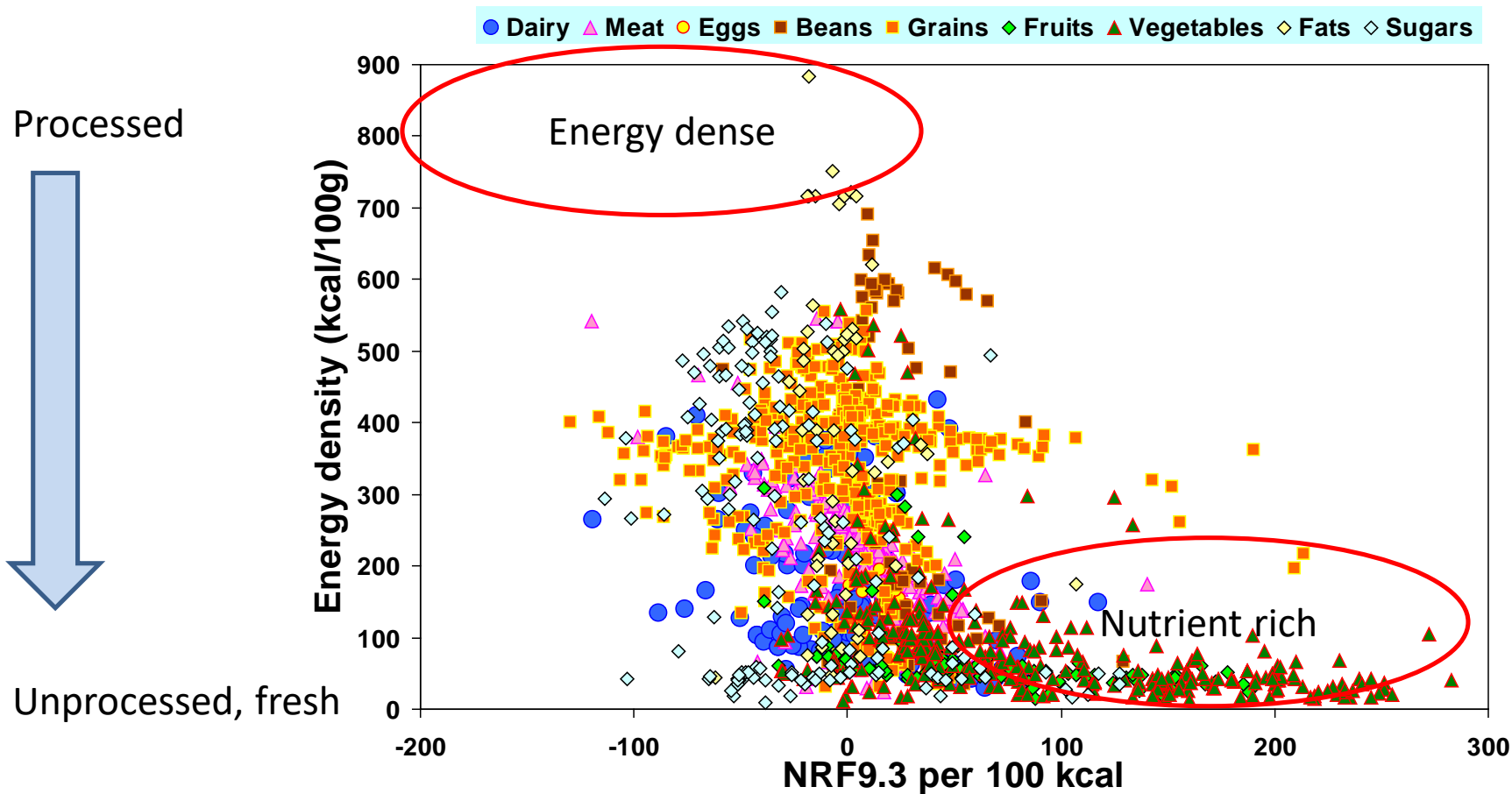
Dry grains, sweets, fats cost less

Processed

Unprocessed, fresh

Legend: ● Dairy △ Meat ■ Grains ◆ Fruits ▲ Vegetables ◇ Fats ◇ Sugars

Y-axis: Energy density (kcal/100g)

X-axis: Energy cost ($/1000 kcal)

