Interaction of Climate Change and Food Systems

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  - Program Director-Nutrition @ NIH/Eunice Kennedy Shriver National Institute for Child Health and Disease
  - Co-Chair, American Society for Nutrition Climate/environmental change, Health Agriculture and Improving Nutrition (CHAIN) Research Interest Section
  - Research focus on micronutrients

Objectives

- Define the parts of a food system
- Describe how at least four parts of the food system influence or are influenced by climate change
- Compare and contrast the diets, and nutritional and climate implications of those diets in the developing vs developed world
- Identify solutions for climate change and the food system

Food System

- All parts of producing the food and getting it to the consumer

- What parts can you name?
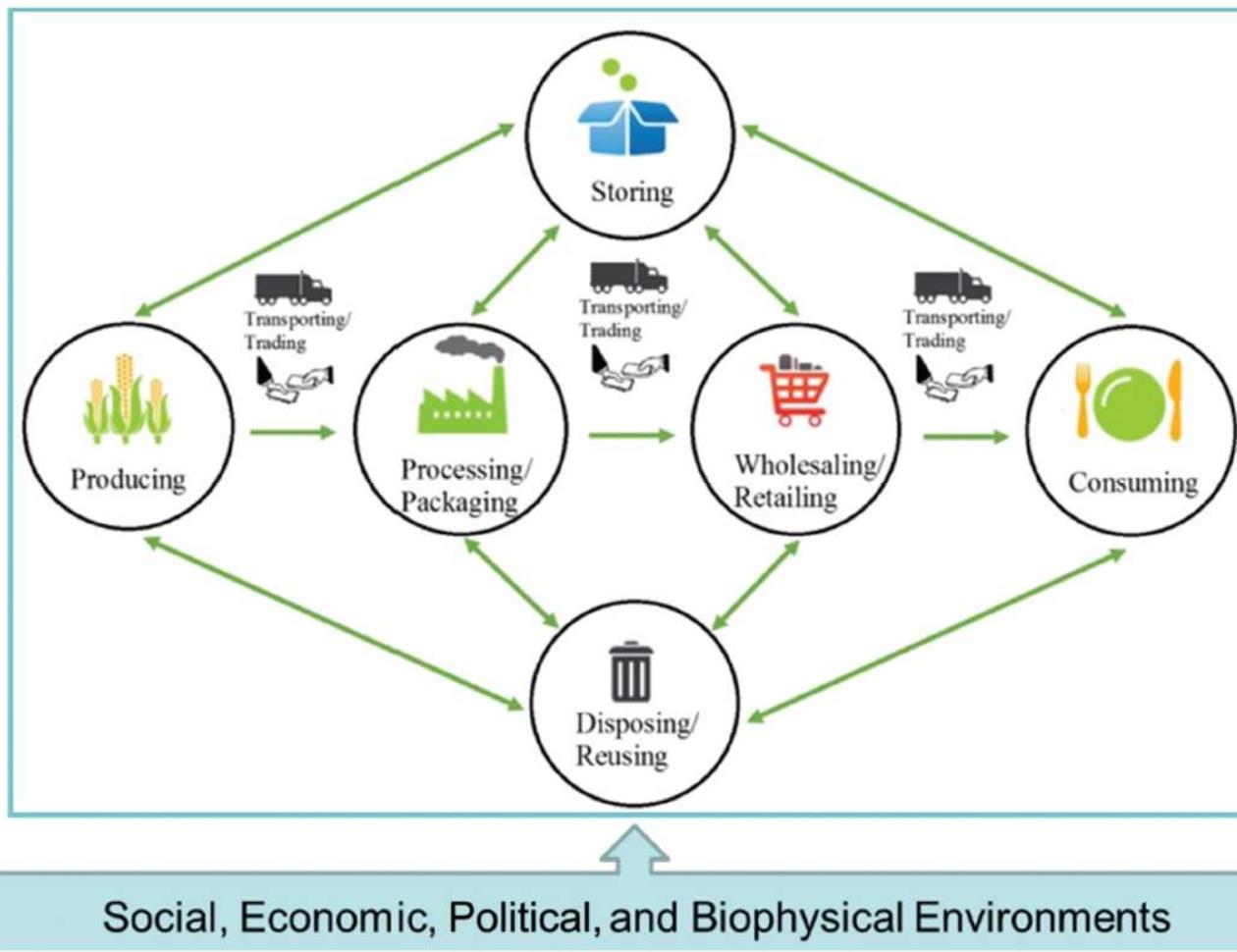
FIGURE 2 Food system activities as driven by a wide set of environments.

