PARMA SUMMER SCHOOL

26 – 28 SEPTEMBER 2023

Innovative food products

Consumer Acceptance of Innovative Foods: The Role of Information

Dr. Vincenzina Caputo
Associate Professor - Michigan State University

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Building Sustainable Food Systems

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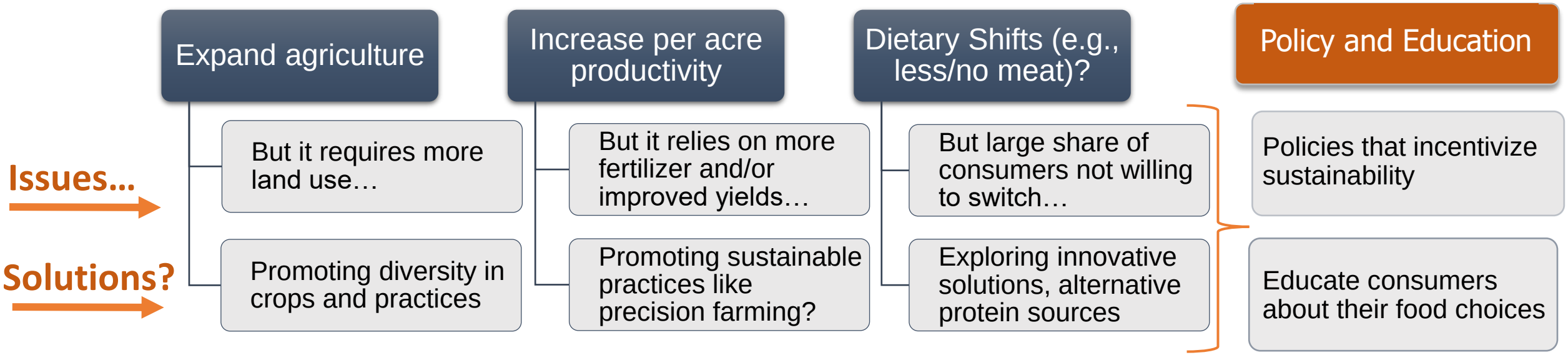
- As the global population continues to grow, ensuring that we can feed everyone while minimizing the impact on the planet is a key priority! Some key innervations:



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Innovative Foods and Information

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- Focus today on…
  - Plant-based meat alternatives
  - Gene-editing on agricultural and food production

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Plant-Based Meat Alternatives

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Plant-based Alternatives: What?

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- Plant-based meat alternatives (PBMAs) are produced with no or reduced content of animal products to resemble conventional meat products in terms of taste, flavor and texture:
- Target: Unlike the first generation of plant-based food (e.g., tofu), PBMAs are also targeted to meat eaters.

  - Facts, **US Market**: PBMA dollar sales grew to $1.4 billion in 2022, which increased by **43% in the past three years** (Good Food Institute, 2022)
  - Facts, **European Market**: Sales of PBMAs grew to €2 billion in 2022, which increased by **19% in the past three years** (Good Food Institute, 2022).

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PBMAs: Benefits?

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- Less agricultural land use, water usage, greenhouse gas emissions, and energy use.

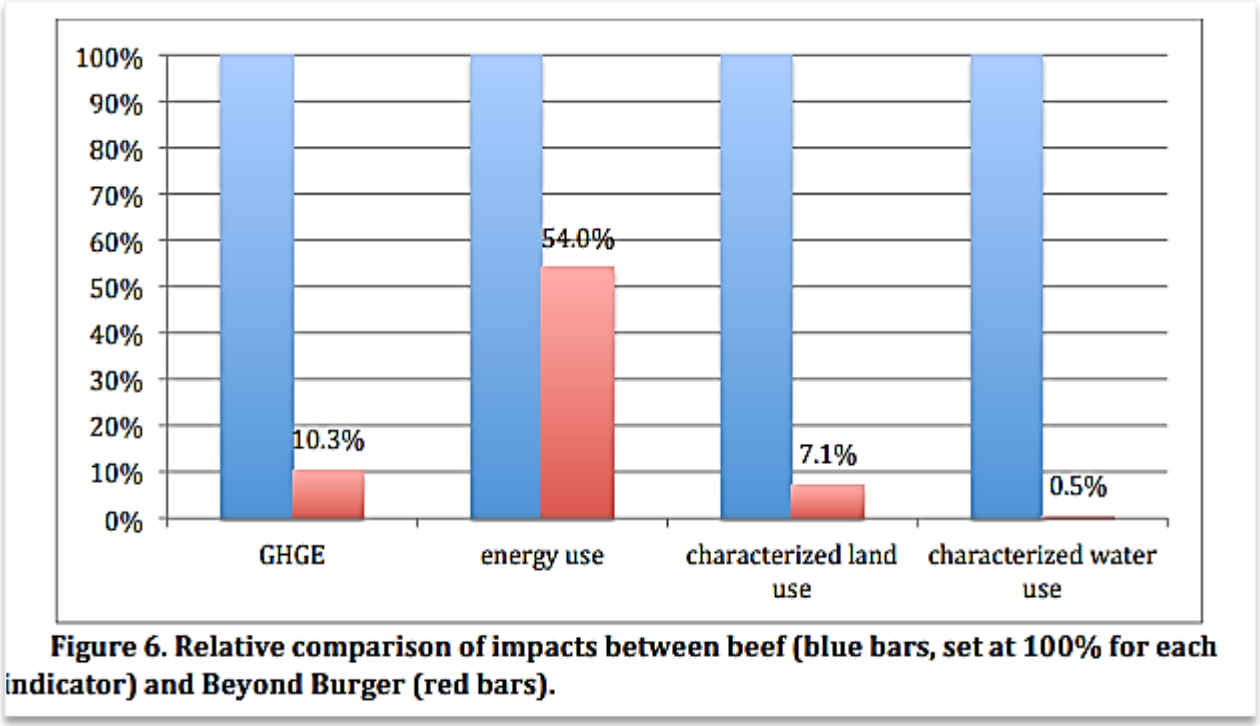
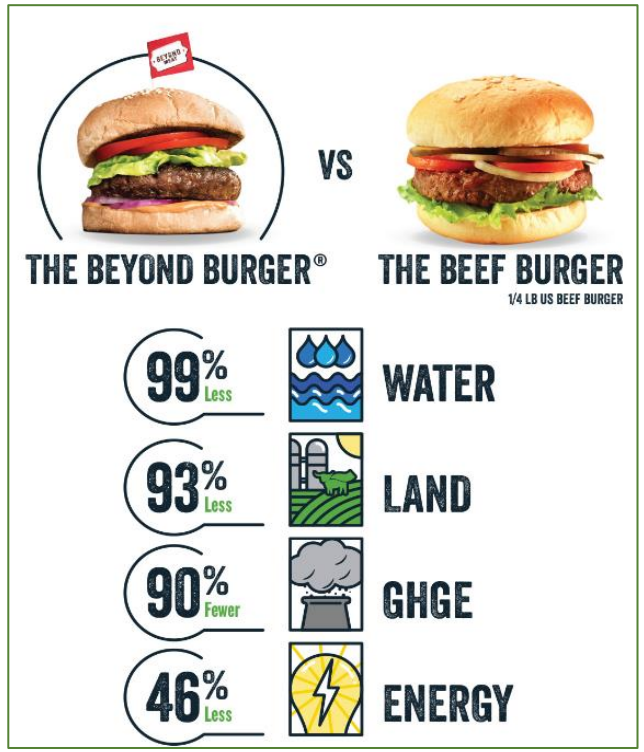