21
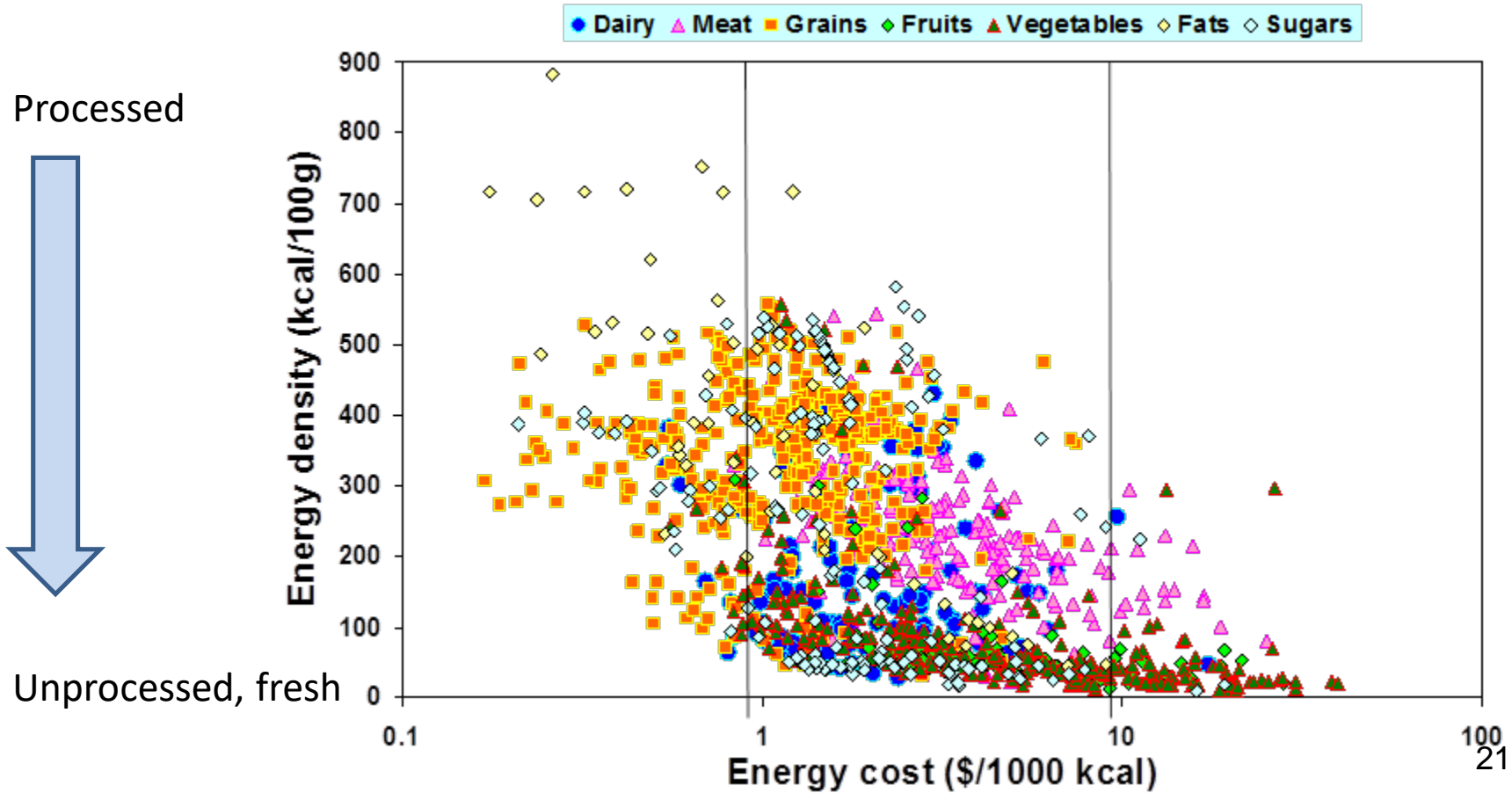
Hydrated nutrient-rich foods cost more

Unprocessed, fresh

Processed

Legend: ● Dairy △ Meat ○ Eggs ■ Beans ■ Grains ◆ Fruit ▲ Vegetables ◇ Fats ◇ Sugars

Nutrient density (NR9.3 per 100 kcal)

