

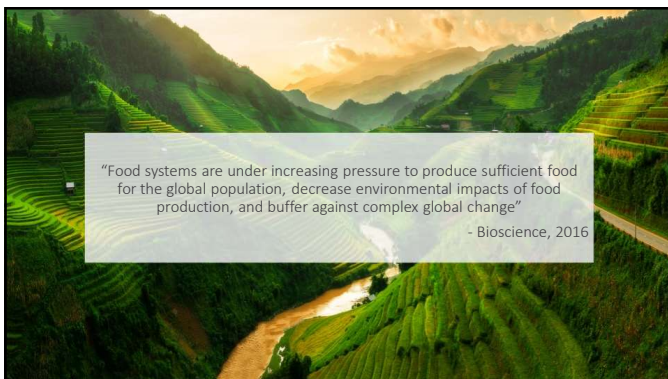


1

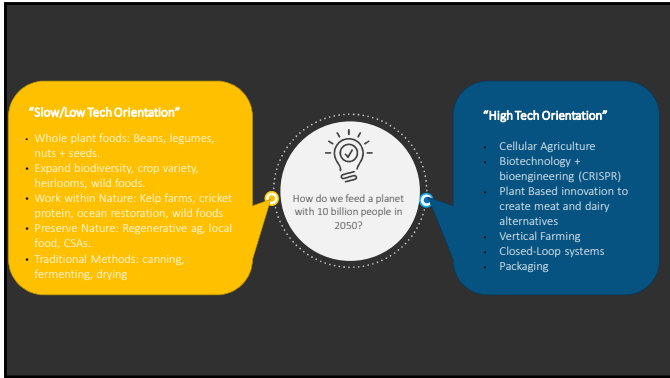
Learning objectives

- 1 List three ways agriculture systems interact with planetary boundaries.
- 2 Define two future forms of agricultural production, and one benefit and drawback to each.
- 3 Identify two foods that have emerged using advancements in technology, and their potential impact on future food systems.

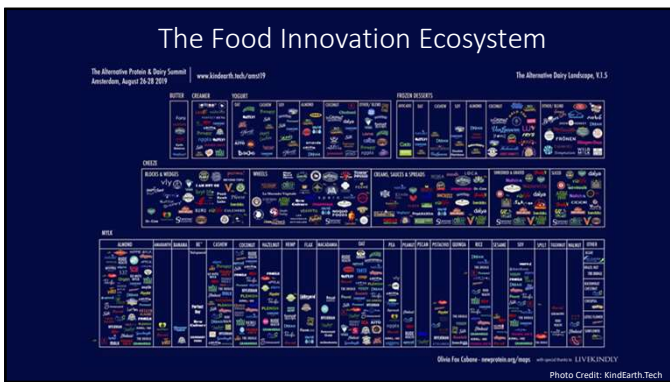
2



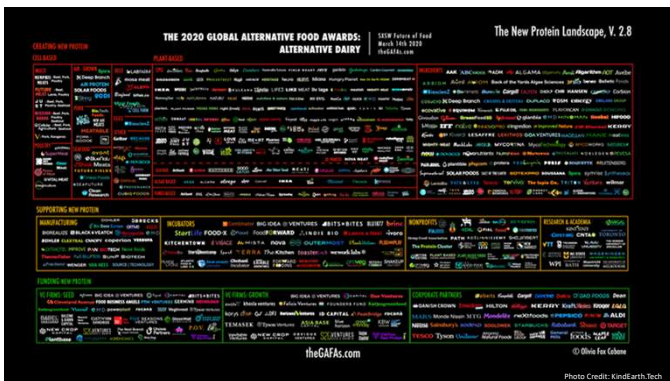
3



4



5



6

Agriculture Impacts all 4 Dimensions of Sustainable Diets

Socio-cultural

- Gender equity
- Food security
- Culturally appropriate
- Indigenous peoples
- Animal welfare

Planetary Health

- Land use change
- Biodiversity loss
- Greenhouse gas emissions (GHGe)
- Food loss and waste

Economic

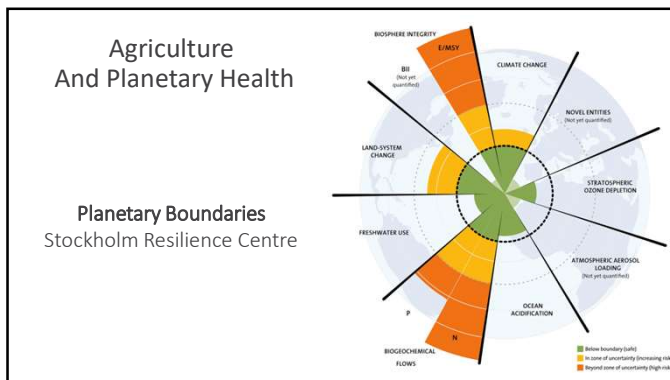
- Profits & revenue
- Jobs
- Fair wages
- Affordability