Social, Economic, Political, and Biophysical Environments

Drewnowski 2020
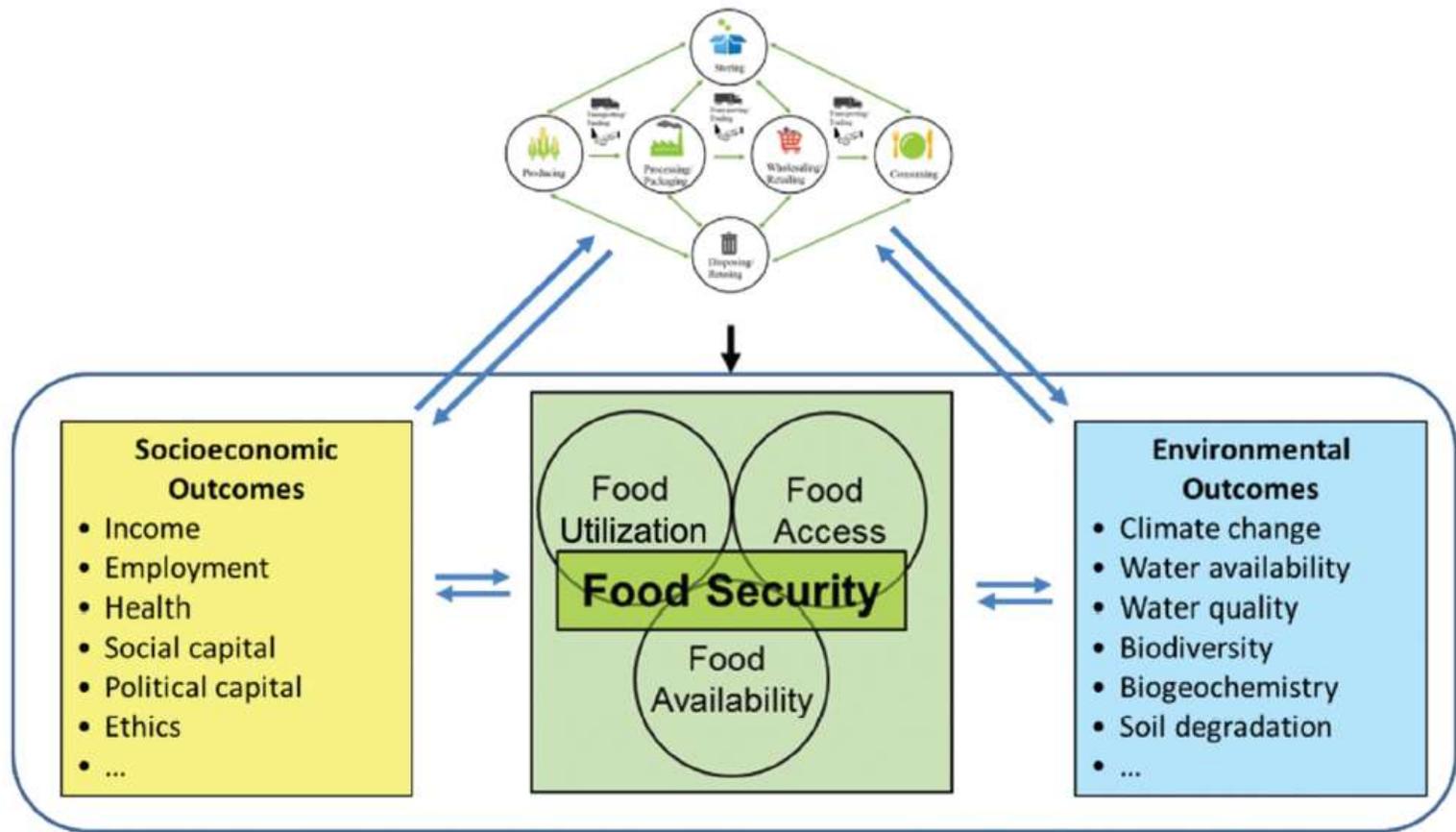
FIGURE 3 Food system outcomes for food security, other socioeconomic goals, and environment.

Drewnowski
2020

Climate Change Influencing Food Systems
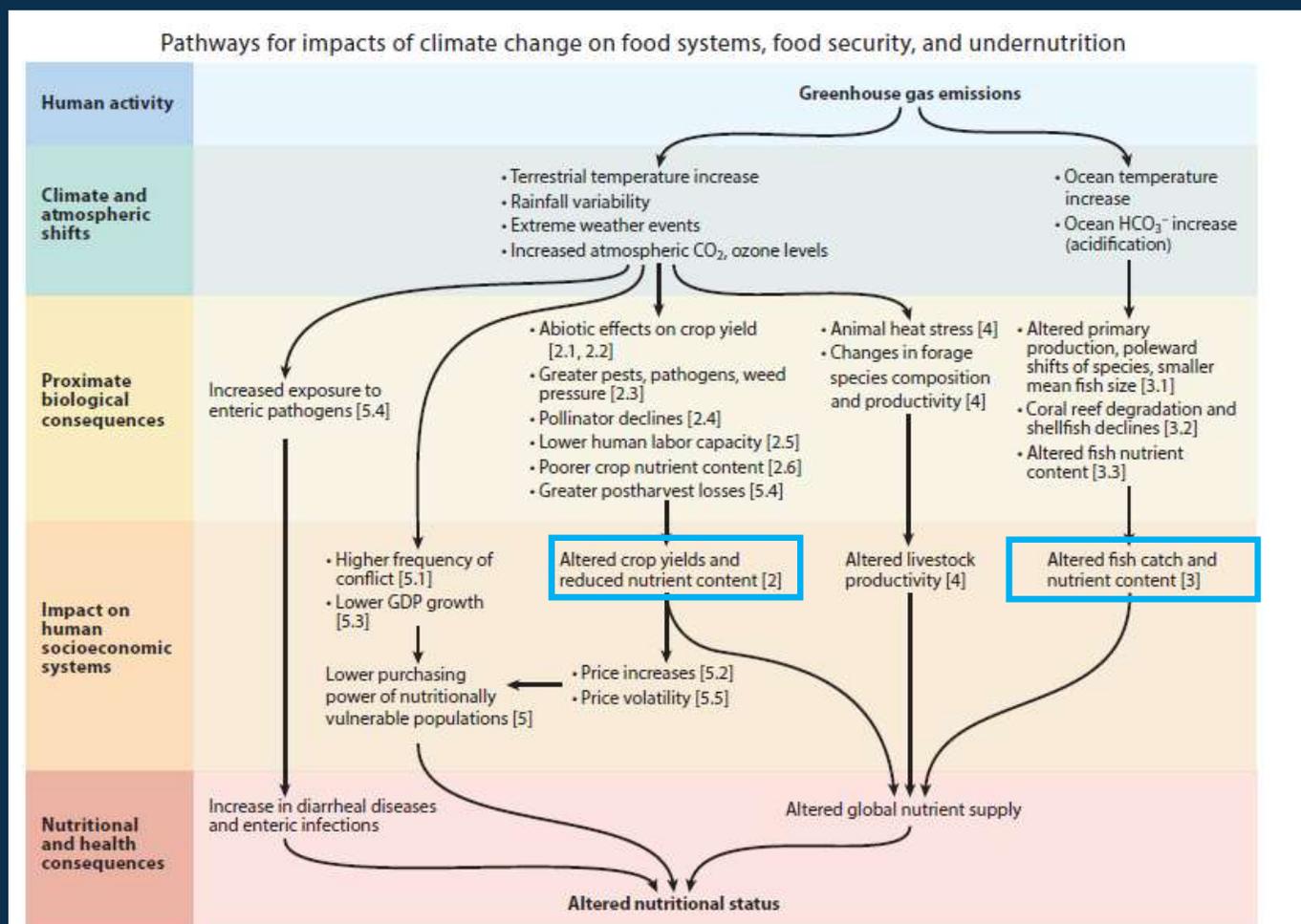
Figure 2