Nutrient rich and expensive

Energy dense and cheap

Energy cost ($/1000 kcal)
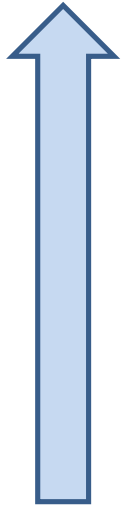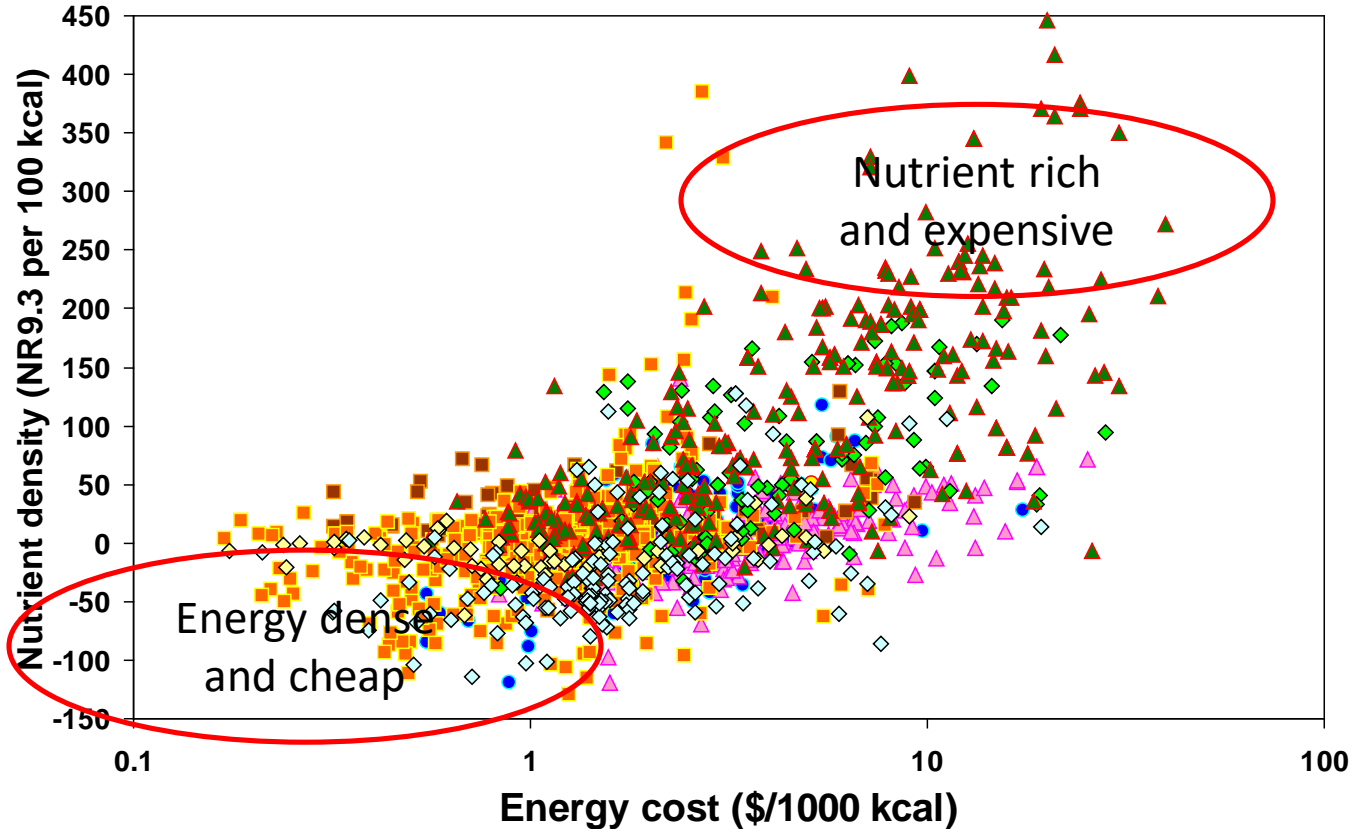
Access to Nutrition Index (ATNI)

- ATNI 2018 questions. Does the company have a nutrient profiling (NP) system? If yes:
  - Is the NP system used for product development or reformulation?
  - Which products and categories are covered by the NP system?
  - Where does the company publish its NP system for public access?
  - **How did the company develop its NP system?**

GLOBAL INDEX 2018 **OVERALL RANKING**

1	Nestlé ⬛	6.8
2	Unilever	6.7
3	Danone ⬛	6.3
4	FrieslandCampina ⬛	6.0
5	Mondelez	5.9
6	Mars	5.6
7	PepsiCo	5.2
8	Kellogg	5.0
8	Grupo Bimbo	5.0
10	Campbell's	4.0
11	Arla	3.3
12	Ferrero	3.2
13	Coca-Cola	3.0
14	Ajinomoto	2.4
15	General Mills	2.3
16	ConAgra ▲	1.4
17	Meiji	0.8
18	BRF ▲	0.5
19	Suntory ▲	0.1
20	Tingyi ▲	0.0
20	Kraft Heinz ⬛ ▲	0.0
20	Lactalis ▲	0.0