Nutrition

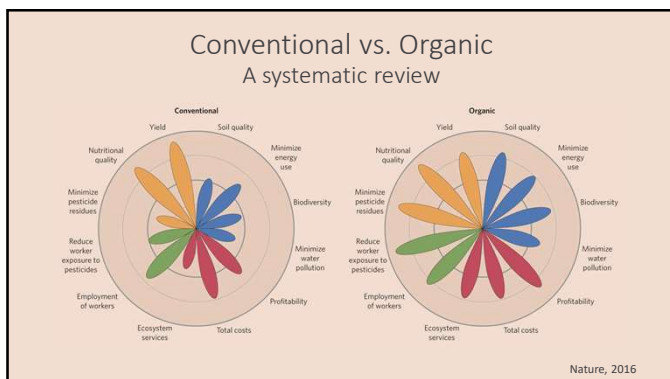
- Triple burden of malnutrition
- Access to diverse foods
- Food Safety

World health organization, 2019; BCFN 2015

7



8



9

Organic Agriculture and Planetary Boundaries

Climate Change

- Organic farming practices sequester significantly more carbon in the soil, (Science, 2004, Rodale Institute 2011)
- Organic farming reduces fossil fuel consumption and releases 40% fewer carbon emissions (AAP 2012, Rodale Institute 2011)
- Organic farming outperforms conventional practices in years of drought, and are more resilient to temperature extremes (HEN 2014)

Freshwater

- 15-20% more water percolates through organic systems, replenishing ground table and helping crops perform well in extreme temperatures (Rodale Institute 2011)

Biodiversity

- Pollinator Services (PLoS One, 2014)
- Enhance soil fertility, enhance soil microbial activity and abundance (Applied Ecology, 2019, PLoS One, 2017)
- Crop Rotation and Cover Crops (USDA NOP, 2015)

Nitrogen and Phosphorus

- Healthy soil more efficiently recycles Nitrogen and Phosphorus (Sustainable Agriculture Research, 2014)
- Organic farming practices reduces pesticide, fertilizer and other chemical runoff, protecting local land and waterways (HEN, 2014)

10

Organics : Evidence of 3 primary benefits

American Academy of Pediatrics
Organic Foods: Health and Environmental Advantages and Disadvantages

Joel Forman, Janet Silverstein, COMMITTEE ON NUTRITION and COUNCIL ON ENVIRONMENTAL HEALTH

ABSTRACT: The US market for organic foods has grown from \$3.5 billion in 1996 to \$28.6 billion in 2010, according to the Organic Trade Association. Organic products are now sold in specialty stores and conventional supermarkets. Organic products contain numerous ...

Pesticide exposure, food safety and human health: (AAP 2012, HEN, 2014, PLoS Med 2018)

- Pesticide exposure. Organic produce consistently has lower pesticide levels than conventional produce. Pregnant and nursing women, infant and young children are at potentially greater risk from organophosphate pesticides, due to rapidly dividing cells, smaller body weights and the establishment of critical metabolic, hormonal and cognitive pathways.
- Antibiotic-resistant bacteria. Choosing organic foods can help reduce risk of exposure to antibiotic resistant bacteria, and could contribute to a reduction in the threat of human disease by drug-resistant organisms.
- Farmworkers/farmworker community exposure, linked with numerous adverse health outcomes (cognitive, neurologic, respiratory).

Hunger and Environmental DPG, 2014 American Academy of Pediatrics, 2012

11


CDC, 2020

12

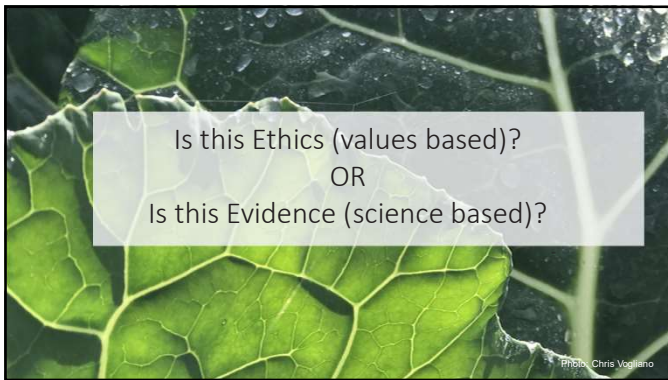
Organics: Areas Requiring Further Research

Nutrition, Cost and More...