Figure 6. Relative comparison of impacts between beef (blue bars, set at 100% for each indicator) and Beyond Burger (red bars).

Source: Heller & Keoleian, 2018 (Link)



Source: Vegconomist, 2018 (Link)

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PBMAs: Issues I

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- Environmental Concerns…

Sep 28, 2016, 05:20pm EDT

In The Midst Of Drought, California Farmers Used More Water For Almonds

Mallory Pickett Former Contributor ⓘ
Science
I write about science and technology.

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Source: Forbes, Sep 28, 2016 (Link)

Between 2007-2014 "23,000 acres of natural land have been converted to almond farms. 16,000 of those acres were land previously classified as wetlands. Additionally, some agricultural land has been converted from lower-water crops to almonds.

Overall almond acreage increased about 14% in California between 2007-2014 […]. [B]ecause so much land was converted from natural land or lower-water crops, the irrigation increase for the almond industry was nearly twice that."

Plant-Based Food Companies Face Critics: Environmental Advocates

Some analysts say they cannot determine if plant-based foods are more sustainable than meat because the companies are not transparent about their emissions.

"An Impossible Burger has 21 ingredients, according to the company's website, including soy.

"The problem with plant-based products, generally speaking, is that while they may be fixing one problem, combating the fact that growing meat is very carbon intensive and emits a lot of carbon dioxide, depending on the ingredients and where they are sourced from, you could still be involved in deforestation issues," said Ms. Dobre of Sustainalytics. "You still need the space to grow the soy that is in many of these products."

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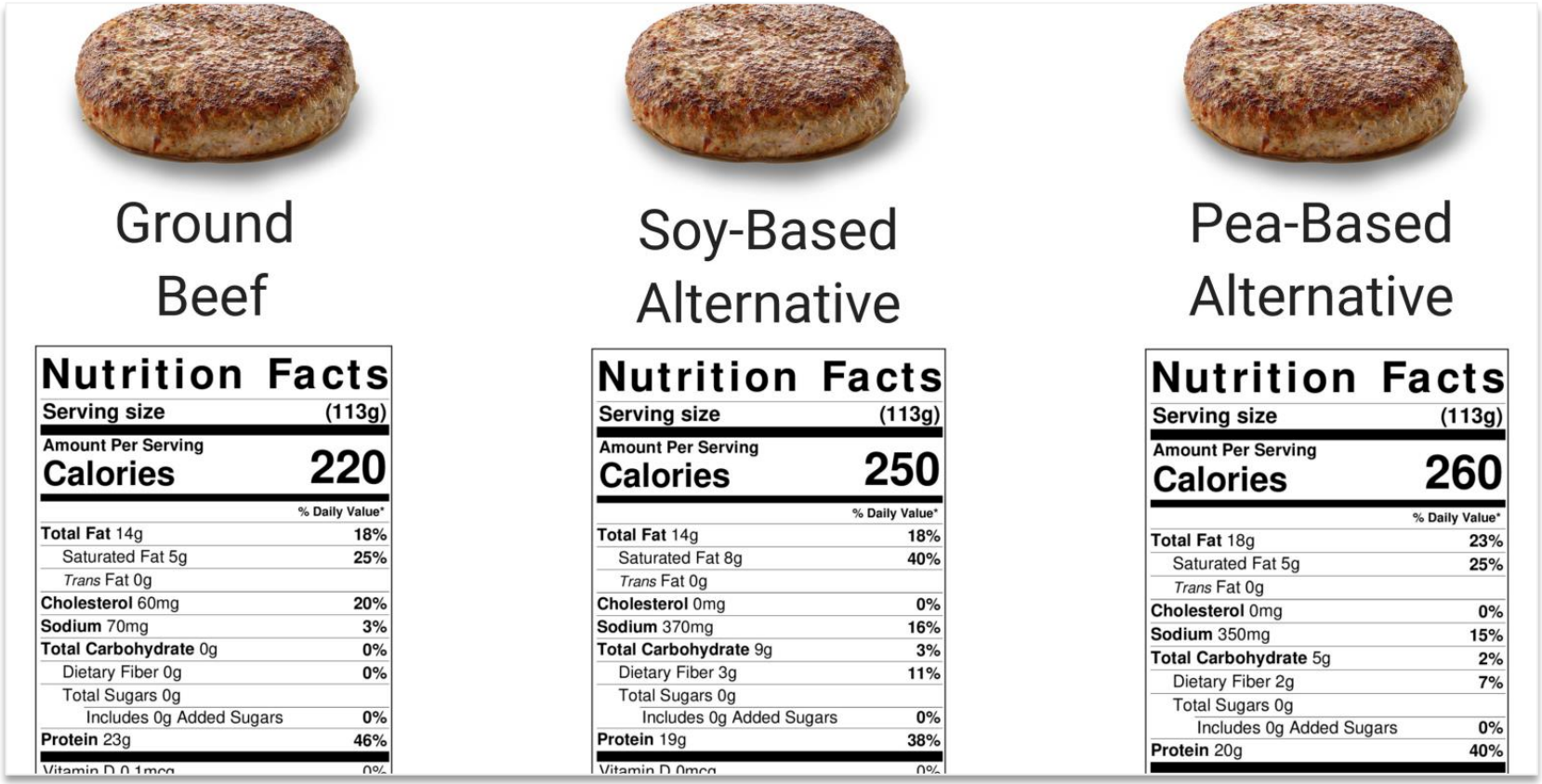
PBMAs: Issue II