⬛ Assessed against the BMS methodology: An adjustment based on the BMS score is incorporated in the overall score
▲ Did not provide information to ATNF

● Category A ● Category B ● Category C ● Category D ● Category E ● Category F ● Category G

New emphasis on plant-forward diets
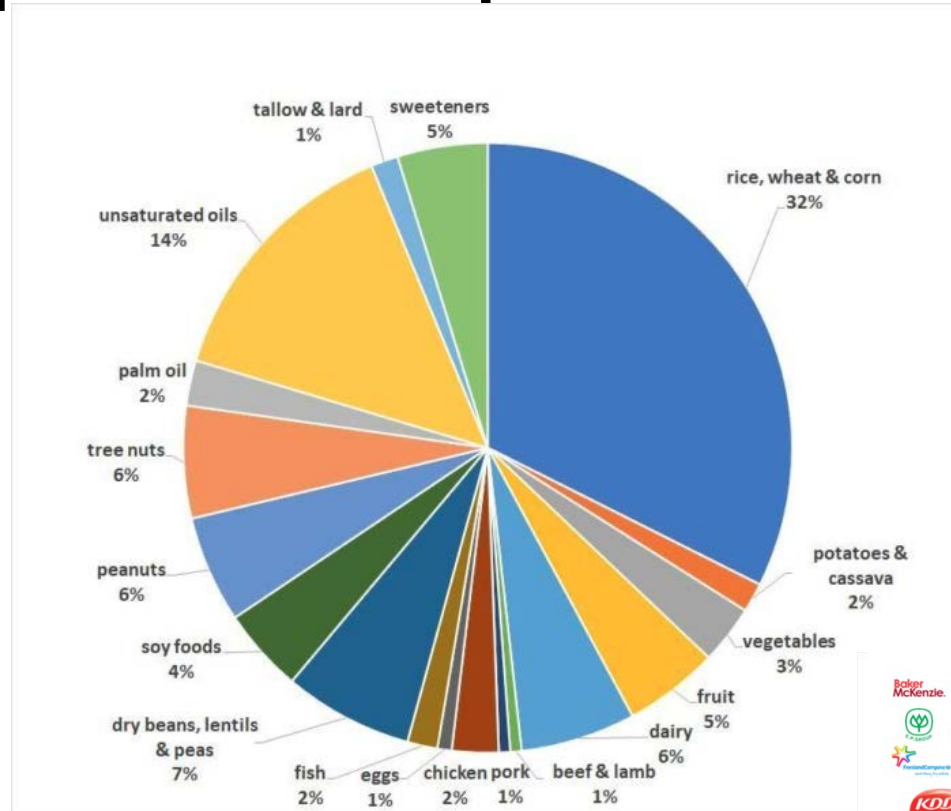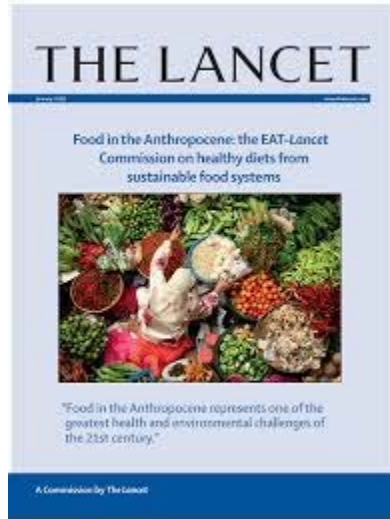
Requires a new focus on protein quality

- The FSA Ofcom model awards points for protein.

Points	Fruit, Veg & Nuts (%)	NSP Fibre (g)	or AOAC Fibre (g)	Protein (g)
0	≤ 40	≤ 0.7	≤ 0.9	≤ 1.6
1	>40	>0.7	>0.9	>1.6
2	>60	>1.4	>1.9	>3.2
3	-	>2.1	>2.8	>4.8
4	-	>2.8	>3.7	>6.4
5	>80	>3.5	>4.7	>8.0

- Protein is calculated per 100g.
- No distinction between animal and plant protein (or dairy)

