Good Food Institute

The State of the Industry: Plant-based meat, eggs, and dairy *2021*

Presented by Karen Formanski, Sharyn Murray, Dr. Priera Panescu, and Madeline Cohen

Photo credit: Black Sheep Foods

Agenda

Welcome & introduction to the Good Food Institute

2021 Plant-based State of the Industry

- Commercial landscape
- Investments
- Science and technology
- Government & regulatory

Q&A

The Good Food Institute

GFI is a 501(c)(3)nonprofit developing the roadmap for a sustainable, secure, and just protein supply. We focus on three key areas of work:

Science and Technology
Advancing foundational, open-access research in alternative proteins and creating a thriving research and training ecosystem around these game-changing fields.

Corporate Engagement
Partnering with companies and investors across the globe to drive investment, accelerate innovation, and scale the supply chain—all faster than market forces alone would allow.

Policy
Advocating for fair policy and public research funding for alternative proteins.

GFI officially earned GuideStar's 2019 and 2020 Platinum Seal of Transparency—obtained by less than 1% of nonprofits—reflecting our commitment to maximum impact, efficiency, and inclusion.

We work as a force multiplier, bringing the expertise of our departments to the rest of the world.

United States
Brazil
India
Europe
Asia Pacific
Israel

130+ staff in 6 regions

GFI’s approach

The challenge

Current meat, egg, and dairy production is unsustainable and inefficient. It is a key driver of climate change, environmental degradation, and antibiotic resistance.

GFI’s solution: Accelerating alternative proteins

We can create meat, eggs, and dairy more sustainably and efficiently by making them from plants, cultivating them directly from cells, or producing them by fermentation.

Instead of asking consumers to give up the foods they love, GFI is accelerating the transition to alternative proteins by helping companies make products that are **delicious**, **affordable** and **accessible**.

Commercial landscape

Top brands by category in 2021 (alphabetized)

Plant-based meat

Plant-based dairy

Top U.S. retailers offer plant-based meat and dairy products in private-label lines

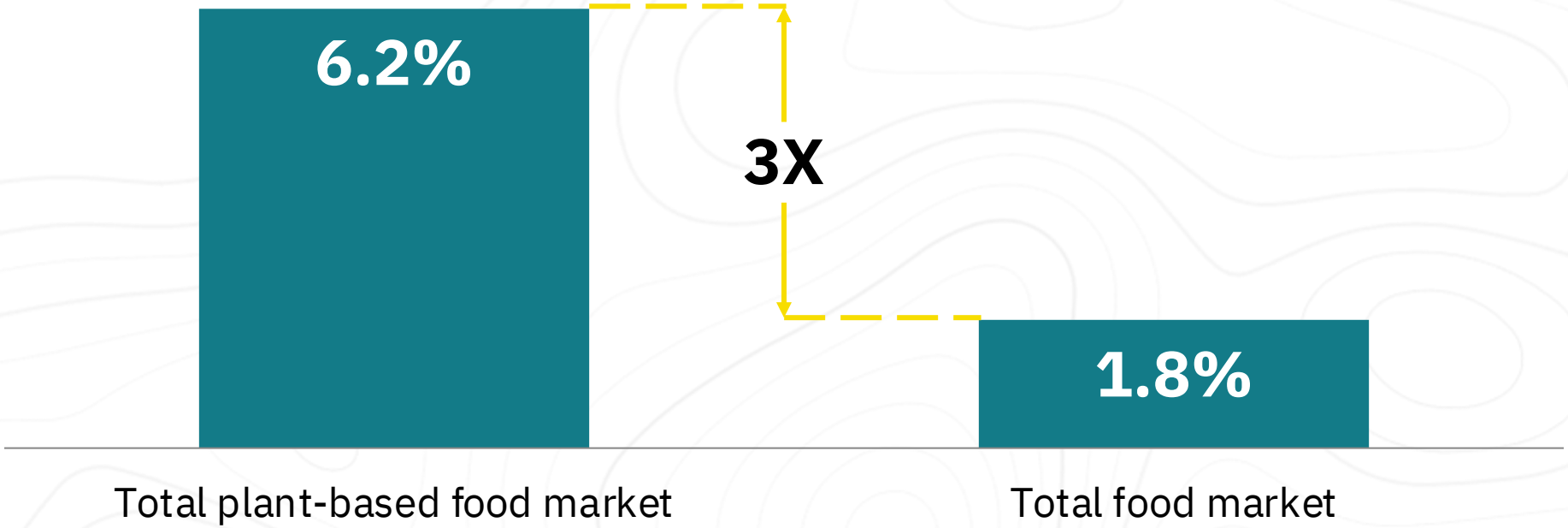
	Walmart	Kroger	Albertsons	Ahold Delhaize	Whole Foods Market
					
Meat	✓	✓	✓	✓	✓
Milk	✓	✓	✓	✓	✓
Other dairy	✓	✓	✓	✓	✓
Meals/meal prep		✓	✓		✓

Source: GFI Good Food Retail Report

Plant-based foods sales are growing 3x faster than total food sales.

Total food and plant-based food markets comparison: dollar sales growth

2021



Note: The data presented in this graph is based on custom GFI and PBFA plant-based categories that were created by refining standard SPINS categories. Due to the custom nature of these categories, the presented data will not align with standard SPINS categories.

Source: SPINS Natural Enhanced Channel, SPINS Conventional Multi Outlet Channel (powered by IRI) | 52 Weeks Ending 12-26-2021

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PLANT BASED FOODS ASSOCIATION

SPINS®

Plant-based categories: Summary table

Category	2021 dollar sales	1-year dollar sales growth (2020-2021)	3-year dollar sales growth (2018-2021)	2021 unit sales
Plant-based milk	$2.6 B	4%	33%	788 M
Plant-based meat	$1.4 B	0%	74%	281 M
Plant-based creamer	$516 M	33%	134%	121 M
Plant-based meals	$513 M	9%	83%	113 M
Plant-based ice cream and frozen novelty	$458 M	3%	41%	92 M
Plant-based yogurt	$377 M	9%	76%	170 M
Plant-based cheese	$291 M	7%	85%	59 M
Plant-based protein liquids and powders	$289 M	10%	29%	19 M
Plant-based butter	$214 M	9%	92%	56 M
Plant-based ready-to-drink beverages	$202 M	22%	87%	51 M
Plant-based bars	$174 M	1%	-7%	50 M
Tofu and tempeh	$126 M	-9%	28%	44 M
Plant-based condiments, dressings, and mayo	$83 M	6%	20%	16 M
Plant-based dairy spreads, dips, sour cream, and sauces	$65 M	20%	280%	13 M
Plant-based eggs	$39 M	42%	1076%	8 M
TOTAL	**$7.4 B**	**6%**	**54%**	**1.9 B**

Note: The data presented in this graph is based on custom GFI and PBFA plant-based categories that were created by refining standard SPINS categories. Due to the custom nature of these categories, the presented data will not align with standard SPINS categories.