Anthropogenic greenhouse gas emissions are likely to impact human nutritional status through a cascading set of biophysical and socioeconomic changes. Details for the mechanisms and impacts of each cause may be found in the text sections provided in brackets.

Myers et al 2017

Climate change and crop quality

- Increased atmospheric CO_2
  - Reduction in protein content by 7-15% in rice, wheat, barley, potatoes
    - Would cause 200 million people to fall short of protein recommendations
  - Reduction in zinc and iron content by 3-11% in cereal grains, legumes
    - Would cause 150-200 million new cases of zinc deficiency
  - Reduction in other minerals in more extreme conditions

Myers et al 2017

Climate change and arable land

- Increased heat
- Decreased water availability
  - Both decrease yield especially for maize and wheat
- Increased atmospheric CO_2
  - Increases yield for some plants (wheat, rice, soy)

- May see an increase in need for arable land
  - May see a shift in what crops are grown where
  - May see a shift to pasture land (grazing)→own unintended consequences

Myers et al 2017;
Raiten & Combs 2019

Climate change and marine foods

- Seafood is important source of protein, fatty acids, vitamins, and minerals
- 1% decline in fish catch annually regardless of climate change
- Fishing rates are unsustainable
- Warming seas
  - Decrease potential fish catch 3-13% by 2050
  - Potential decrease in fatty acid, mineral content of fish

Myers et al 2017

Food Systems influencing Climate Change

Lifecycle analysis/assessment (LCA)

- Lifecycle analysis is the attempt to measure all of these steps together
- 4 phases:
  - Goal and scope
  - Life cycle inventory
  - Life cycle impact assessment
  - Interpretation

Cucurachi et al 2019

Beef Production→Methane Production

- Ruminants produce methane (CH4) via digestion
- Single dairy cow produces 70-120 kg CH4/year
- Animal agriculture contributes 3.9% of GHG in US
  - Compare to 80% from transportation, industry, power
- Animal source foods in the US contribute 0.6% of total global emissions
- Plant foods in the US contribute 0.5% of total global emissions

Raiten & Combs 2019;
Raiten et al 2020

Almond Production→Water Utilization
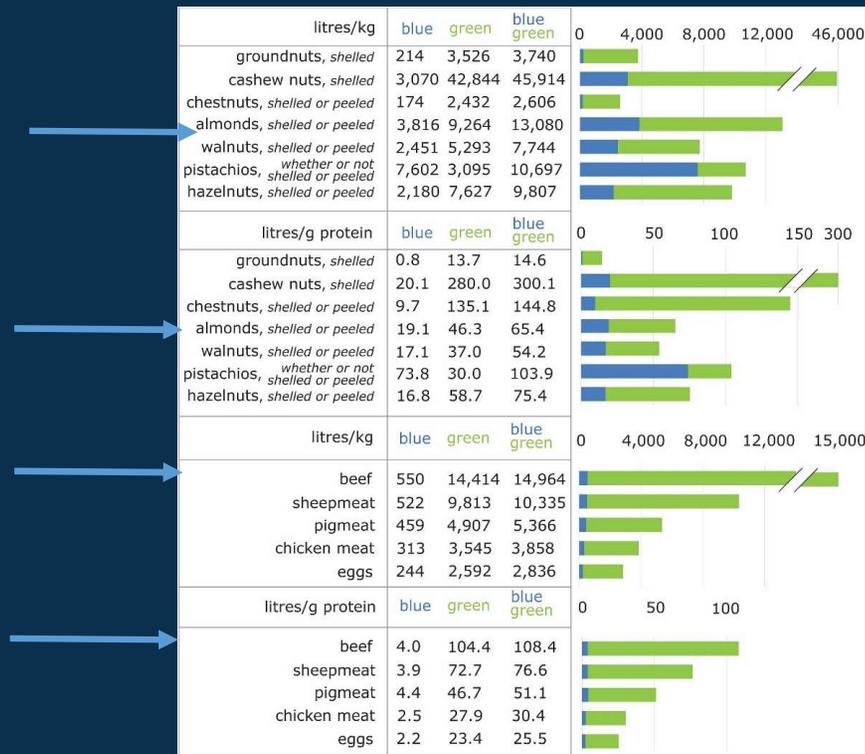
Almonds→exacerbate water stress