- Nutrient composition and clinical importance (AAP, 2012; HEN 2014, Environmental Health, 2017).
- Relationship with Allergic Disease (British Journal of Nutrition, 2008).
- Cost (Hartman, 2020, AAP 2012)
- Potential harm of people avoiding nutrient rich fruits and vegetables out of fear of pesticides that meet US regulations (Food and Chemical Toxicology, 2012).
- EPA thresholds: do they adequately account for potential synergistic exposure to a mixture of pesticides or low-level toxicity? (Environmental Health Perspectives, 2015).



13

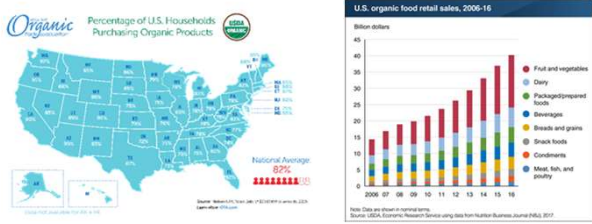


Is this Ethics (values based)?
OR
Is this Evidence (science based)?

Photo: Chris Vegliano

14

Fresh produce, plant-based diets get a lot of attention in sustainability.
That's good.
But packaged and prepared foods, beverages and snacks are also important places
where positive shifts toward sustainability can happen.



Percentage of U.S. Households Purchasing Organic Products

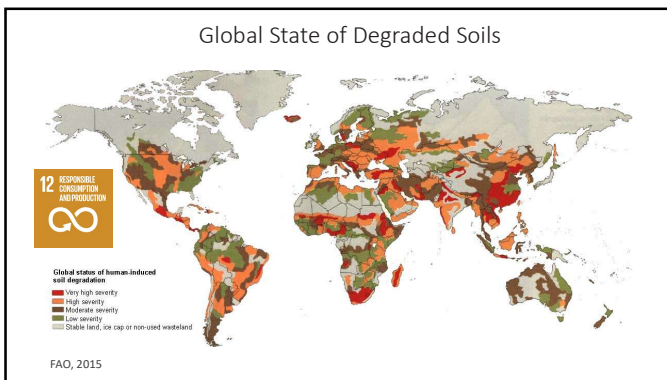
U.S. organic food retail sales, 2006-16

USDA Agricultural Resources and Environmental Indicators, 2019

15



16



17

The Path to Sustainability: Through the Ground

"Healthy soil is the cornerstone of life on earth, facilitating ecosystem biodiversity, ample food production, effective water filtration and storage, and carbon sequestration. Healthy soils can deliver tangible economic and environmental benefits for farmers, businesses and communities for generations to come."

Off-farm economic benefits (corn, soy & wheat acres) (gross)			
	Effect of increased adoption by 7% of U.S. acres of no-till wheat	Effect of adoption on 50% of U.S. acres of no-till wheat	Effect of adoption on 100% of U.S. acres of no-till wheat
U.S. Potential Social Benefits (\$ billions / year)	\$27.7	\$903	\$2,381
Water savings	\$6.0	\$2,367	\$2,367
Reduced fuel	\$71.8	\$2,607	\$6,447
Waters benefits	\$30.6	\$929	\$2,453
Total	\$206	\$2,493	\$9,844

On-farm economic benefits (corn acres only) (net)			
	Effect of increased adoption by 7% of U.S. acres of no-till	Effect of adoption on 50% of U.S. acres of no-till	Effect of adoption on 100% of U.S. acres of no-till
On-farm profit potential, corn only (\$ millions / year)	\$36.7	\$126	\$2,396

Estimates of GAOSS societal off-farm economic benefits and NET on-farm economic benefits accruing to farmers attributable to adoption of the no-till soil health system. Benefits are listed with the most estimated value of economic benefits.

© 2015 World Wildlife Fund/soilhealth.com by The Nature Conservancy. Executive Summary / reThink Soil 7

18

Cover Crops

Support Planetary Boundaries (Union of Concerned Scientists, 2013)

- Climate change
- Biodiversity
- Phosphorus and nitrogen
- Freshwater

Nutrient Dense Ingredients (USDA NRCS, 2019)

- Cover crops including sorghum, oat, cereal rye, hemp, mustard, radish
- Nitrogen fixing "regenerative proteins" legumes, peanuts, peas


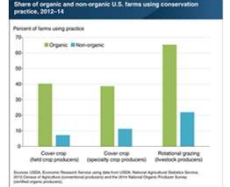
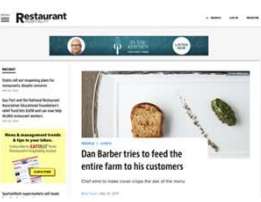


Photo credit: USDA



USDA Agricultural Resources and Environmental Indicators, 2019

19






Photo credit: Alpha Food Labs

20

Is there a connection between Soil Microbes & Human Health?