Protein content in grams per 100 g
Data for 378 foods from Fred Hutch food frequency questionnaire
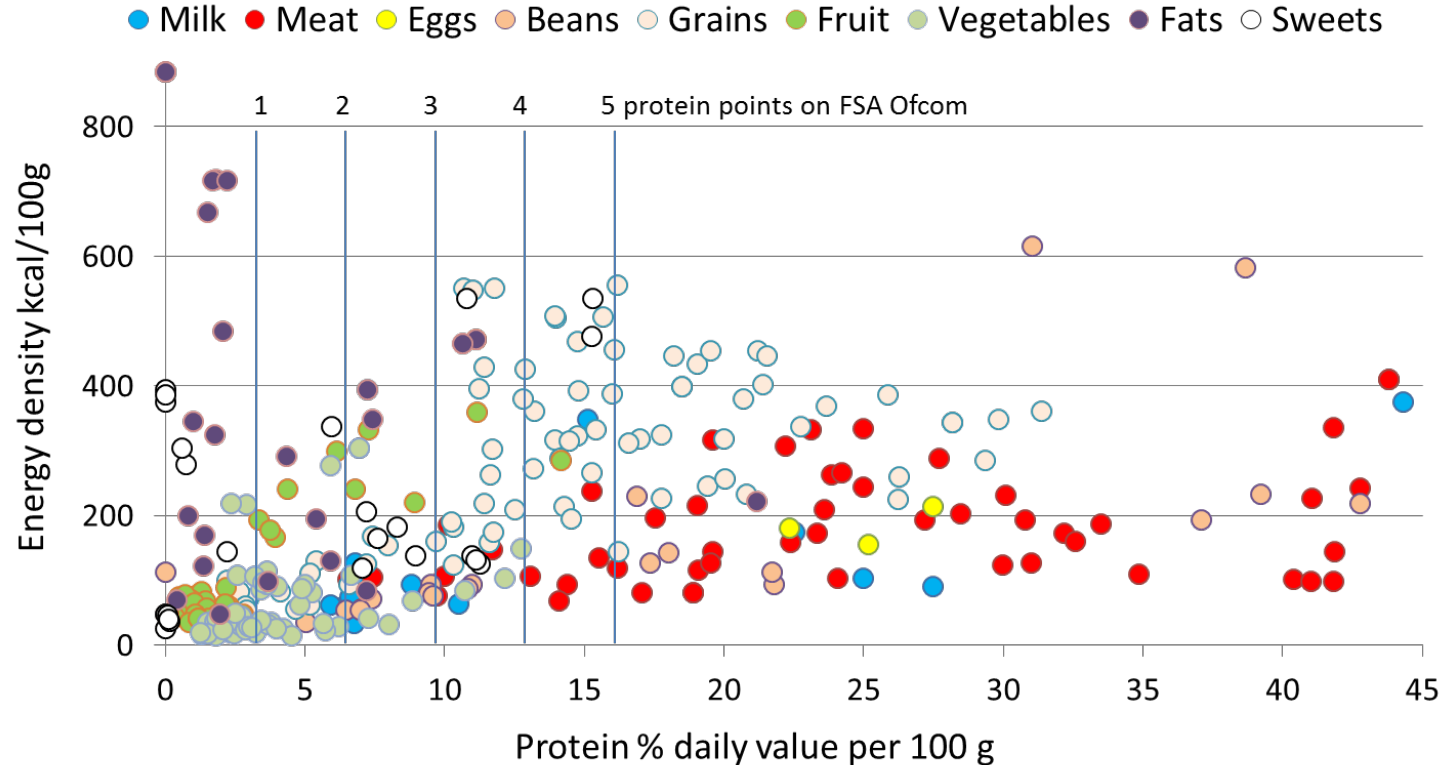
Protein content in % DV per 100 kcal
Data for 378 foods from Fred Hutch food frequency questionnaire