Vanham et al 2020
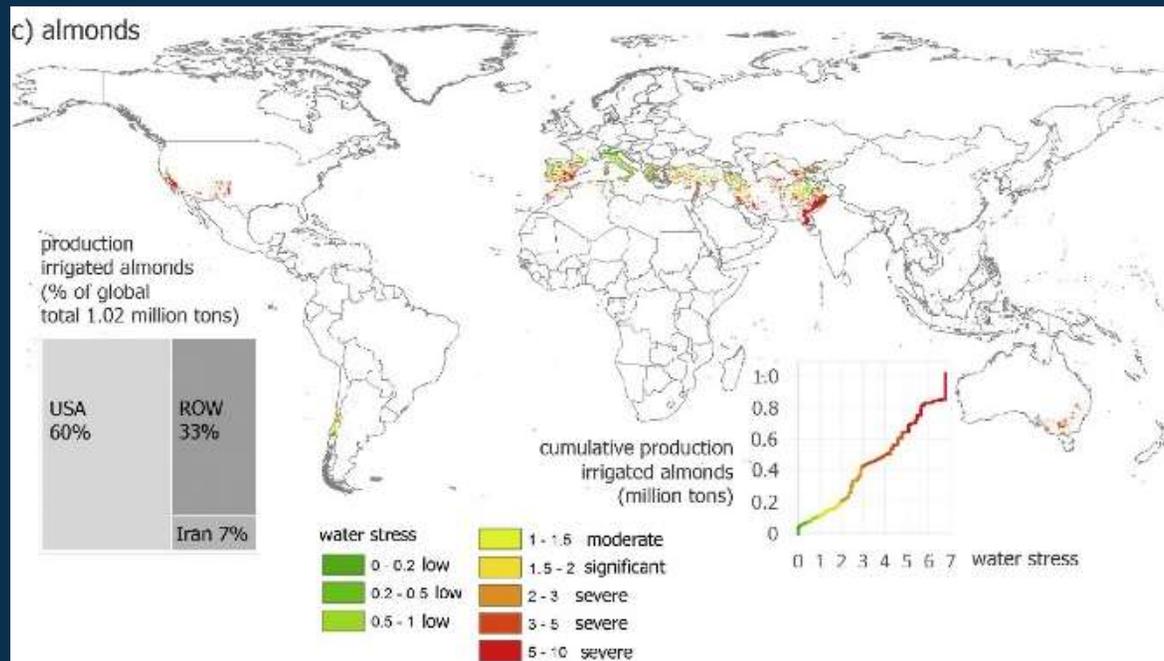
Scope of Food Waste

Figure 4 | Food loss and waste primarily occurs closer to the consumer in developed regions and closer to the farmer in developing regions
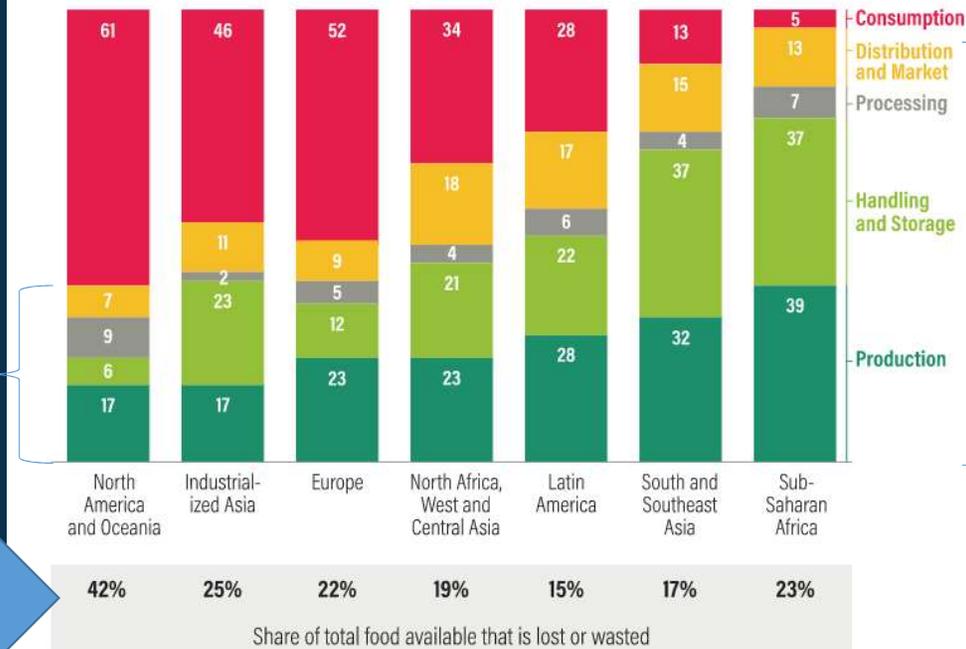
Loss: Imperfect produce, overly cautious sell-by dates