- Proximity to Amish farming systems is associated with reduced rates of allergies and asthma compared to modern farms (NEJM, 2016).
- Children on traditional dairy farms had 1/10th risk of developing asthma compared with other rural children. Exposure for pregnant women may also be beneficial to reduce allergies in offspring (Journal of Immunology, 2014)
- Environmental biodiversity in surroundings of subjects' homes significantly influenced the composition of the bacterial classes on their skin. (PNAS, 2012).




Photo credit: Shutterstock

21



22

The Soil-Microbiome Connection

Post-Harvest Functional Attributes

- Root and soil microbes can increase nutritional quality of food/crop, including vitamins, mineral content, antioxidants, and other secondary metabolites beneficial for human health (Microorganisms, 2019).
- Symbiotic plant microbes and high species richness in soil have been shown to reduce storage-induced pests on staple crops such as potatoes (Trends in Plant Science, 2018).
- Exposure of bees to glyphosate can perturb their beneficial gut microbiota of honey bees, potentially affecting bee health and their effectiveness as pollinators (PNAS, 2018).

23

Savory

VERIFIED 2018

Livestock as a solution?

OUTCOMES BASED:
Measuring results on the land

COLLABORATION:
Rancher & Scientists

Regenerative Grazing:
THE NEW MODEL

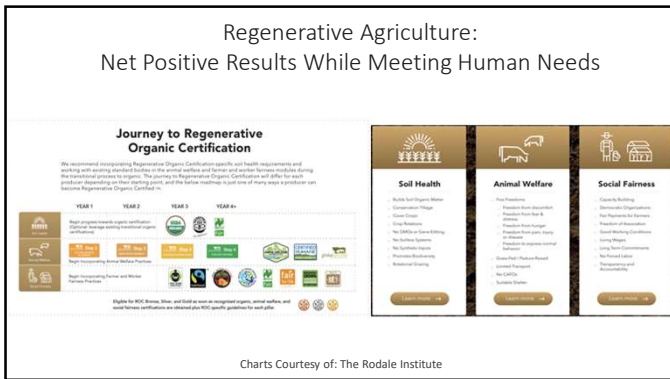
CONTEXTUALIZED:
For country

GOAL:
Bring land back to full ecosystem function, feeding people nutritious food, boosting ranch revenue

LIVESTOCK AS A TOOL:
regenerate soil, nutrient cycling, restore grasslands, sequester carbon, biodiversity

Photo by Chris Vogliano

24



25

High Tech Harvests

“By 2030, vertical farms, indoor hydroponic systems, robotics harvested farms, and other high-tech agricultural innovations will increase the supply of fresh local fruits, vegetables, grains and herbs. Premium grocery retailers will open branded indoor farms to offer consumers fresh picked freshness.”

Mintel, 2020

26

Vertical Farming for the Future

Holds promise to solve several challenges, but more research needed, and may have unintended consequences:

- Brings food production closer to populations.
- Removes seasonality of growing season.
- Uses less space, land and water (more energy).
- Precision ag, pesticide free, contaminant free.
- Potential to increase kcal/nutrient/acre.
- Reduce food miles and storage times.
- Can increase heirloom varieties (biodiversity)
- “Just picked” freshness and flavor
- Resilience in climate change or extreme weather
- Future: hyper-individualized approaches to health
- Cost, unclear impact of a soil-free environment

27

High-tech solutions to fighting food waste



Apeel Sciences
forms a thin "peel" of edible plant material on the surface of the fruit that slows down water loss and oxidation — the factors that cause spoilage.



Lean Path
Collects food wastage data which is used to identify trends and patterns, ultimately leading to less food waste.

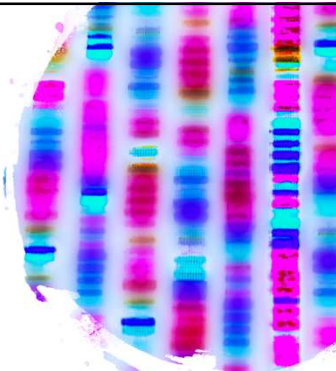
28

CRISPR, the Disruptor

A fast emerging technology

- What it is: selective gene-editing technique
- What it is NOT: Transgenic engineering (GMOs)
- Currently requires regulations and labeling in EU but not US.
- **Potential pros:** Holds promise to remove allergens (gluten), adapt to climate change, boost flavor, nutrition and yields.
- **Potential cons:** Ethical, unknowns (safety, health), and sustainability.