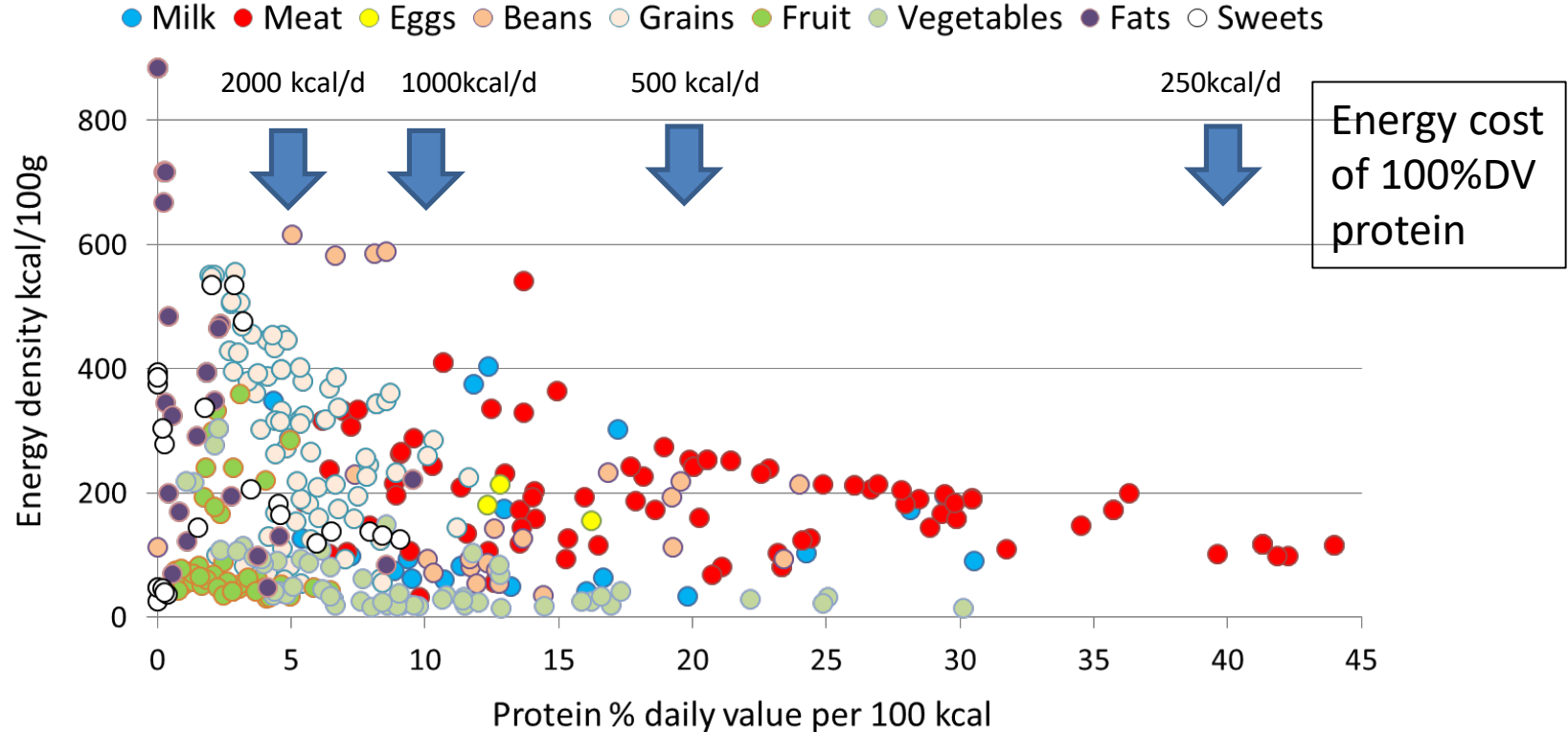
Protein quality is not the same: adjust
Protein Digestibility Corrected Amino Acid Score (PDCAAS)
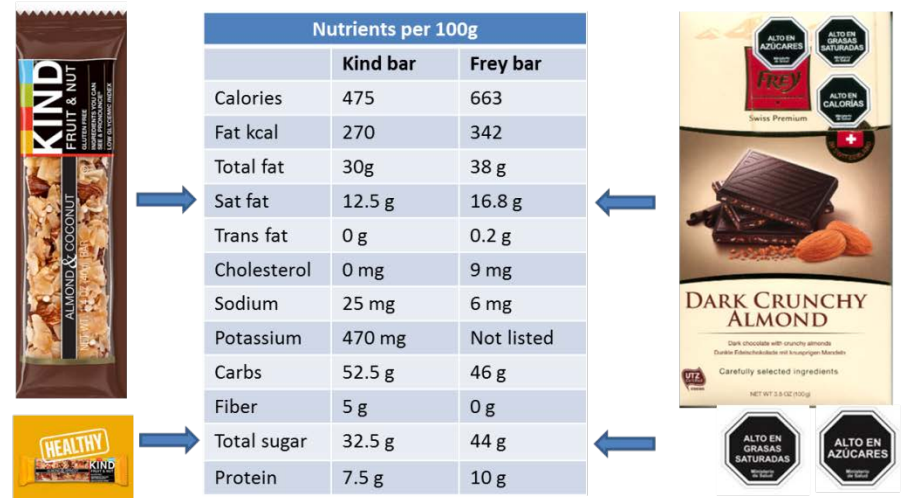
- Compared to milk, plant proteins are not always of the same high quality.