- Health-related concerns…



Ground Beef

Nutrition Facts	
Serving size	(113g)
Amount Per Serving Calories	220
	% Daily Value*
Total Fat 14g	18%
Saturated Fat 5g	25%
Trans Fat 0g	
Cholesterol 60mg	20%
Sodium 70mg	3%
Total Carbohydrate 0g	0%
Dietary Fiber 0g	0%
Total Sugars 0g	
Includes 0g Added Sugars	0%
Protein 23g	46%
Vitamin D 0.1mcg	0%

Soy-Based Alternative

Nutrition Facts	
Serving size	(113g)
Amount Per Serving Calories	250
	% Daily Value*
Total Fat 14g	18%
Saturated Fat 8g	40%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 370mg	16%
Total Carbohydrate 9g	3%
Dietary Fiber 3g	11%
Total Sugars 0g	
Includes 0g Added Sugars	0%
Protein 19g	38%
Vitamin D 0mcg	0%

Pea-Based Alternative

Nutrition Facts	
Serving size	(113g)
Amount Per Serving Calories	260
	% Daily Value*
Total Fat 18g	23%
Saturated Fat 5g	25%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 350mg	15%
Total Carbohydrate 5g	2%
Dietary Fiber 2g	7%
Total Sugars 0g	
Includes 0g Added Sugars	0%
Protein 20g	40%

Source: Van Vliet et al., 2020 (Link)

PBMAs: Issues III

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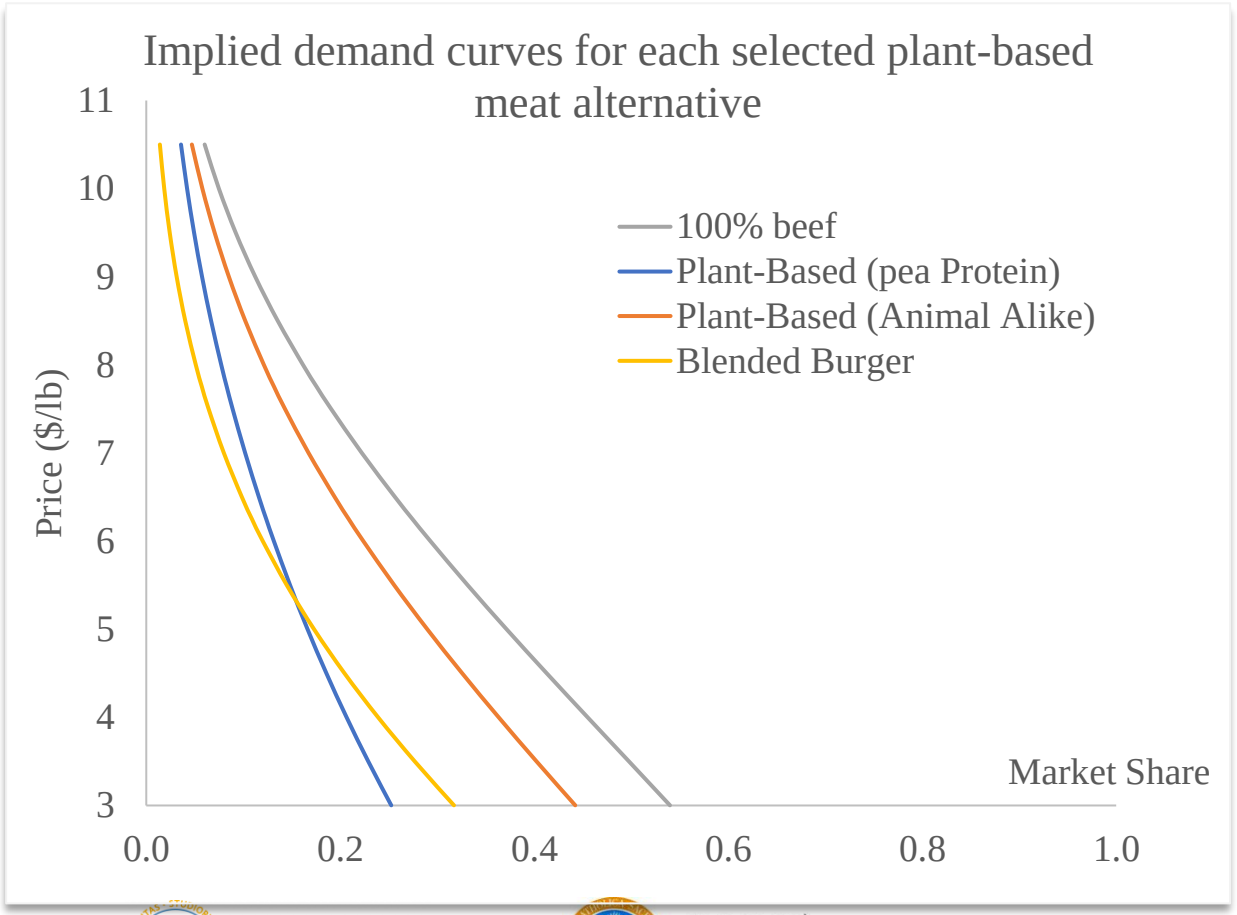
- Low consumer acceptance

Word Association

Farm-raised meat

PBMAs



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Source: Caputo et al, 2022 (Link)

PBMAs: The Role of Information

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- **Van Loo, Caputo and Lusk 2020**

$2.99
Lab-grown beef

$2.99
Plant-based using pea protein

$2.99
Plant-based using animal-like proteins produced by yeast

$2.99
Farm raised beef

If these were the only options, I would not buy any

Treatment name	Description
Control	Only CE questions
Branding	CE questions + Brand names
Sustainability	CE questions + Environmental information
Technology	CE questions + Technological information

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PBMAs: The Role of Information

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$2.99
Lab-grown beef

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Farm raised beef

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Control

$2.99
Lab-grown beef

$2.99
Plant-based using pea protein

$2.99
Plant-based using animal-like proteins produced by yeast

$2.99
Farm raised beef

If these were the only options, I would not buy any

Branding

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Source: Van Loo, Caputo and Lusk 2020

PBMAs: The Role of Information

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- **Sustainability**

Conventional (farm-raised) meat such as ground beef is produced from cows, bulls, steers, and heifers grown in a variety of environments across the country and abroad. Some groups have expressed concerns about environmental and animal welfare impacts of conventional beef production.