Source: SPINS Natural Enhanced Channel, SPINS Conventional Multi Outlet Channel (powered by IRI) | 52 Weeks Ending 12-26-2021

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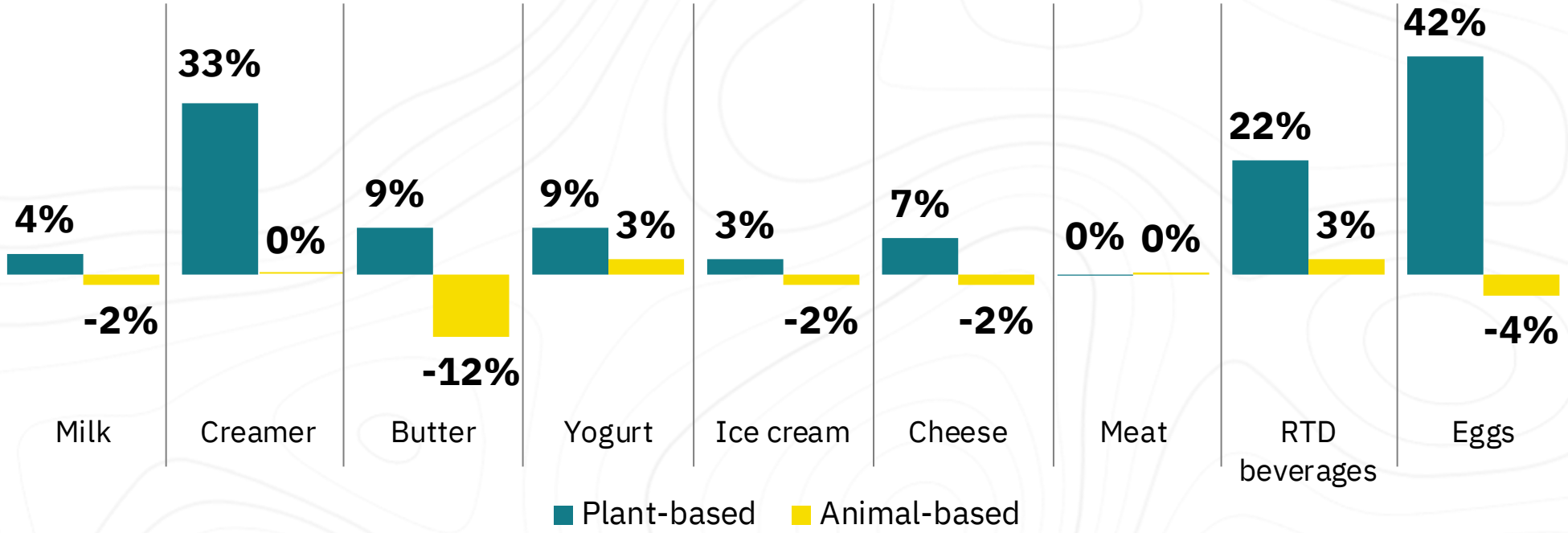
Sales growth comparison shows a clear trend towards plant-based products.

Animal-based and plant-based product comparison: dollar sales growth

2021



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Source: SPINS Natural Enhanced Channel, SPINS Conventional Multi Outlet Channel (powered by IRI) | 52 Weeks Ending 12-26-2021

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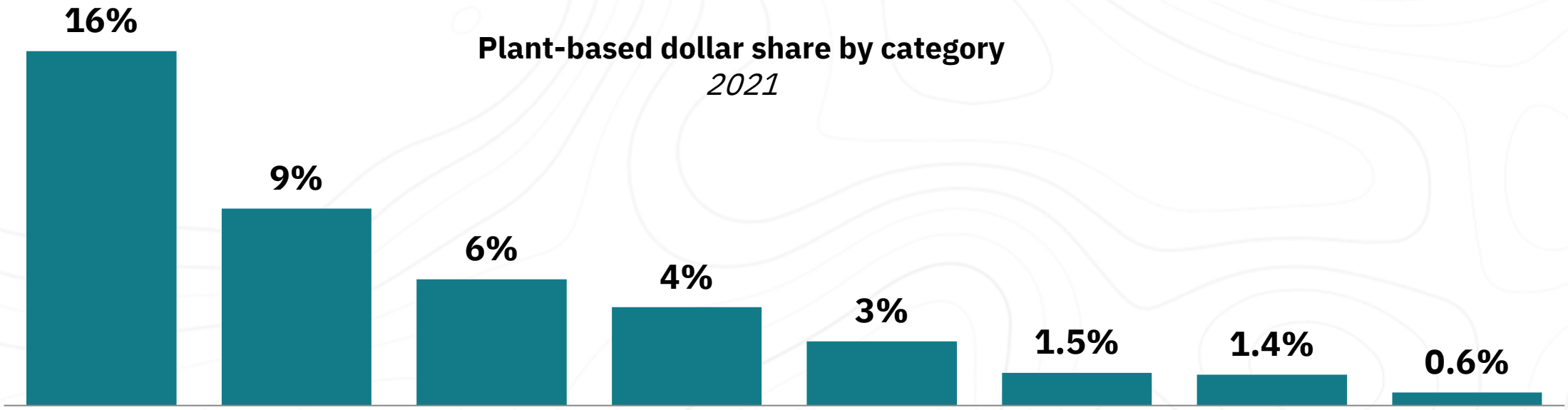
Plant-based milk has the greatest share of total market; other dairy categories are gaining share



% chg 2018-21	Milk	Creamer	Butter	Yogurt	Ice cream	Cheese	Meat*	Eggs
	20%	85%	73%	65%	18%	57%	37%	1057%

Note: SPINS does not report non-UPC animal-based meat counter sales. The plant-based meat share of the total meat category assumes that non-UPC animal-based meat counter sales are equivalent to animal-based packaged meat sales. The data presented in this graph is based on custom GFI and PBFA plant-based categories that were created by refining standard SPINS categories. Due to the custom nature of these categories, the presented data will not align with standard SPINS categories.