- Protein content in nutrient profiling models (NP) may need to be adjusted by protein source or byPDCAAS.

- New adjusted NRFn.3 scores are under development.

- Weighting needs to be given careful attention.

Protein source	Factor	Protein source	Factor
Cow's milk	1.0	Peas/legumes	0.70
Eggs	1.0	Fruits, fresh	0.64
Casein, whey	1.0	Cereals	0.59
Beef	0.92	Peanuts	0.52
Soy	0.91-1.0	Rice	0.50
Chickpeas, soybeans	0.78	Dried fruit	0.48
Black beans	0.75	Wheat	0.42
Vegetables	0.73	Wheat gluten	0.25

Hybrid NRF scores include ingredients

- The KIND citizen petition asked the FDA to recognize that some food ingredients were intrinsically "healthy".
- Nuts, seeds, dried fruit, milk, and yogurt are healthy, yet they contain fat, saturated fat, sugar and sodium.
- Nutrient profiling is becoming less nutrient- and more food- oriented.
- The Chile paradox also applies to cereals.

Two almond bars: US and Chile

Nutrients per 100g	Kind bar	Frey bar
Calories	475	663
Fat kcal	270	342
Total fat	30g	38 g
Sat fat	12.5 g	16.8 g
Trans fat	0 g	0.2 g
Cholesterol	0 mg	9 mg
Sodium	25 mg	6 mg
Potassium	470 mg	Not listed
Carbs	52.5 g	46 g
Fiber	5 g	0 g
Total sugar	32.5 g	44 g
Protein	7.5 g	10 g

Some concerns about plant milks

Nutrient profiling of plant milks

GOT BOOBS? —
"An almond doesn't lactate"—FDA to crack down on use of the word "milk"

FDA head says current products don't meet labeling standards, guidance coming soon.

BETH MOLE - 7/18/2018, 2:32 PM

FDA commissioner: 'An almond doesn't lactate... we have a standard of identity for milk and I intend to enforce that'

By Elaine Watson
18-Jul-2018 - Last updated on 18-Jul-2018 at 04:54 GMT
3 COMMENTS

'An Almond Doesn't Lactate'

The coming war over nut milks

Mike Riggs from the November 2018 issue - view article in the Digital Edition

The increasing availability of plant-based alternatives to products
a blessing for vegans, vegetarians, and others who—for reasons
based fare. If milk makes you gassy, you can buy a white, milk-like
coconuts. If you love the texture of beef but not the idea of eating
with a meaty texture that bleed beet juice.
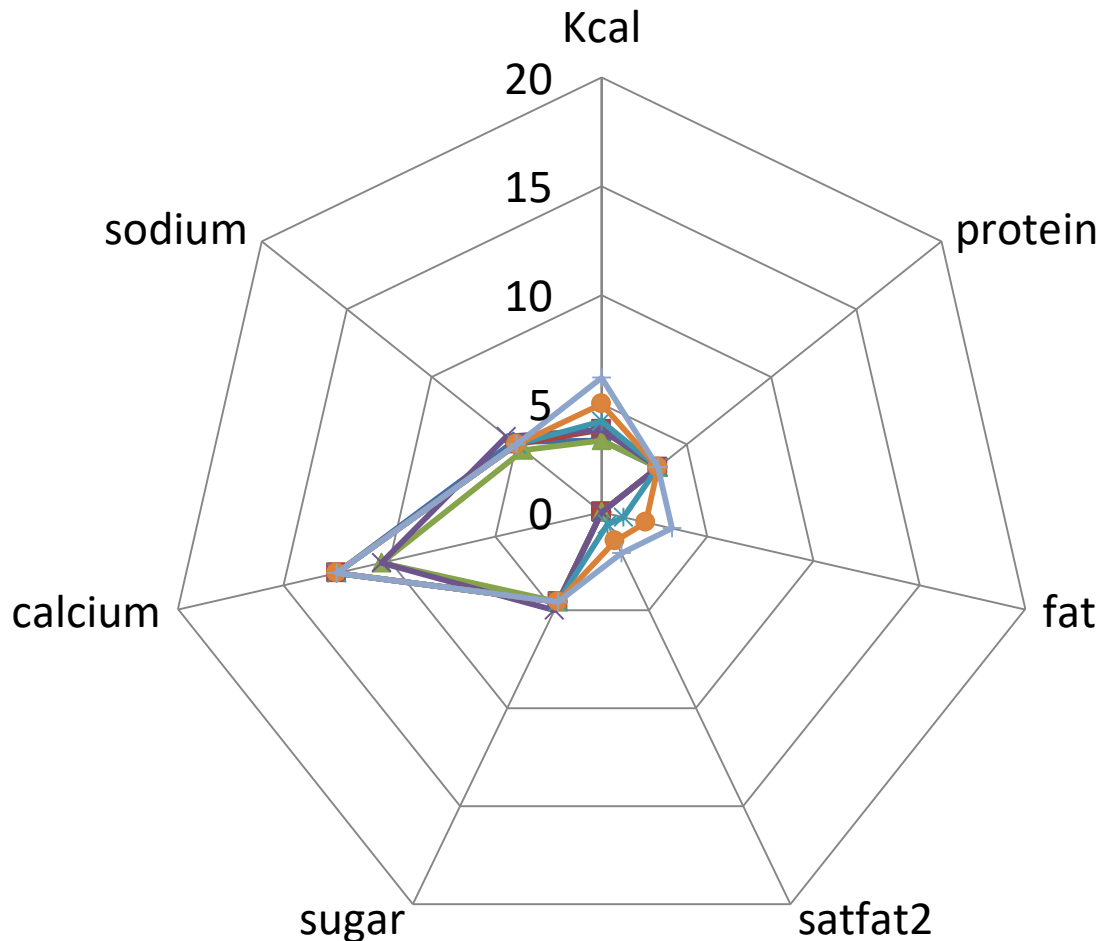
Legend:
- milk skim whole foods
- milk skim harris teeter
- milk skim food city
- milk, skim target
- milk 1% low fat supervalu
- milk 2% target
- milk whole, target