Three meat or protein alternatives have been suggested to be more environmentally friendly and better for animal welfare.

The table below compares some estimated reductions in environmental impacts of each of the three alternatives compared to conventional beef.

	Plant-based meat using pea protein	Plant-based meat using animal-like proteins produced by yeast	Lab-grown meat
Water	99% less	75% less	96% less
Land	93% less	95% less	99% less
Energy	46% less	93% less	45% less
Greenhouse gas emissions	90% less	87% less	96% less

- **Technology**

Plant-based meat using pea protein

The primary source of protein in this burger comes from peas. In addition, trace amounts of beet lend a beefy red color while coconut oil and potato starch ensure mouth-watering juiciness and chew. The result is an plant-based patty that mimics the taste of an animal meat burger patty.

Plant-based meat using animal-like proteins produced by yeast

The burger patty is made from plant-based heme, wheat protein, coconut oil, potato protein.
Heme is an iron-containing molecule that occurs naturally in every single plant and animal and is responsible for the characteristic of taste and aroma of meat. The plant-based heme is produced by a yeast, using fermentation. In order to have yeast producing the plant-based heme, the yeast is genetically engineered by adding the gene responsible to make heme in soy to the yeast. Since this heme is identical to the one found in animal meat, this plant-based burger patty mimics the taste of an animal meat burger.

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Source: Van Loo, Caputo and Lusk 2020

Information Influences Consumer Demand for PBMAs

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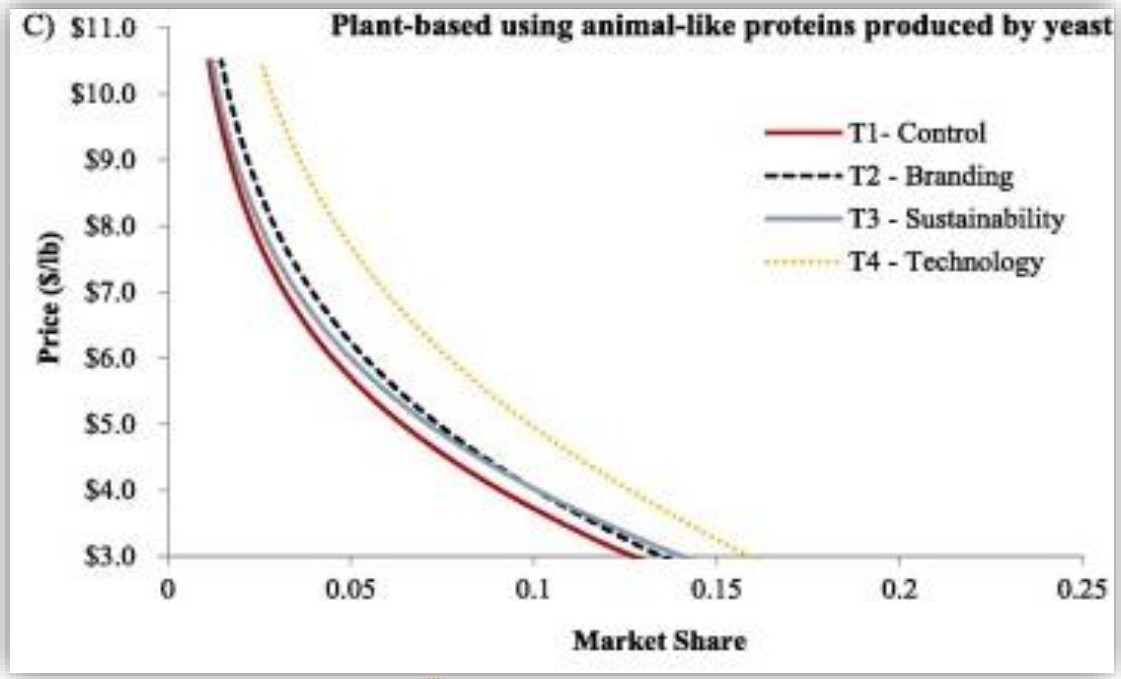
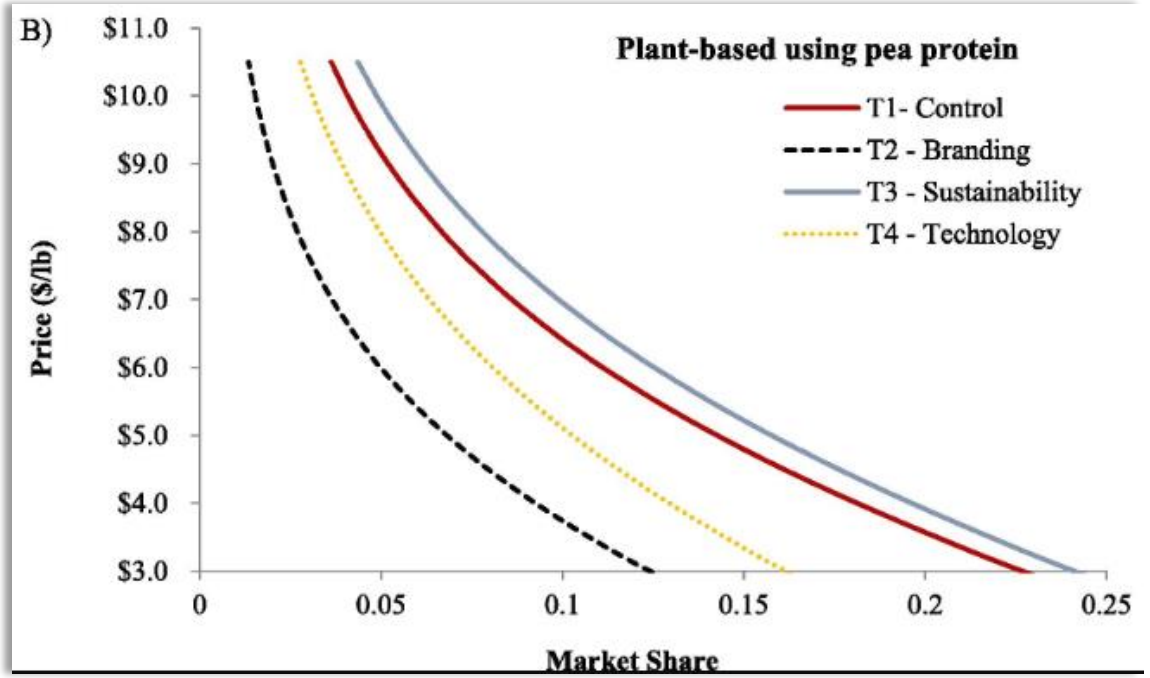
- PBMAs made with pea proteins: Providing information on sustainable aspects increase acceptance.