(Global Food Security, 2018)



29

Insect Protein

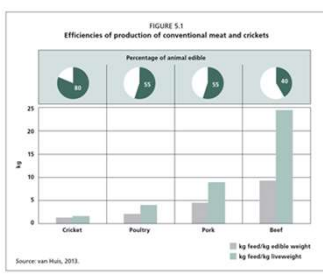


FIGURE 5.1
Efficiencies of production of conventional meat and crickets

Percentage of animal edible

Source: van Huis, 2013.

Key Attributes

- Etymology-eating insects-is common for 2 billion people in 130 countries.
- Cultural and nutritional value.
- Significantly less land, water GHG
- High feed/conversion efficiency ratio
- Ethical and humane
- Low risk of zoonotic infections
- Versatility across food system
- Food security, access + affordability

(FAO, 2013, Nature, 2018)

30



Regenerative Aquaculture

Sea kelp, sea vegetables, bivalves

- Regenerate ocean water and coastal ecosystems.
- A variety of nutrient-dense, sustainable foods.
- Revitalizing livelihoods for fishing communities.
- Familiar Food: 32% of Americans have eaten seaweed in the past month. (Changing Tastes, 2019)




We are Ocean Farmers creating jobs and protecting the planet

31




32

Protein Innovation: Cell-Meat & Plant-Based

Meeting the Growing Demand for Protein

- Global Middle class forecasted to grow 67% by 2030 (The Brookings Institution, 2017).
- 2050 consumption of beef up 65% , pork 43%, poultry 220%, and eggs 64% (UN FAO 2012)
- Rising incomes and urbanization is linked with significant increases in beef consumption (AIAS, 2017).
- How do we meet this demand without exceeding planetary boundaries?

Global Demand for Meat 2005 vs. 2050 (tons)



Meat Type	2005 (tons)	2050 (tons)	% Change
Beef	64M	106M	65%
Mutton	13M	25M	92%
Pork	180M	263M	43%
Poultry	82M	261M	220%
Eggs	82M	133M	64%

Photo credit: Gates Notes

33

Cell-Based Meat

A Fast-Emerging Sector

- What it is: stem cells from animal muscle fibers and grow in nutrient-rich mediums (Harvard Business School, 2015)
- Language and regulatory framework still being developed by USDA and FDA (American Meat Institute, 2019)
- What it is NOT: Plant-based meat
- Potential pros:** significantly reduce environmental and ethical impact of livestock, use of hormones, antibiotics (Harvard Business School, 2015).
- Potential cons:** consumer acceptance, industry disruption, cost.
- Related innovation happening across animal foods, including seafood, collagen, milk, eggs and chicken.

Photo credits: JUST

34

Friends of the Earth US, 2018

Key Concerns

The report will examine important business and consumer trends products for "the report" and generally an overview of environmental concerns. While some products are likely to have been developed specifically for environmental purposes, there are others that are likely to have been developed for other purposes, such as safety and environmental concerns, marketing claims, and consumer interests. These concerns are presented in the report to provide a general overview of the market and opportunities for environmental improvements. Most products are not currently on the market.

KEY QUESTIONS NEED TO BE ANSWERED BEFORE PRODUCTS ARE ALLOWED TO ENTER THE MARKET

- Are there any potential animal replacement products being developed?
- Are there any products in the pipeline that are currently being developed, including animal replacement products, and products from other sources, such as sustainable, high welfare production systems?
- Are there any products in the pipeline that are currently being developed?
- Are there any products in the pipeline that are currently being developed?
- Are there any products in the pipeline that are currently being developed?
- Are there any products in the pipeline that are currently being developed?