Source: SPINS Natural Enhanced Channel, SPINS Conventional Multi Outlet Channel (powered by IRI) | 52 Weeks Ending 12-26-2021

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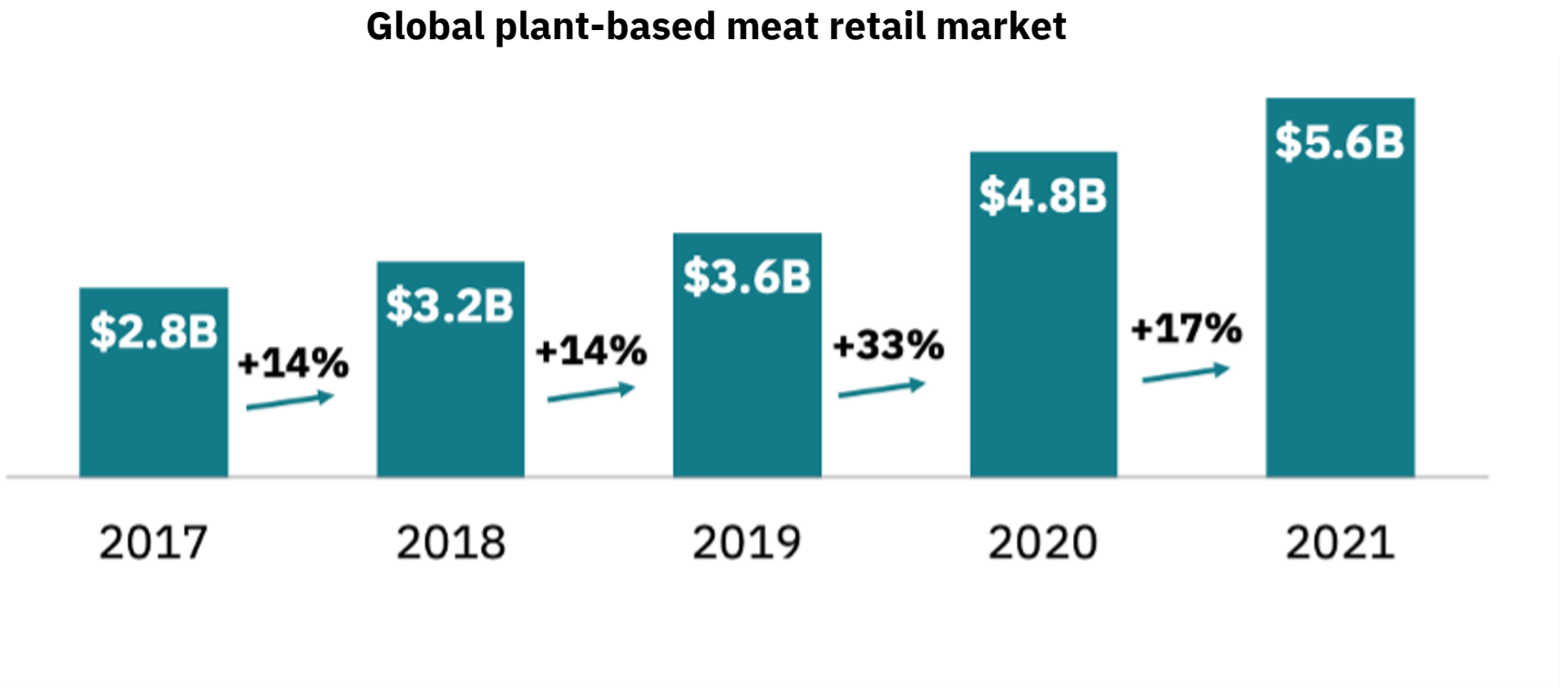
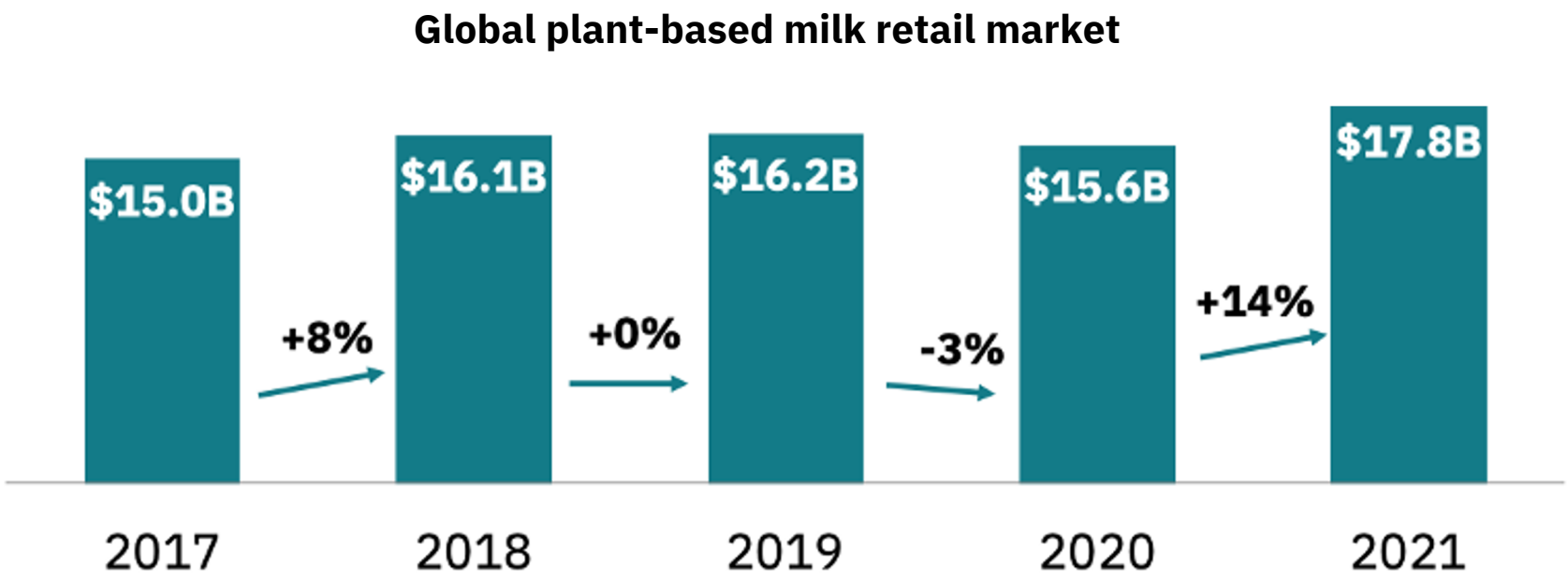
Estimated global plant-based meat retail market overview