- PBMAs produced by yeast: understanding the technology behind their creation increases acceptance.



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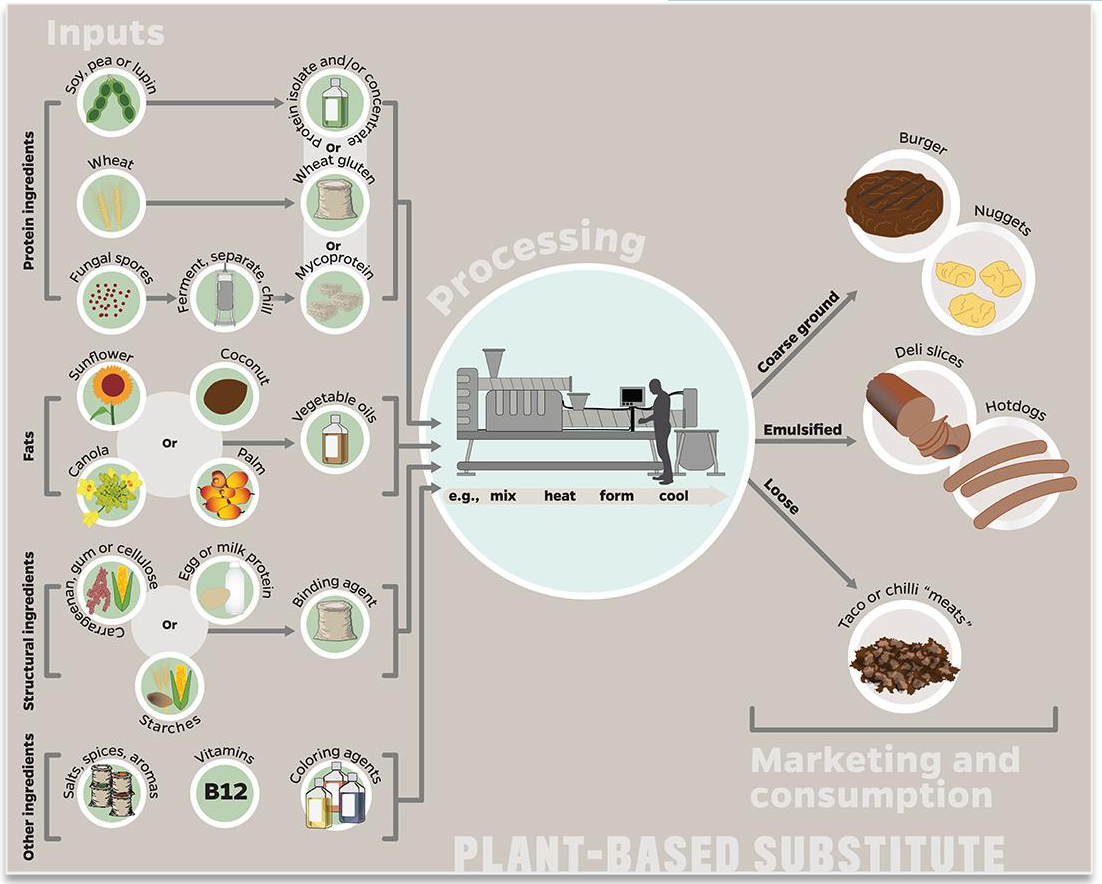
Source: Van Loo, Caputo and Lusk 2020

PBMAs – Final Remarks

- Plant-based meat and seafood alternatives are becoming more and more popular.
- Their expansion does not come without negative side effects.
- Not all consumers are on-board with the transition.



Source: Santo et al., 2020 (Link)

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Gene-Editing in Food Production

Source: The Financial Times, Feb 11, 2019 (Link)