Examples of Products	Label-Driven Meat	Scientifically Engineered Protein
<p>Examples of Products</p> <p>The report is about individual and "meat" products, such as chicken, beef, pork, lamb, and fish. It is not about plant-based meat products, which are not currently on the market.</p>	<ul style="list-style-type: none"> Heritage Foods Meat Matters Just Eat (Formerly Just Eat Takeaway.com) Meatless 	<ul style="list-style-type: none"> Impossible Foods Meat from the Future Perfect Day UPSIDE Foods UPSIDE Foods (UPSIDE Foods)
<p>Description of Products</p> <p>The report is about individual and "meat" products, such as chicken, beef, pork, lamb, and fish. It is not about plant-based meat products, which are not currently on the market.</p>	<p>Label-Driven Meat</p> <p>Label-Driven Meat is a category of meat products that are labeled as "meat" and are not currently on the market.</p>	<p>Scientifically Engineered Protein</p> <p>Scientifically Engineered Protein is a category of meat products that are labeled as "meat" and are not currently on the market.</p>

Processing Aids (not required to be listed on ingredient panel)	Plant-based meat	Meat from other sources	Meat from other sources
<p>Processing Aids (not required to be listed on ingredient panel)</p> <p>Processing Aids are substances that are used in the production of meat products and are not currently on the market.</p>	<p>Plant-based meat</p> <p>Plant-based meat is a category of meat products that are labeled as "meat" and are not currently on the market.</p>	<p>Meat from other sources</p> <p>Meat from other sources is a category of meat products that are labeled as "meat" and are not currently on the market.</p>	<p>Meat from other sources</p> <p>Meat from other sources is a category of meat products that are labeled as "meat" and are not currently on the market.</p>
<p>Regulatory Requirements for Safety Assessment</p> <p>Regulatory Requirements for Safety Assessment are the requirements that must be met for meat products to be sold in the United States.</p>	<p>Regulatory Requirements for Safety Assessment</p> <p>Regulatory Requirements for Safety Assessment are the requirements that must be met for meat products to be sold in the United States.</p>	<p>Regulatory Requirements for Safety Assessment</p> <p>Regulatory Requirements for Safety Assessment are the requirements that must be met for meat products to be sold in the United States.</p>	<p>Regulatory Requirements for Safety Assessment</p> <p>Regulatory Requirements for Safety Assessment are the requirements that must be met for meat products to be sold in the United States.</p>
<p>Transparency</p> <p>Transparency is the requirement that meat products must be labeled with their ingredients and other information.</p>	<p>Transparency</p> <p>Transparency is the requirement that meat products must be labeled with their ingredients and other information.</p>	<p>Transparency</p> <p>Transparency is the requirement that meat products must be labeled with their ingredients and other information.</p>	<p>Transparency</p> <p>Transparency is the requirement that meat products must be labeled with their ingredients and other information.</p>
<p>Health Impacts</p> <p>Health Impacts are the effects of meat products on human health.</p>	<p>Health Impacts</p> <p>Health Impacts are the effects of meat products on human health.</p>	<p>Health Impacts</p> <p>Health Impacts are the effects of meat products on human health.</p>	<p>Health Impacts</p> <p>Health Impacts are the effects of meat products on human health.</p>
<p>Environmental Impacts</p> <p>Environmental Impacts are the effects of meat products on the environment.</p>	<p>Environmental Impacts</p> <p>Environmental Impacts are the effects of meat products on the environment.</p>	<p>Environmental Impacts</p> <p>Environmental Impacts are the effects of meat products on the environment.</p>	<p>Environmental Impacts</p> <p>Environmental Impacts are the effects of meat products on the environment.</p>
<p>Marketing and Promotion Claims-Examples</p> <p>Marketing and Promotion Claims-Examples are the claims that are made for meat products.</p>	<p>Marketing and Promotion Claims-Examples</p> <p>Marketing and Promotion Claims-Examples are the claims that are made for meat products.</p>	<p>Marketing and Promotion Claims-Examples</p> <p>Marketing and Promotion Claims-Examples are the claims that are made for meat products.</p>	<p>Marketing and Promotion Claims-Examples</p> <p>Marketing and Promotion Claims-Examples are the claims that are made for meat products.</p>

35

SPINS and Good Food Institute, 2020

Plant-Based Meat Dollar Sales and Dollar Sales Growth by Store Section

Store Section	Dollar Sales (2019)	% of Total Sales
Frozen plant-based meat	\$417M	~60%
Refrigerated plant-based meat	\$213M	~30%
Shelf-stable plant-based meat	\$10M	~1%

Plant-Based Milk and Meat Shares of Total Category

Category	Share of Total Category (2019)
Plant-based milk	14%
Plant-based meat	2%
Plant-based meat	5%

Source: SPINS, Nielsen, and Good Food Institute. © 2020 SPINS and Good Food Institute. All rights reserved.

36

How are Consumers Responding?