Source: Euromonitor Passport; GFI analysis

Global plant-based milk retail market overview

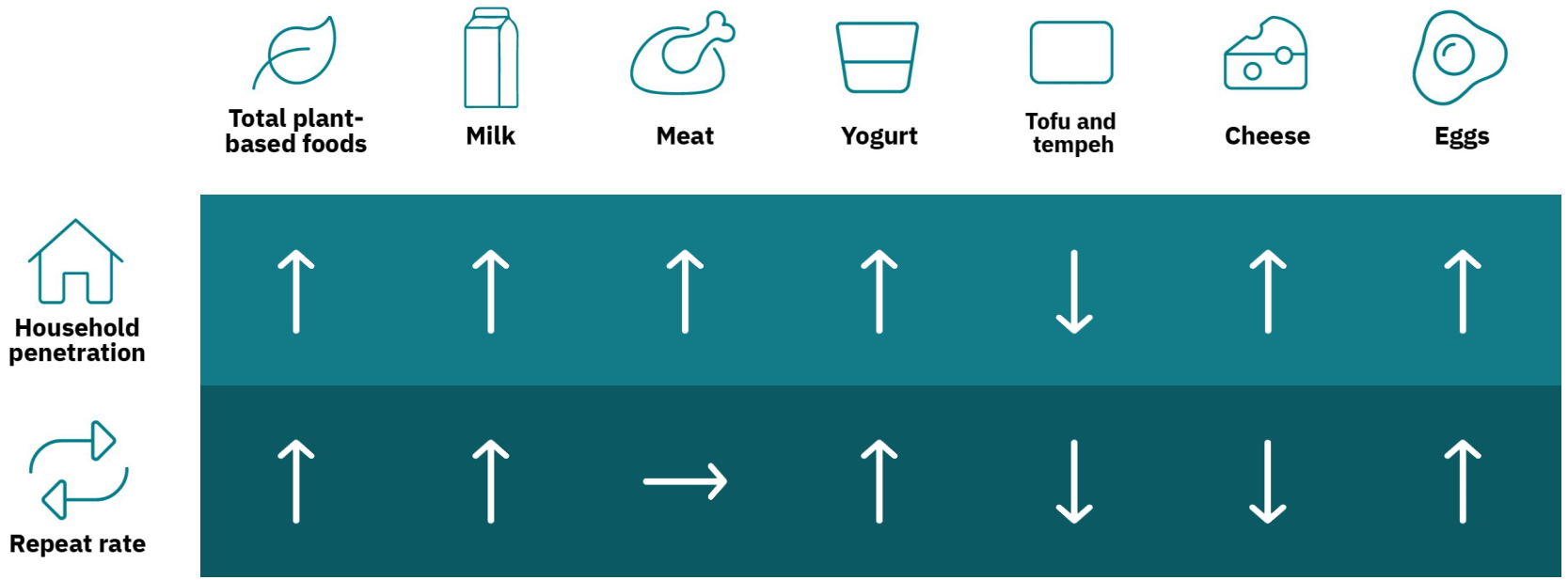


Source: Euromonitor Passport; GFI analysis

More consumers are eating more plant-based foods

Plant-based foods purchase dynamics: Change from prior year

2021



Note: The data presented in this graph is based on custom GFI and PBFA plant-based categories that were created by refining standard SPINS categories. Due to the custom nature of these categories, the presented data will not align with standard SPINS categories.

Source: NCP, All Outlets, 52 weeks ending 12-26-21

Plant-based purchasers tend to be younger and from higher income brackets

Total plant-based food consumer demographics

2021

	Cohort	Dollar index	Buyer index
HH age	HH Age 18-34	116	113
	HH Age 35-44	124	111
	HH Age 45-54	116	107
	HH Age 55-64	92	96
	HH Age 65+	69	81
HH education	HH Educ-Graduated High School or Less	68	85
	HH Some College	96	98
	HH Graduated College	113	107
	HH Post Graduate School	123	109
Ethnicity	White	97	97
	Asian	100	124
	African American	116	105
	Other Race	102	106

	Cohort	Dollar index	Buyer index
Income	HH Earning Under 20K	81	87
	HH Inc $20k-$24.9k	73	85
	HH Inc $25k-$34.9k	82	90
	HH Inc $35k-$44.9k	88	93
	HH Inc $45k-$49.9k	87	96
	HH Inc $50k-$59.9k	94	97
	HH Inc $60k-$69.9k	90	101
	HH Inc $70k-$99.9k	101	103
	HH Inc $100k+	127	112
Kids	HH with Children	113	110
	HH without Children	94	95

Note: the data presented in this graph is based on custom-GFI plant-based categories that were created by refining standard SPINS categories. Due to the custom nature of these categories, the presented data will not align with standard SPINS categories.
Source: NCP, All Outlets, 52 weeks ending 12-26-21

The biggest open opportunities are to win on taste and price

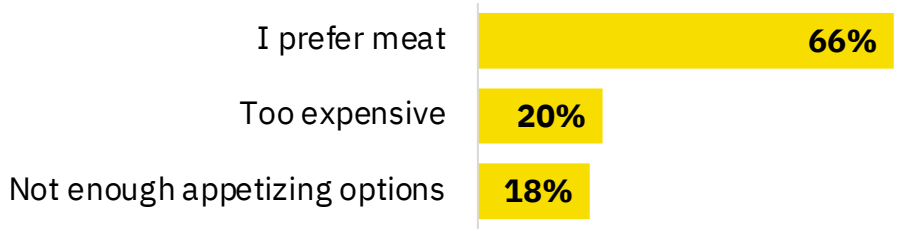
INNOVATE ON TASTE

There is room for growth in products and flavors on offer.

- 46% of consumers eating plant-based proteins more often are doing so for **variety** in meals.
- General preference for meat is a barrier for 66% of consumers who do not eat plant-based proteins.

U.S. consumers: barriers to eating plant-based meat products

February 2021



CLOSE THE PRICE GAP

Plant-based products are priced at a premium compared to animal-based products.

Plant-based

$0.67 / ounce

$0.08 / fl. oz.

Animal-based

$0.59 / ounce

$0.09 / fl. oz.