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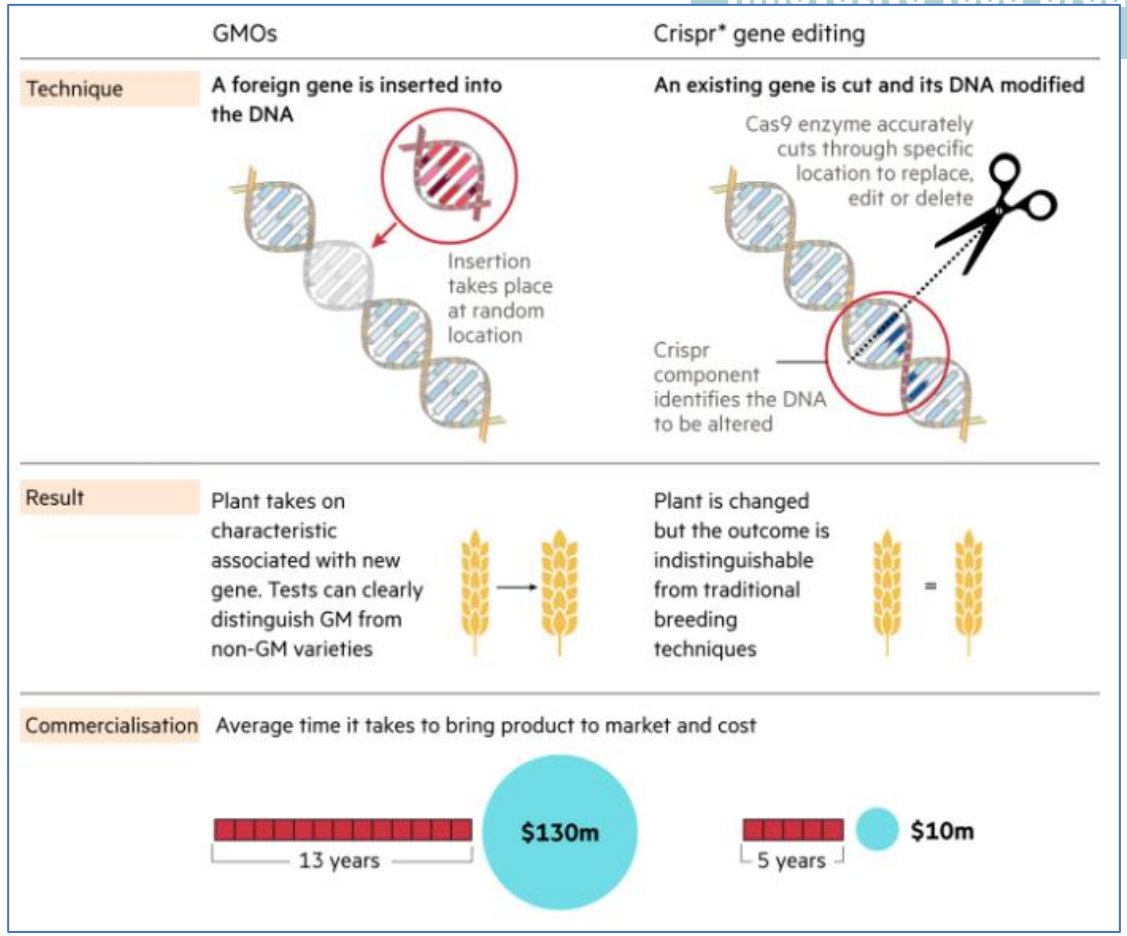
Gene-Edited Food: What?

- Gene-editing represents an evolution of traditional genetic engineering technologies like **genetic modification - or GMOs**.

- Unlike the first-generation of genetic modification, also known as GMOs (Genetically Modified Organisms), changes of the DNA are targeted and controlled, and it does not necessarily imply the insertion of foreign DNA.



Source: The Financial Times, Feb 11, 2019 (Link)

Gene-Edited Food: Benefits?

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- Agricultural applications address a range of relevant issues in the agricultural and food space, including:

Improving nutritional value of food, reducing spoilage, no allergens, etc.

Consumer benefits

Increased yields with less land and fewer inputs, increased resistance to adverse weather conditions, increased resistance to diseases, etc.

Environmental benefits

Reducing animal and plant diseases, increase animal welfare, etc.

Welfare Benefits

Reducing costs for farmers and offer cheaper food to consumers

Economic benefits

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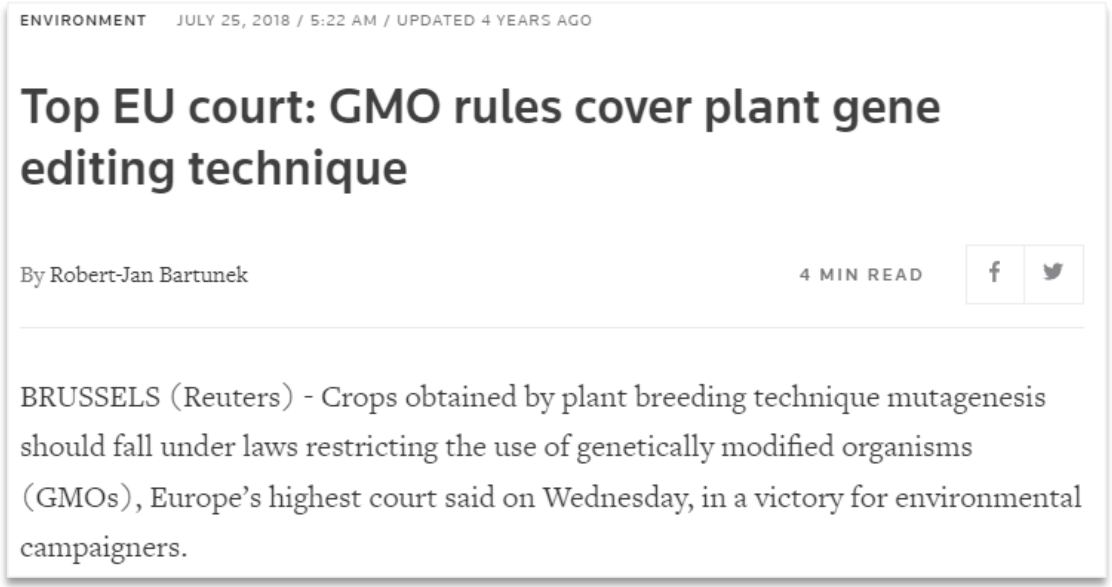
Gene-Edited Food: Issue I

- **Legislative hurdles:** In Europe, gene-editing technology continues to be a topic of debate, with regulatory frameworks emphasizing precaution and strict oversight to balance innovation with potential risks.



ENVIRONMENT JULY 25, 2018 / 5:22 AM / UPDATED 4 YEARS AGO

Top EU court: GMO rules cover plant gene editing technique

By Robert-Jan Bartunek 4 MIN READ

BRUSSELS (Reuters) - Crops obtained by plant breeding technique mutagenesis should fall under laws restricting the use of genetically modified organisms (GMOs), Europe's highest court said on Wednesday, in a victory for environmental campaigners.