Spoilage during transportation/storage; unable to harvest at ideal time

We waste/lose MORE food but at different points

Graph: World Resources Report 2019
Annotations: Droward 2012

Food waste and climate change

- Wasted food into landfills→anaerobic decomposition→methane
  - Pre-consumer loss is less likely to go into landfills (composted, used for animal feed)
- Leads to food overproduction which wastes resources (land, water)/produces GHG pointlessly

- 1/7 people in the world live in hunger
- Their needs could be met with 50% of the existing food waste!!!!!

Droward 2012

Towards a more sustainable diet

EAT-LANCET Report

About EAT

EAT is a global, non-profit foundation established by the Stordalen Foundation, Stockholm Resilience Centre and Wellcome Trust to catalyze a food system transformation.

Our vision:

A fair and sustainable global food system for healthy people and planet – leaving no one behind.

Our mission:

Transform our global food system through sound science, impatient disruption and novel partnerships.

SCIENCE   POLICY

EAT
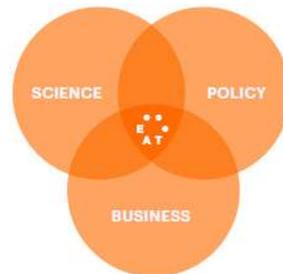
BUSINESS

To ensure success, we connect and partner across science, policy, business and civil society to achieve **five urgent and radical transformations by 2050:**

- Shift the world to healthy, tasty and sustainable diets
- Realign food system priorities for people and planet
- Produce more of the right food, from less
- Safeguard our land and oceans
- Radically reduce food losses and waste

The EAT-Lancet Commission

Co-chaired by Prof. Walter Willett and Prof. Johan Rockström, the EAT-*Lancet* Commission brought together 19 Commissioners and 18 co-authors from 16 countries in various fields including human health, agriculture, political science and environmental sustainability.

Prof. Walter Willett MD
Harvard T.H. Chan School of Public Health, Harvard Medical School & Channing Division of Network Medicine, Brigham and Women's Hospital

Prof. Johan Rockström PhD
Potsdam Institute for Climate Impact Research & Stockholm Resilience Centre

The Stockholm Resilience Centre hosted the EAT-*Lancet* Commission secretariat and co-led the Commission's research activities with EAT. All Commissioners and co-authors contributed to the manuscript ideas, structure, and reviewing and have seen and approved the final version of the manuscript.

EAT-Lancet
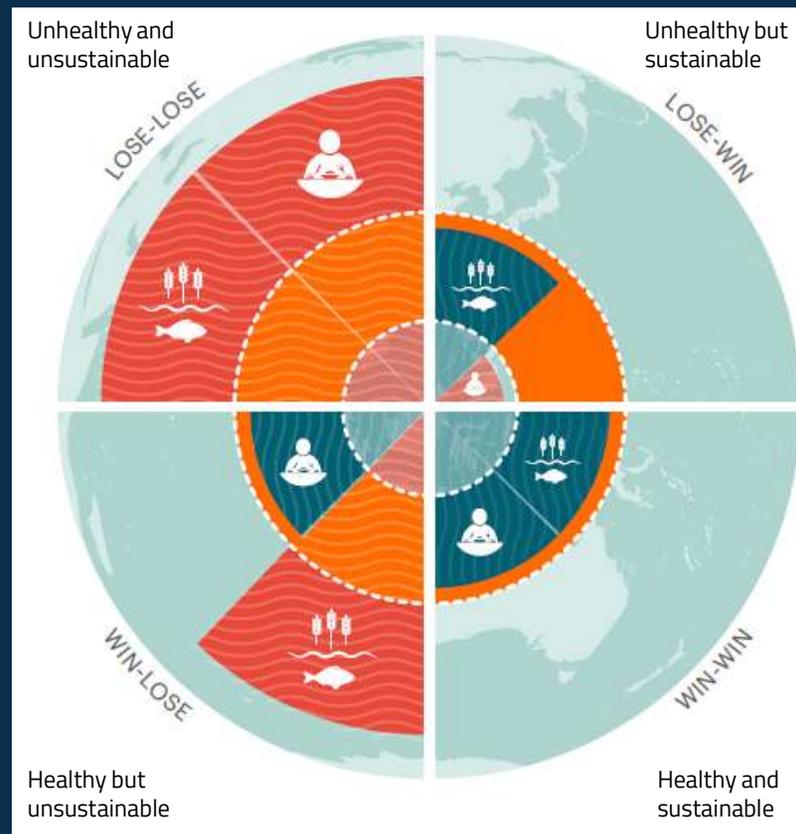
EAT-Lancet Diet for Planetary Health

		Macronutrient intake grams per day (possible range)	Caloric intake kcal per day
	Whole grains **Rice, wheat, corn and other**	232	811
	Tubers or starchy vegetables **Potatoes and cassava**	50 (0–100)	39
	Vegetables **All vegetables**	300 (200–600)	78
	Fruits **All fruits**	200 (100–300)	126
	Dairy foods **Whole milk or equivalents**	250 (0–500)	153
	Protein sources		
	Beef, lamb and pork	14 (0–28)	30
	Chicken and other poultry	29 (0–58)	62
	Eggs	13 (0–25)	19
	Fish	28 (0–100)	40
	Legumes	75 (0–100)	284
	Nuts	50 (0–75)	291
	Added fats		
	Unsaturated oils	40 (20–80)	354
	Saturated oils	11.8 (0-11.8)	96
	Added sugars **All sugars**	31 (0–31)	120

Table 1
Scientific targets for a planetary health diet, with possible ranges, for an intake of 2500 kcal/day.