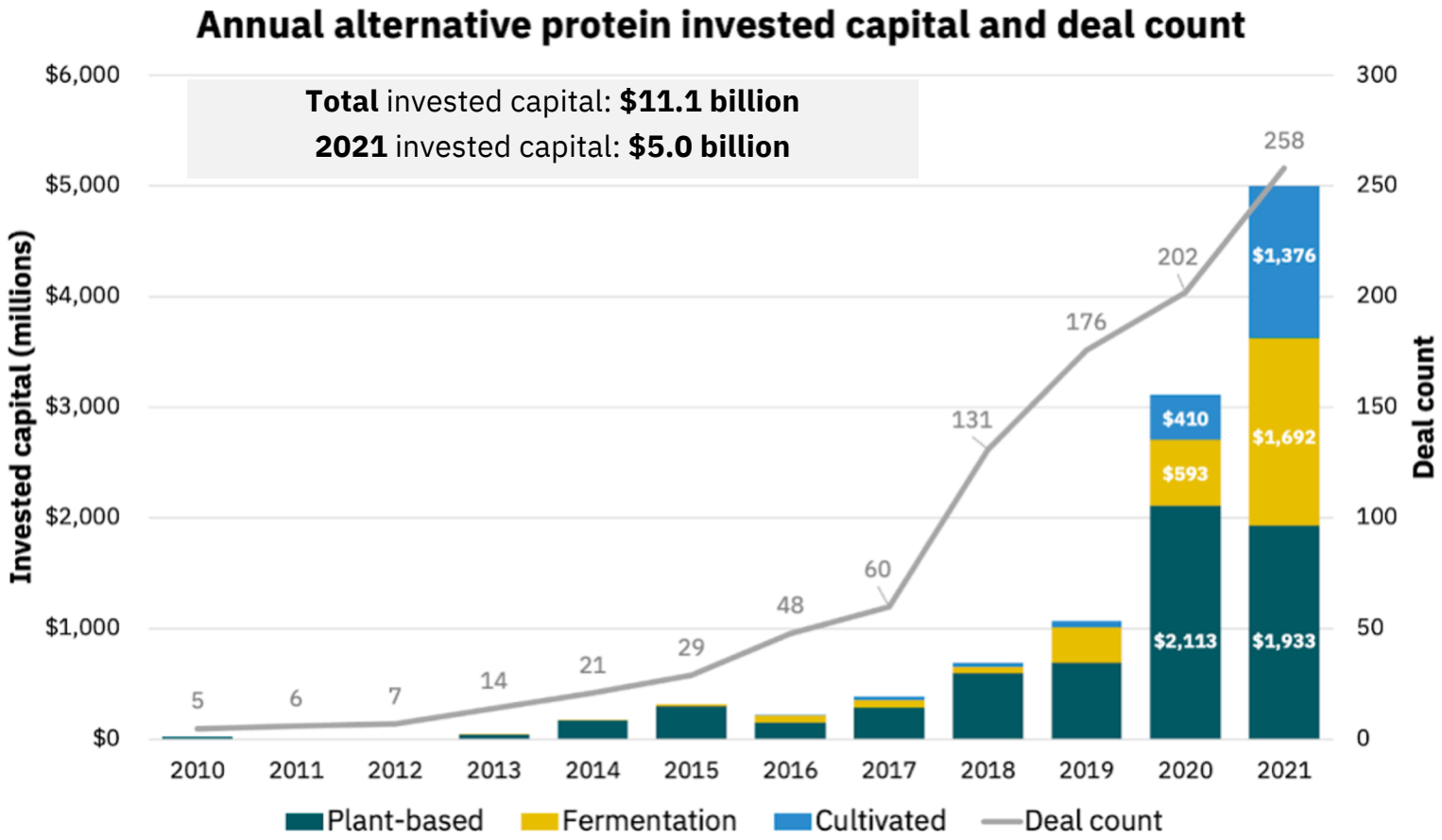
$0.34 / ounce

$0.03 / fl. oz.

Source: Mintel Reports US, Plant-based Proteins, 2021; pricing data lists point-in-time, non-promotional prices, for products at select stores.
Bases: 536 internet users aged 18+ who are eating plant-based proteins more often; 390 internet users aged 18+ who do not eat plant-based proteins