A Consumer Survey on Plant Alternatives to Animal Meat
INTERNATIONAL FOOD INFORMATION COUNCIL | FOODINSIGHT.ORG

International Food Information Council, 2019

Diet type A lower percentage of omnivores (44%) have tried a plant alternative to animal meat compared with vegetarians (72%), “sometimes” vegetarians (77%), vegans (76%) and pescatarians (75%).
Income The likelihood of trying a plant alternative to animal meat increased as income rose. Those making over \$120,000 were the most likely consumers (72%) and those making less than \$40,000 were the least likely consumers (35%).
Age More common among the younger population, with those under 45 years of age being the most likely consumers (62%).
Gender Men (53%) were more likely consumers than women (44%).
Education Those with a college degree (62%) were more likely consumers than those without a college degree (37%).

37

3 Ways to Take Action

- 1 Advocate for agricultural systems that support human health and planetary boundaries.
- 2 Help clients, patients and the public identify solutions that fit across their day, including packaged and prepared food, snacks and beverages.
- 3 Keep up with emerging “high tech” and “low tech” solutions, help translate what we know and where there are gaps.

38

References

- Schipanski M., MacDonald G., Reszenzweig S et al. (2016) Realizing Resilient Food Systems. *Bioscience*. 66(7): 600-610.
- Lal, R. (2004) Soil Carbon Sequestration Impacts on Global Climate Change and Food Security. *Science*,304): 1623-1627.
- Rodale Institute. (2011). *The Farming Systems Trial-Celebrating 30 years*. Rodale Institute, Kutztown, Pennsylvania
- Rodale Farming Systems Trial.
- Forman J. and Silverstein J. Committee on Nutrition and Council on Environmental Health. (2012). *Organic Foods: Health and Environmental Advantages and Disadvantages*. *Pediatrics* 130 (5) e1406-e1415.
- Picciotto J., Sassi J., Engel S et al. (2018). Organophosphate exposures during pregnancy and child neurodevelopment: Recommendations for essential policy reforms. *PLoS Medicine*. 15(10):e1002671.
- Hunger and Environmental Nutrition Dietetic Practice Group of the Academy of Nutrition and Dietetics. (2014). *Organic Talking Points*. <https://www.eating.org/resources/organic-food-talking-points>. Accessed 4/28/20.
- Sanchez-Bayo, F. and K. Goka. (2014). Pesticide Residues and Bees – A Risk Assessment. *PLoS ONE*. 9(4): p. e94482.
- Lori M, Symmacik S, Mader P, et al (2017). Organic farming enhances soil microbial abundance and activity-A meta-analysis and meta-regression. *PLoS One*: 12(7):e0180442.
- Sheoran, H. S., R. Kakar, N. Kumar, and Seema. (2019). Impact of organic and conventional farming practices on soil quality: A global review. *Applied Ecology and Environmental Research* 17: 951-68.
- Mie A., Andersen H., Gunnarsson S, et al. (2017). Human health implications of organic food and organic agriculture: a comprehensive review. *Environmental Health*. 16:111.
- Kummeling J., Thijs C., Huber M, et al. (2008) Consumption of organic foods and risk of atopic disease during the first 2 years of life in the Netherlands. *British Journal of Nutrition*. 99(3):588-605.
- Curl C., Beresford S., Fenske R, et al. (2015). Estimating Pesticide Exposure from Dietary Intake and Organic Food Choices: The Multi-Ethnic Study of Atherosclerosis (MESA). *Environmental Health Perspectives*. 123 (5):475-483.
- Reiss R., Johnston J., Tucker K, et al. (2012). Estimation of cancer risks and benefits with a potential increased consumption of fruits and vegetables. *Food and Chemical Toxicology*. 50: 4421-4427.