FIGURE 3 Regional dietary intakes compared to the EAT–*Lancet* healthy reference diet. Source: Willett et al. (6). Credit: EAT Foundation.

Fanzo et al 2020

Changes in production to meet EAT-Lancet

FIGURE 5 Necessary changes in global food production by 2050 in business as usual with full food waste (yellow) and to deliver the EAT–*Lancet* healthy reference diet with half food waste (green). Source: Willett et al. (6). Credit: EAT Foundation.

Fanzo et al 2020
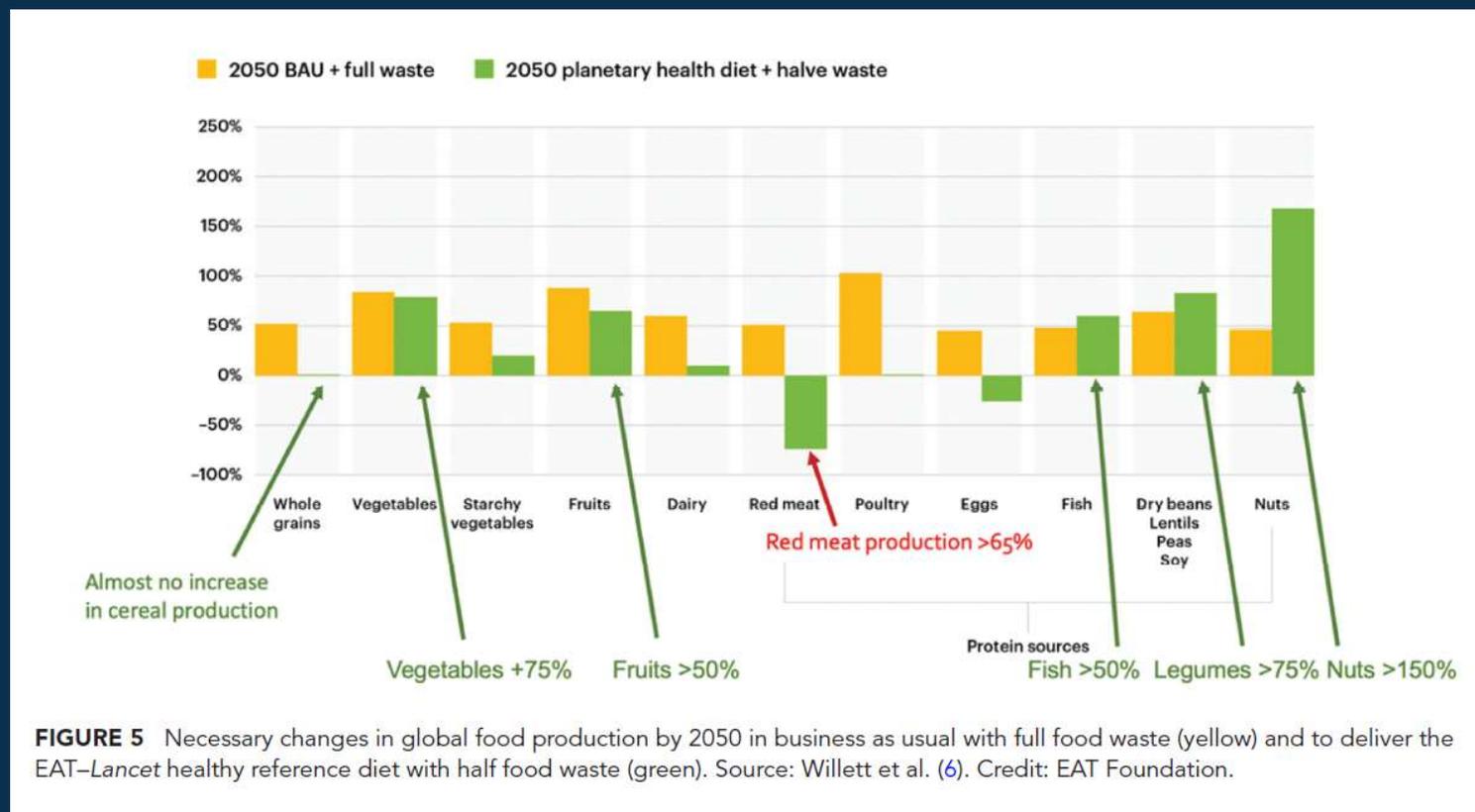
Criticisms

- Does EAT-Lancet apply everywhere?
    - Didn't consider cultural aspects
- Potentially inadequate B12 and B2, other analyses suggest inadequate calcium, iron, vitamin D, vitamin B12
- Cost