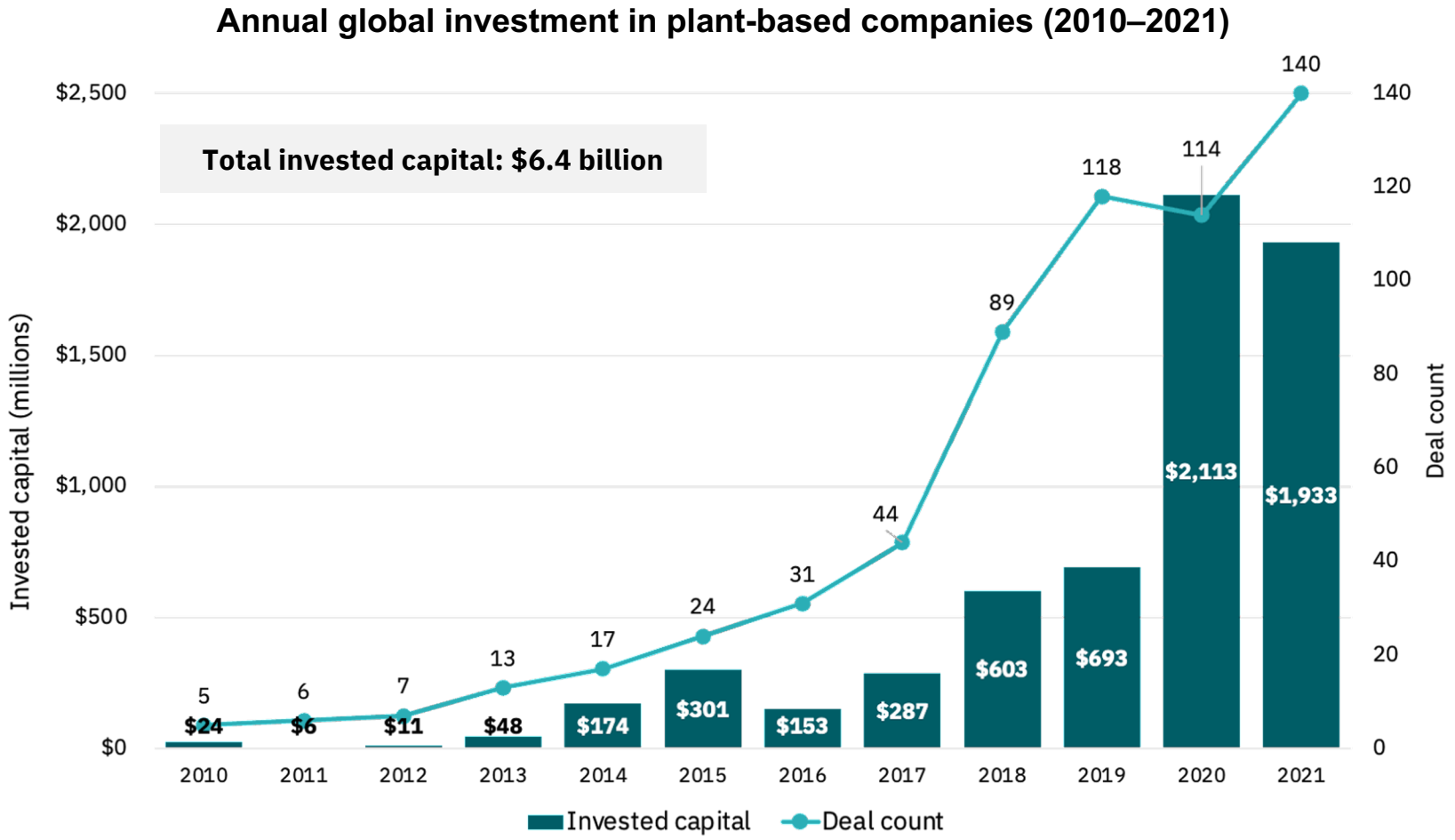
Investments

Rapid investment growth



Source: GFI analysis of PitchBook Data, Inc. Data has not been reviewed by PitchBook analysts.
Note: Invested capital includes accelerator and incubator funding, angel funding, seed funding, equity and product crowdfunding, early-stage venture capital, late-stage venture capital, private equity growth/expansion, capitalization, corporate venture, joint venture, convertible debt, and general debt completed deals.

Plant-based investments surpass $6 billion



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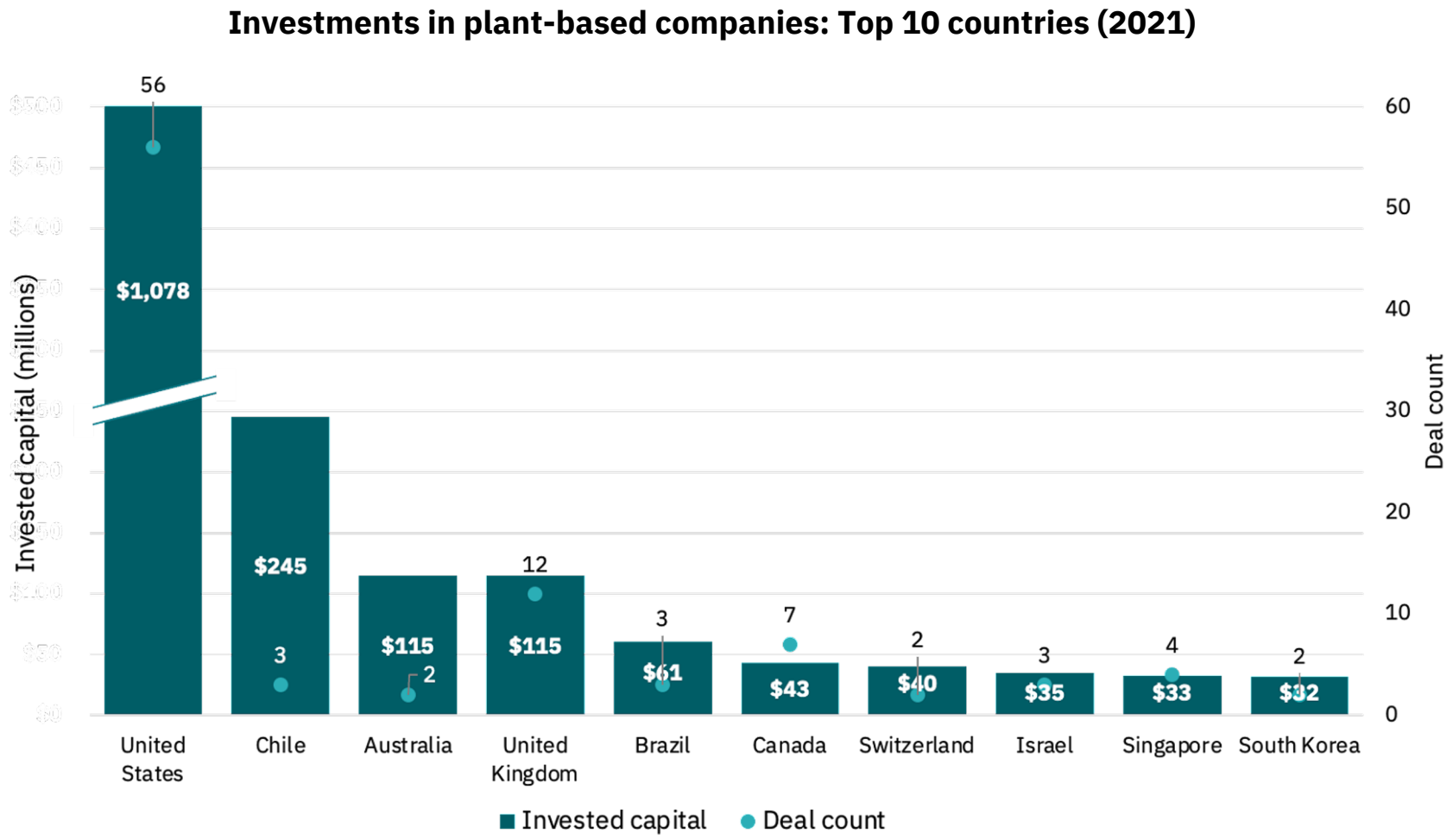
Geographical diversification



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Key plant-based funding rounds (2021)

Late Stage VC

- IMPOSSIBLE™ — $500M
- MEATLESS FARM — LOVINGLY MADE FROM PLANTS — $75M
- PARABEL® — $29M

Private equity

- ABOVE FOOD™ — $31M
- THE JACKFRUIT COMPANY — $23M

Series E

- ripple — Dairy-Free. As It Should Be.™ — $57M

Series D

- NotCo — $235M

Series C

- Daring. — $65M
- fazenda futuro — $58M
- MIYOKO'S CREAMERY — SONOMA CALIFORNIA — $52M
- LAVA — $24M

Series B/B2

- v2food™ — $110M
- SIMULATE® — $50M
- Daring. — $40M
- Gathered Foods — $26M
- Planted foods — $21M
- DAIZ — $17M
- Nada moo! — $10M
- UNLIMEAT — $9M

Source: GFI analysis of PitchBook Data, Inc. Data has not been reviewed by PitchBook analysts.