Source: Reuters, Jul 25, 2018 (Link)

April 29, 2021
8:14 AM EDT
Last Updated 10 months ago

Europe

EU calls for rethink of GMO rules for gene-edited crops

By Philip Blenkinsop

3 minute read

Source: Reuters, Apr 29, 2021 (Link)

Gene-Edited Food: Issues II

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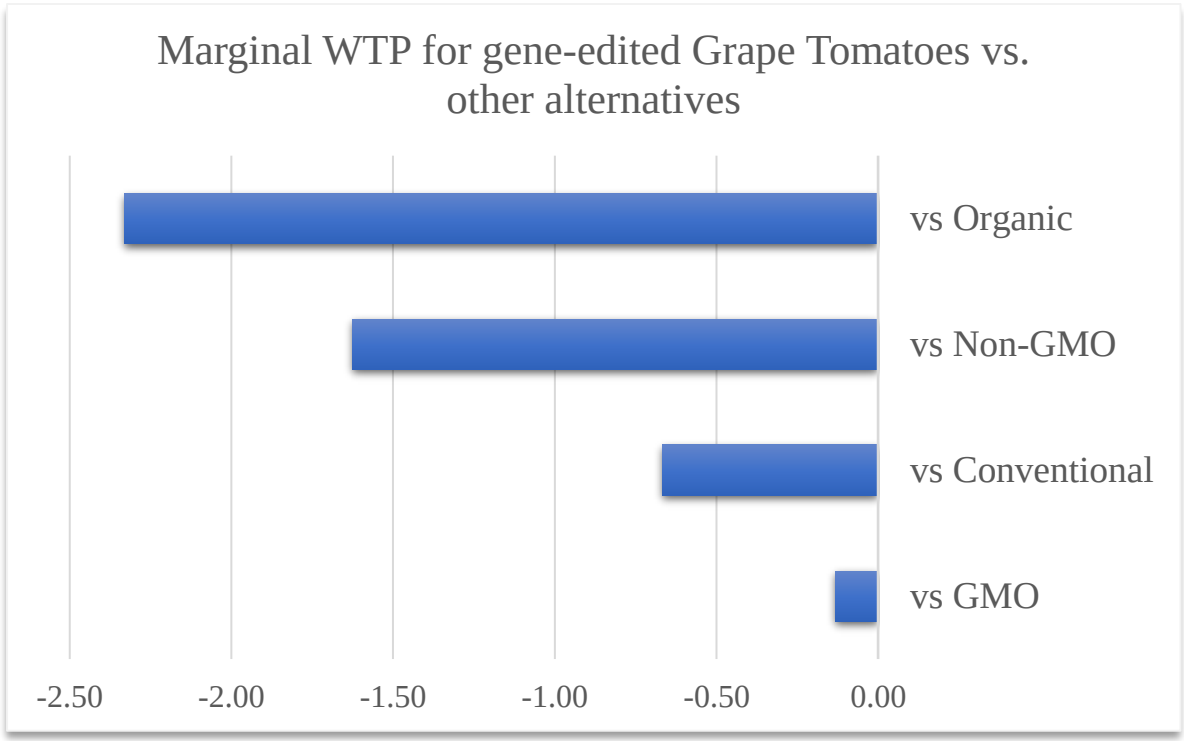
- Low consumer acceptance

Word Association, Gene Editing

Source: Caputo et al., 2020 (Link)



Source: Caputo et al., 2020 (Link)

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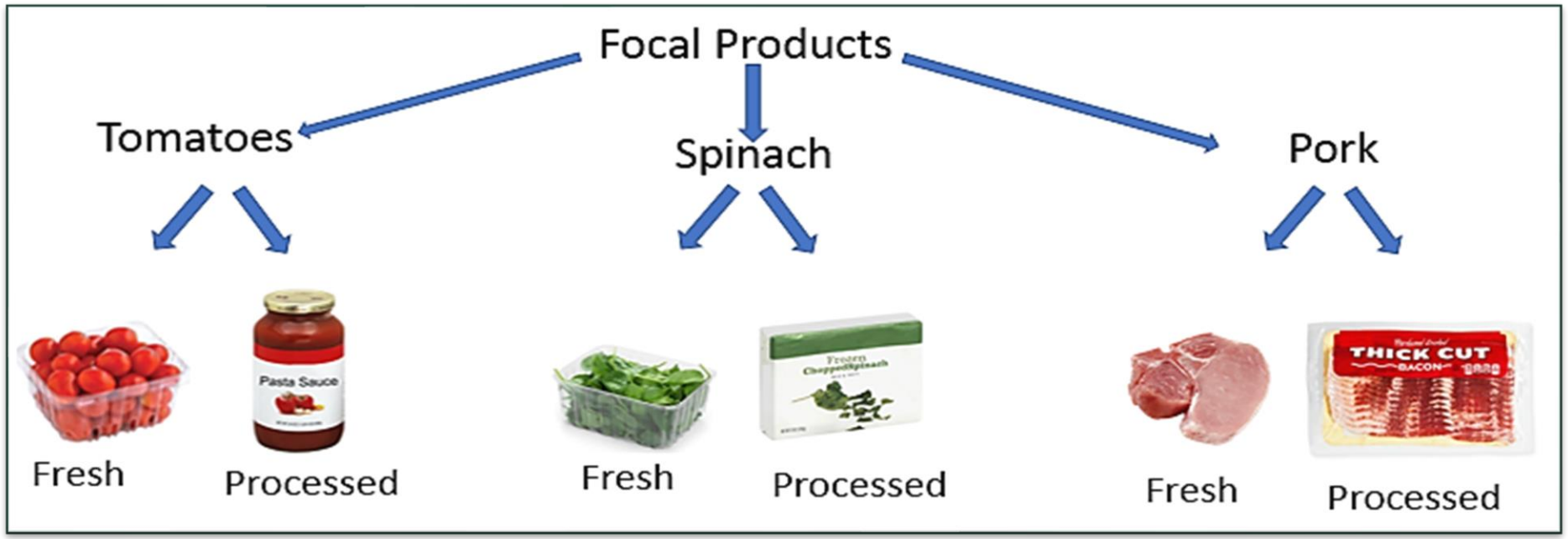
Gene-Edited Food: The Role of Information

- Caputo et al. 2020, Food Industry Association, FMI report
- We assess consumer demand for various gene-edited plant-based and meat products



Source: Caputo et al., 2020 (Link)