- Individual actions are unsustainable—must be a package
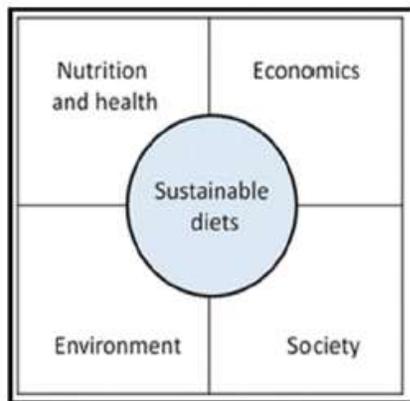
Fanzo et al 2020;
Raiten et al 2020
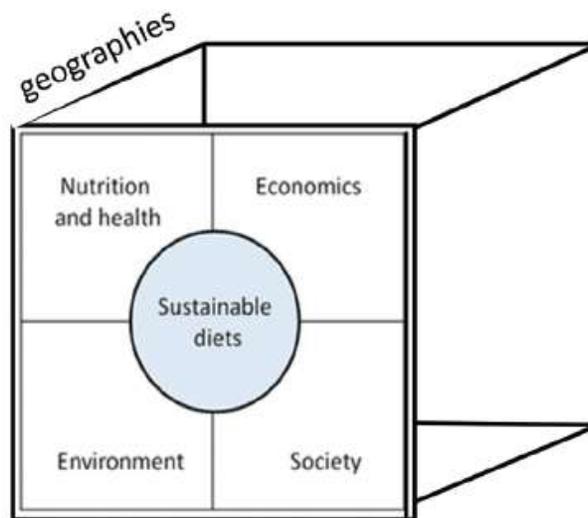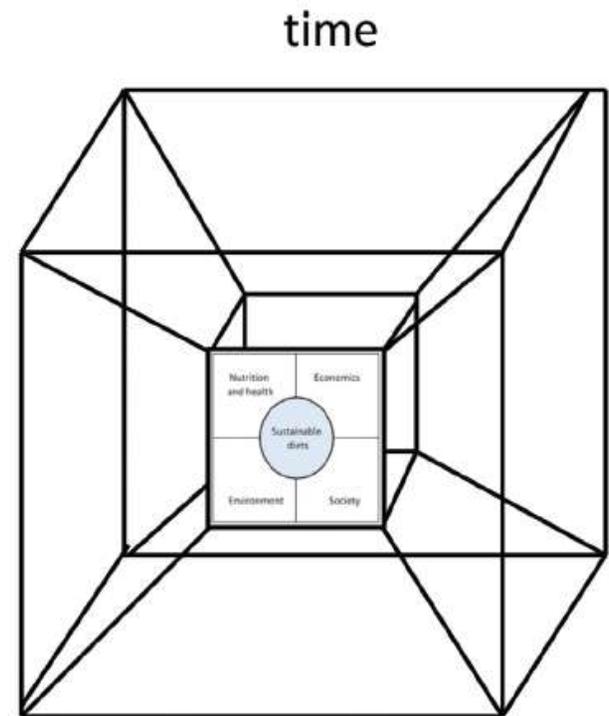
FIGURE 6 The 4-dimensional tesseract model of sustainable diets adding space and time.

Dietary needs vary by time/place

Developed World (specifically US)

- Overweight and Obesity
- Sometimes paired with micronutrient malnutrition
  - Iron deficiency anemia is not absent
- Diets generally adequate to excessive in animal source foods
- In US, 2/3 of dietary protein comes from animal source foods

Developing World

- Iron Deficiency Anemia
- Stunting
  - Overweight and obesity are not absent
- Diets have migrated away from traditional patterns and towards grain crops
- Diets generally inadequate to poor in animal source foods

Raiten et al 2020

Box 2 The global health context

Malnutrition, NCDs and the 'Dual Burden' (overnutrition and undernutrition) [18]

- Childhood underweight remains the 8th highest contributor to overall global disease burden despite significant improvements.
- Among children <5 years, childhood underweight was the leading risk factor worldwide in 2010.
- In most of sub-Saharan Africa (except southern Africa), the share of disease burden attributable to these 3 risk factors has fallen substantially; yet, they remain the leading causes <5 years disease burden.
- High body-mass index (BMI) has increased in the US and globally to become the 6th risk worldwide.
- 2 of 3 overweight/obese people live in developing countries, the vast majority in emerging markets and transition economies.
- The importance of a definition of diet quality within the context of food security has been highlighted by the emphasis on the global risk attributable to poor dietary quality, including excess dietary sodium and insufficient intake of fruit, nuts/seeds, whole grains, vegetables and seafood.
- Diet-related chronic diseases account for more than half of the world's diseases and hundreds of millions of dollars in public expenditure.

Box 2; Raiten & Aimone 2017

Why?