Key plant-based funding rounds (2021) (continued)

Series A

Redefine Meat	Plantible	Hungry Planet	Outstanding Foods	Stockfeld Dreamery	Abbot's Butcher	Planted Foods
$29M	$27M	$25M	$21M	$19M	$19M	$19M

Series A (continued)

New Wave Foods	This	Heura	Wicked Healthy	Spero
$18M	$16M	$15M	$14M	$11M

Early Stage VC

Unlimeat	Nova Meat
$23M	$7M

General debt

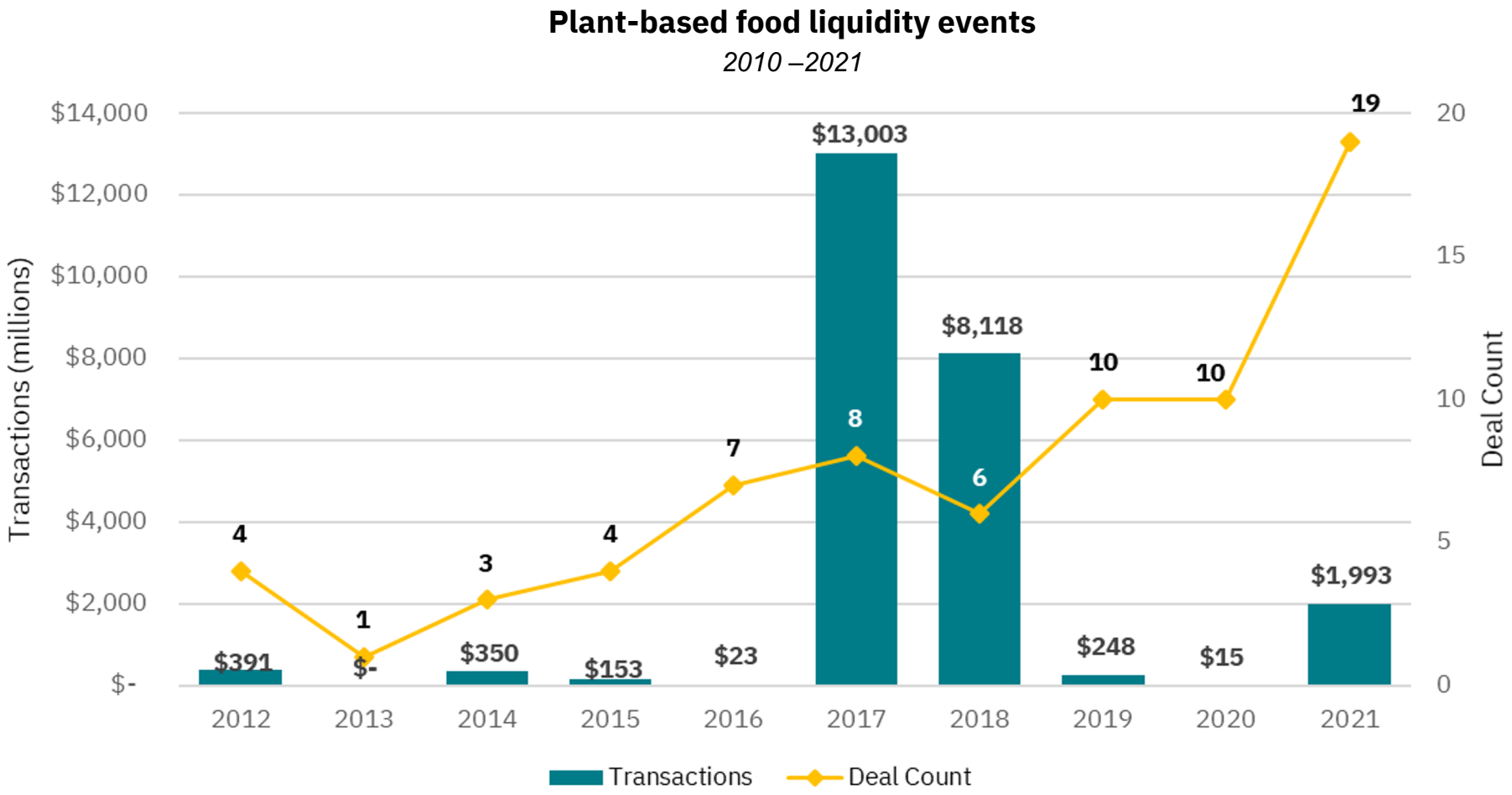
Kitehill
$2.5M

Seed

Next Gen	Mighty
$30M	$6M

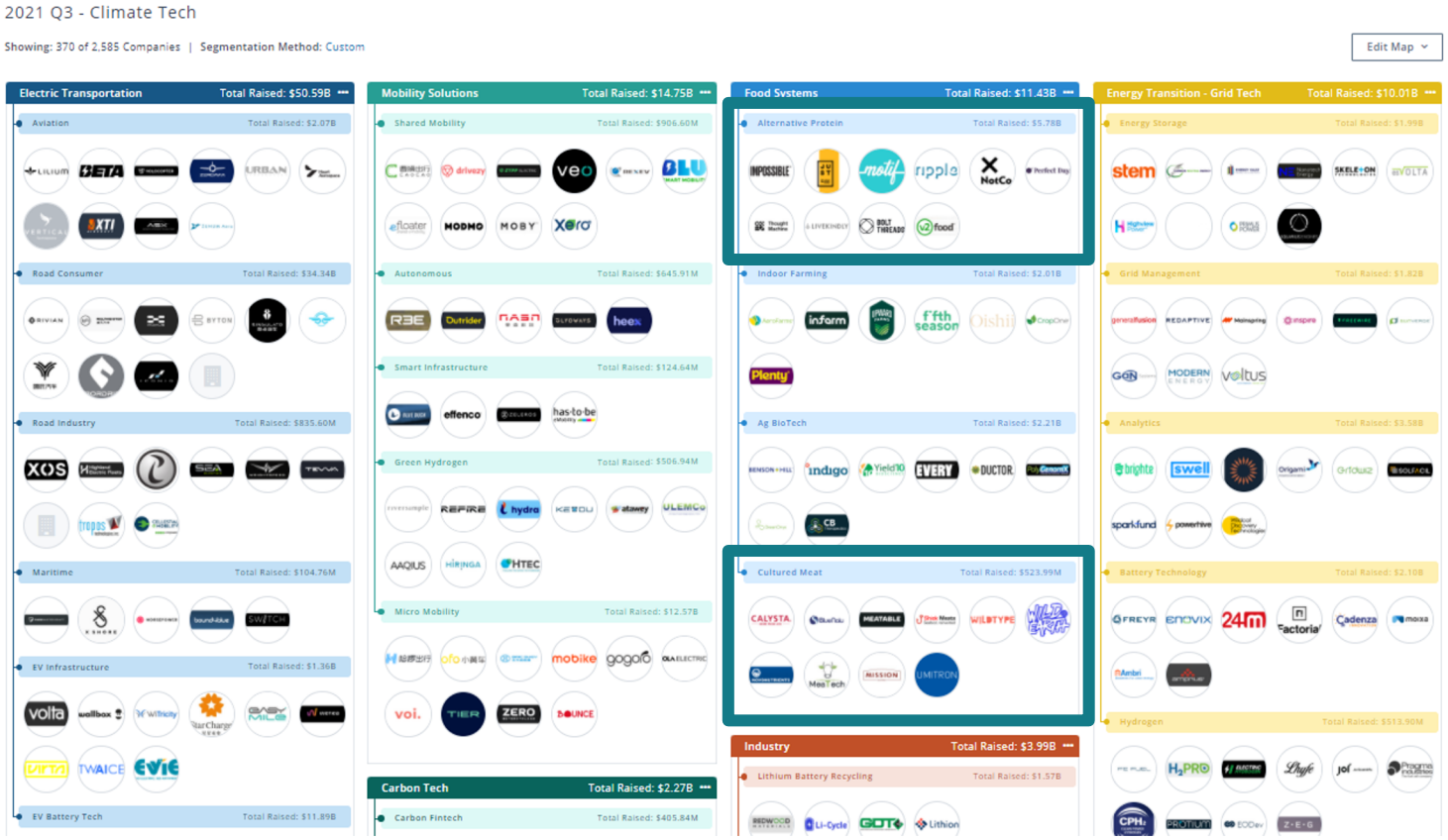
Source: GFI analysis of PitchBook Data, Inc. Data has not been reviewed by PitchBook analysts.