39

References

- United States Department of Agriculture National Agricultural Statistics Service. (2017). 2016 Certified Organic. https://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Organic_Production/ Accessed 4/27/20.
- United States Department of Agriculture Agricultural Marketing Service. Organic Practices Factsheet. September 2015. <https://www.ams.usda.gov/publications/content/introduction-organic-practices> Accessed 4/28/20.
- Delate, Kathleen & Cambardella, Cynthia & Chase, Craig & Turnbull, Robert. (2015). A Review of Long-Term Organic Comparison Trials in the U.S.. Sustainable Agriculture Research. 4. 10.5539/sarv.4n3p5.
- Environment International. *Volume 8*, September 2015, Pages 69–75. <http://www.sciencedirect.com/science/article/pii/S0169370915003248>
- United States Department of Agriculture Economic Research Service. (2017). Growing Organic Demand Provides High Value Opportunities for Many Types of Producers. <https://www.ers.usda.gov/amber-waves/2017/january/february/growing-organic-demand-provides-high-value-opportunities-for-many-types-of-producers/> Accessed 4/28/20.
- FAO (2015). SOIL: The Foundation of nutrition. <http://www.fao.org/resources/infographics/infographics-details/en/c/358223/> Accessed 5/16/20.
- FAO. (2015). Status of the World's Soil Resources. <http://www.fao.org/3/a/s1999e.pdf> Accessed 5/15/20.
- United States Department of Agriculture Economic Research Service. (2019). Agricultural Resources and Environmental Indicators, 2019. <https://www.ers.usda.gov/publications/pub-details/?pubid=91025> Accessed 4/28/20.
- ReThink Soil. A roadmap to soil health. Nature Conservancy.2016.
- Motta EVS., Raymann K., Moran NA. (2018) Proceedings of the National Academies of Science. 9:115 (41):10305-10310.
- Stein MM., Hrusch C L., Gozdz J., et al.(2016) Innate immunity and asthma risk in amish and hutterite farm. Child. New England Journal of Medicine. 2016;375:411–421.
- Hanski I., von Hertzen L., Fyhrquist N. et al. Environmental biodiversity, human microbiota, and allergy are interrelated. Proceedings of the National Academy of Sciences. 109 (21): 8334–8339.
- Lundell A. C., Johansen S., Adlerberth I. et al. (2014). High Proportion of CD5 B Cells in Infants Predicts Development of Allergic Disease. The Journal of Immunology 193 (2).
- Rilling M.C., Lehmann A., Lehmann J., et al. (2018). Soil biodiversity effects from field to fork. Trends Plant Sci. 2018;23:17–24.
- Rashid M., Mujawar I., Shahad T. et al.(2016). Bacteria and fungi can contribute to nutrients bioavailability and aggregate formation in degraded soils. Microbiological Research.2016: 183:26-41.

40

References

- Mintel Global Food and Drink Trends 2030. <https://www.mintel.com/global-food-and-drink-trends> Accessed 3/10/20.
- Stull V., Finer E., Bergmans R. et al. (2018). Impact of Edible Cricket Consumption on Gut Microbiota in Healthy Adults, a Double-blind, Randomized Crossover Trial. Nature.
- Huis, A. et al. (2013). EDIBLE INSECTS: Future prospects for food and feed security. Food and Agriculture Organization of the United Nations (FAO).
- Directive 2001/18/EC of the European Parliament and of the Council of 12 March 2001 on the deliberate release into the environment of genetically modified organisms and repealing Council Directive 90/220/EEC (OJ 2001 L 106, p. 1) <https://eur-lex.europa.eu/eli/dir/2001/18/20010312/eng.pdf> Accessed 4/24/20.
- Alvarez J. and Preble M. (2015). "Disrupting the Meat Industry: Tissue Culture Beef." Harvard Business School Case 515-001. November 2014 (Revised March 2015).
- Perle D. (2018) From Lab to Fork: Critical Questions on Laboratory-Created Animal Product Alternatives (2018). Friend of the Earth U.S., North American Meat Institute (2019). "Meat Industry Applauds USDA, FDA Joint Regulatory Framework for Cell-Based Meat Products." <https://www.meatinstitute.org/index.php?ht=display/ReleaseDetails/1154030/pdf/287> Accessed 4/25/20.
- Khan, H. (2017). The unprecedented expansion of the global middle class: An update. Global Economy & Development Working Paper 100. Washington, DC: The Brookings Institution.
- Food and Agriculture Organization of the United Nations. (2012). World Agriculture Towards 2030/2050. ESA Working Paper No. 12-03. p.131.
- Li X., Yan C. and Zan L. (2018). Current situation and future prospects for beef production in China-A review. Asian-Australian Journal of Animal Science, 31(7), 984-991.
- The Calumny Institute of America and Harvard T.H. Chan School of Public Health-Department Nutrition. (2018). Menu of Change Annual Report. https://www.menuofchange.org/images/uploads/pdf/2019MOC_AnnualReport.pdf . Accessed 4/25/20.
- Santo, R. and Clinton S. (2017). Redefining protein: Adjusting diets to protect public health and conserve resources. 10.1134/076.2.2.35350.24644.
- Reganold, J. P., & Wachter, J. M. (2016). Organic agriculture in the twenty-first century. Nature plants, 2(1), 1–8.
- Shew, A. M., Nalley, L. L., Sneli, H. A., Nayga Jr, R. M., & Dixon, B. L. (2018). CRISPR versus GMOs: Public acceptance and valuation. Global food security, 19, 71–80.

41