- Calories (energy rich foods) are cheap and easy to grow

- Governments/the "Green Revolution" have encouraged the production of energy rich foods

- "Nutrition transition" may be exacerbated by climate change

Drewnowski 2020;
Fanzo et al 2020;
Raiten & Aimone 2017

Drewnowski 2020
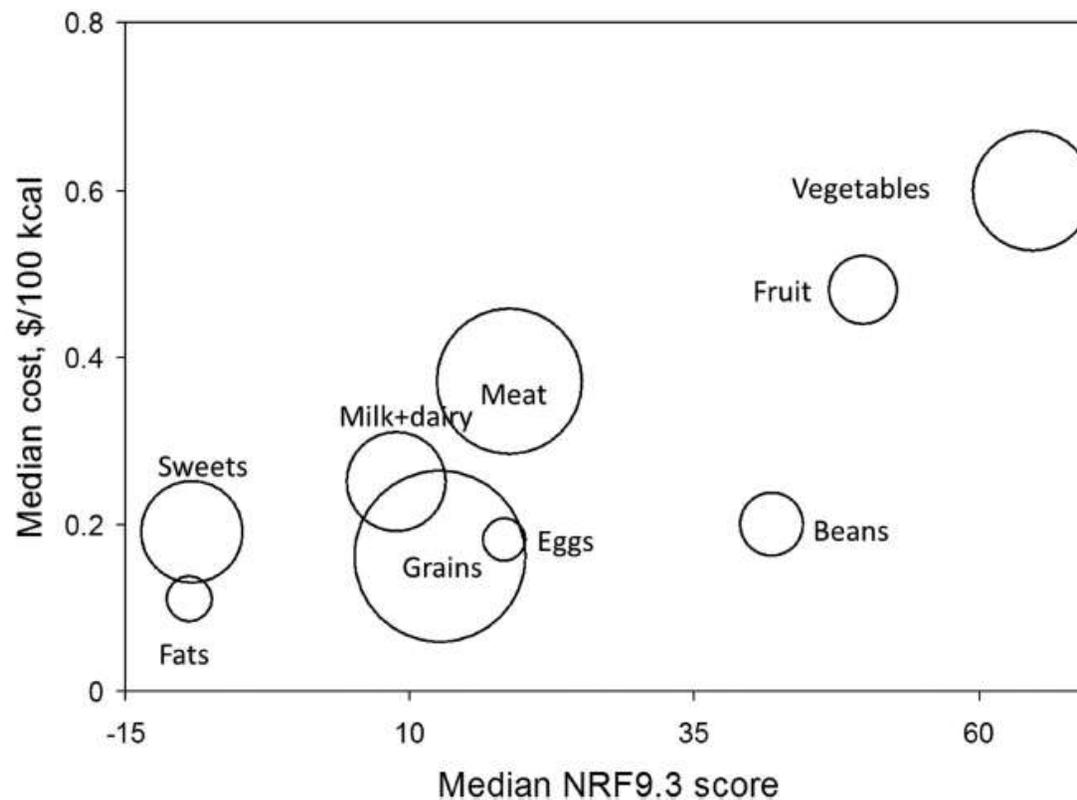
FIGURE 8 The relation between median NRF9.3 nutrient density scores and median national food prices by USDA major food group. NRF, Nutrient-Rich Food.

So...

- Be careful about blanket recommendations to eat less animal source food (ASF)

- More equitable distribution of ASF intake would probably be wise→ie eat less ASF for many but not all people in the US
  - Differentiate between ASF
    - Ruminant (cows) vs non-ruminant meat vs dairy and eggs

Effects of foods on climate change also vary by time/place

- Dairy produces 4% of greenhouse gases globally

- BUT "North American and European dairy cows produce 4X more milk than the global average cow"→lowest greenhouse gas per gallon

- Developing nations need 10-20 cows to produce the same amount of milk as a US cow
  - this is also where ASF intake needs to increase to meet dietary needs

Drewnowski 2020;
Raiten et al 2020

Technology

- Need to adopt technologies to improve the efficiency of growing nutrient rich foods
  - CRSPR-Cas9
    - Will this be acceptable to people?

- Up to this point, biotech advances have allowed us to adapt to climate change, but there will be a breaking point

World Resources Report 2019;
Raiten & Aimone 2017;
EAT-Lancet

We all eat

—so what can you do?

Individual Actions

- Avoid food waste
- Remember that in the developed world, most waste takes place at the consumer level
    - Consider composting
        - Be a savvy consumer regarding sell-by/best-by dates
- Moderate but don't necessarily eliminate intake of animal source foods
    - Meatless Monday, Meatless meals

EAT-Lancet;
Meyers 2017

Savvy Label Reading

- Examples of commonly used phrases:
- **"Best if Used By/Before"** date
  - indicates when a product will be of best flavor or quality. **It is not a purchase or safety date.**
- **"Sell-By"** date
  - tells the store how long to display the product for sale for inventory management. **It is not a safety date.**
- **"Use-By"** date
  - is the last date recommended for the use of the product while at peak quality. **It is not a safety date** except for when used on infant formula.
- **"Freeze-By"** date
  - indicates when a product should be frozen to maintain peak quality. **It is not a purchase or safety date**.

https://www.foodsafety.gov/keep-food-safe/foodkeeper-app
https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/food-labeling/food-product-dating/food-product-dating

Policy/Advocacy Actions

- Let politicians know you care about these issues
  - Allow sustainability to be considered in Dietary Guidelines for Americans
- Redirect farm subsidies towards sustainability goals
- Advocate for research and development of new food system technologies
- Provide food system aid to developing countries in a way that recognizes the value of local foodways

EAT Lancet
World Resources Report 2019

Takeaways

- This is complicated
    - Relationships are bi-directional
    - Must account for health needs
    - Use approaches that account for complexity and interrelationships
- Individual solutions are inadequate—systems/policy change required
- Solutions are not static
- This is urgent!

Questions?

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