Gene-Edited Food: The Role of Information

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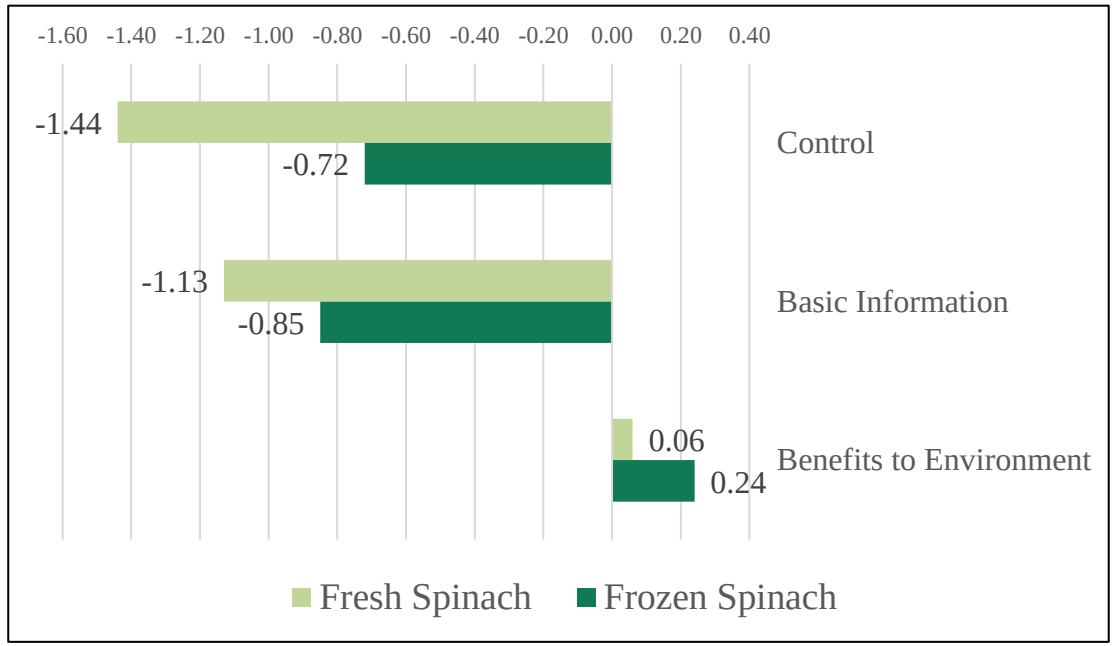
- Benefits to the environment

The gene-edited fresh spinach that you have the option to hypothetically purchase in the following section was created by turning pre-existing genes from the spinach on or off **to use 40% less water in production and thus reducing the environmental impact.**

- Claim in the choice questions

- Marginal WTPs of gene-edited vs. GMO Fresh Spinach & Frozen Spinach



Source: Caputo et al., 2020 (Link)

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Source: Caputo et al., 2020 (Link)

Gene-Edited Food: The Role of Information

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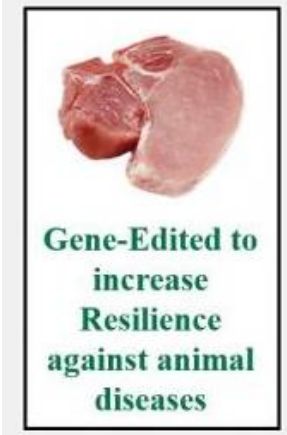
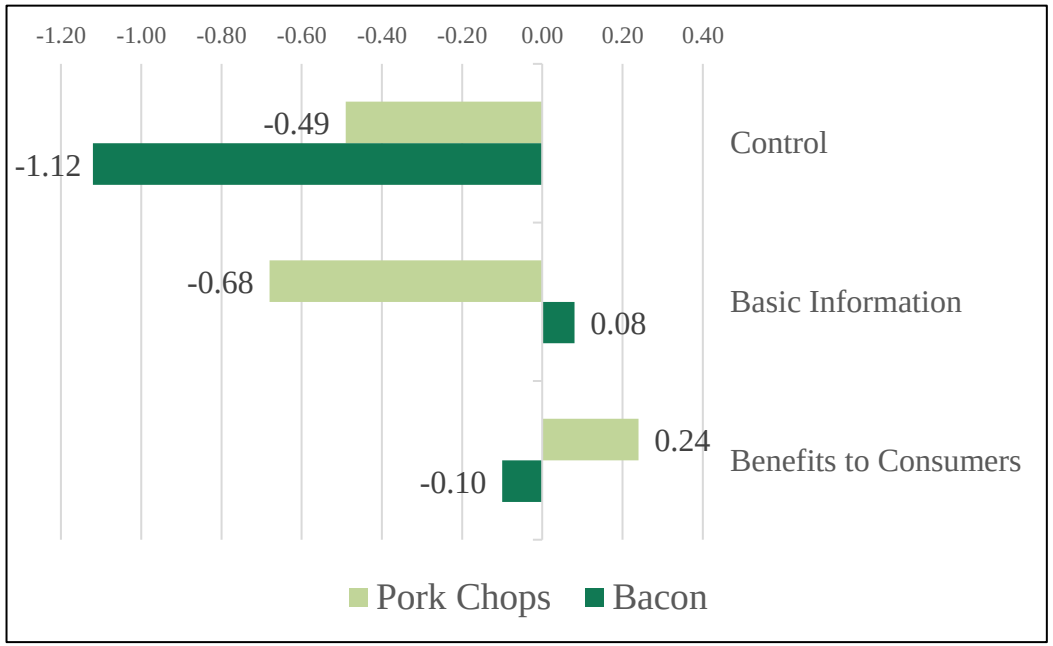
- Benefits to the animal welfare

The gene-edited pork chops that you have the option to hypothetically purchase in the following section were created by turning pre-existing genes of the pig on or off **to increase the resilience of animals against a contagious and potentially deadly virus and thus enhancing the health care of the animals.**



- Claim in the choice questions

- Marginal WTPs of gene-edited vs. GMO, Pork Chops & Bacon



Source: Caputo et al., 2020 (Link)

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Source: Caputo et al., 2020 (Link)

Gene-Editing: Final Remarks

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- Consumers have low levels of knowledge and awareness about gene-edited food and associated predominantly negative feelings with the technology.

- Information about the technologies needs to be supplemented with specific benefit messages if the technology is to be more widely accepted.

- Future marketing and policy efforts need to be directed and adapted to the specific food innovation in question and cannot be guided by a single, overall approach.

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Thank you!

vcaputo@msu.edu

Current (Selected) Research Projects:

- Market potential of meat alternatives (USDA-ERS)
- Consumer acceptance of gene-editing (USDA-NIFA)
- The Role of trust in science and its communicator in technology adoption (USDA-NIFA)
- Meal-Clicks: Consumer demand for food away from home ordered online(USDA-NIFA)
- Promoting sustainable retailing and consumption (NSF)

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