Nutrition Facts

Serving Size 1 Cup (250ml)
Servings Per Container Approx. 8

Amount Per Serving

Calories 110	Calories from Fat 25

	% Daily Value*
Total Fat 2.5g	4%
Saturated Fat 1.5g	8%
Cholesterol 15mg	5%
Sodium 115mg	5%
Total Carbohydrate 13g	4%
Sugars 13g	
Protein 9g	

Vitamin A 2%	• Calcium 30%

Not a significant source of trans fat, dietary fiber, vitamin C and iron.

*Percent Daily Values are based on a 2,000 calorie diet.

Nutrition Facts

Serving Size: 8 Fl.oz. (238g)
Servings Per Container: 4

Amount Per Serving

Calories 105   Calories from Fat 3

% Daily Value *

	% Daily Value *
Total Fat 0g	0%
Cholesterol 0mg	0%
Sodium 47mg	2%
Total Carbohydrates 20g	7%
Dietary Fiber 1g	3%
Sugars 16g	
Protein 1g	

Vitamin A	0%	* Vitamin C	0%
Calcium	1%	* Iron	2%

* Percent Daily Values are based on a 2,000 calorie diet.

Legend:
- almond milk wwf
- almond milk walmart
- almond milk meijer
- almond milk winn dixie
- almond milk supervalu
- almond milk freshmarket
- almond milk califia farms
- almondmilk+cashewmilk WWF
- cashew milk
- cashewmilk WWF
- cashewmilk Harris-Teeter
- cashewmilk creamy WWF
- coconut milk goya
- coconut milk wwf
- coconut milk safeway
- coconut milk iberia
- coconut milk simply asia
- flax hemp milk
- flax hemp milk go beyond
- vanilla hemp milk daily greens
- nut & oat milks blend forager
- nut+oat milk blend forager
- quinoamilk beverage good groce
- quinoamilk, vanilla good groce
- ricemilk enriched ahold
- soy milk whole foods
- soy milk WWF
- soybean milk, natural
- soy milk, organic

ALMOND MILK (WATER, ALMONDS), PEA PROTEIN, CHICORY ROOT EXTRACT, DRIED CANE SYRUP, RICE PROTEIN, RICE STARCH, PECTIN, TAPIOCA DEXTROSE, NATURAL FLAVOR, ALGIN (KELP EXTRACT), MAGNESIUM PHOSPHATE, TRICALCIUM PHOSPHATE, LOCUST BEAN GUM, LIVE CULTURES, CITRIC ACID, MONK FRUIT EXTRACT, VITAMIN D2, VITAMIN B12. Date Available: 04/27/2018

Are plant milks "ultra-processed foods"?

A focus on carbon footprint

Environmental impact of foods is often expressed per kg of food weight (that is per water content)

It ought to be expressed per 2000 kcal/d
Or per nutrient

Summary

- NP models capture nutrient density of foods using:
  - Nutrients and/or dietary ingredients,
  - Protein quality.
- We need to adjust NP models for protein quality.
- We need to express GHGEs per kcal or nutrient
- Are GHGEs driven largely by need for high quality protein?

Thank you

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