Plant-based liquidity events pick up



Source: GFI analysis of PitchBook Data, Inc. Data has not been reviewed by PitchBook analysts.
Note: Liquidity events comprises mergers, acquisitions, reverse mergers, buyouts, leveraged buyouts, and IPOs.

Alternative proteins increasingly recognized as core part of climate tech



Pitchbook includes alternative proteins in it's **Climate Tech Market Map.**

Alternative protein specialist VCs listed in PitchBook's list of **top early-stage VC climate tech funds.**

Top early-stage VC climate tech funds

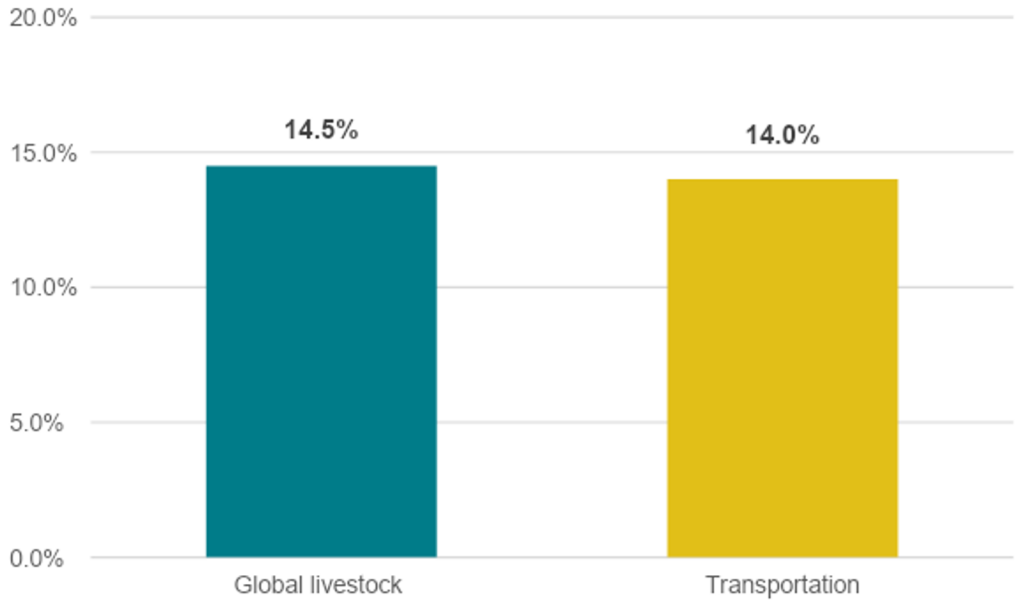
Fund	Fund size ($M)*	Fund status	Close date
SOSV Select	$100.0	Closed	June 14, 2021
New Protein I	$50.0	Closed	May 14, 2021
Blue Horizon Ventures	$394.6	Closed	January 20, 2021
Contiguous Venture Capital	N/A	Closed	December 31, 2020
The Actuator Medtech VC	N/A	Closed	December 31, 2020
Stray Dog Capital II	$27.2	Closed	December 31, 2019
SOSV IV	$277.0	Closed	December 6, 2017
Artesian China Venture	$50.0	Closed	December 31, 2017
Clean Energy Seed	$19.4	Closed	May 24, 2017
SproutX Agtech Seed	$7.6	Closed	March 17, 2017

Source: PitchBook | **Geography:** Global
*As of November 25, 2021

Source: PitchBook Market Maps (left), "Archetypal Investing into Climate Tech A post-COP26 roadmap" report by PitchBook (right).

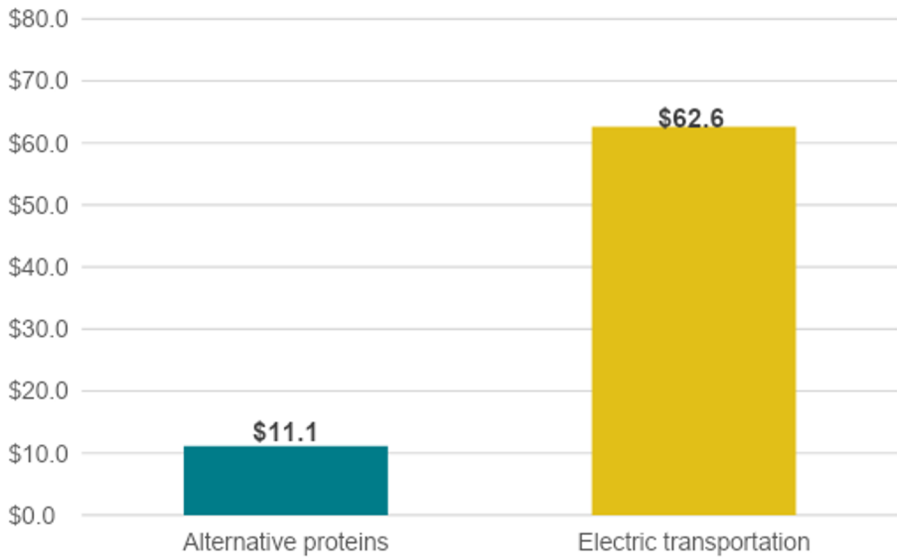
Under-investment in alternative proteins as a climate technology solution

Percent of global GHG emissions[1]



Invested capital[2]

USD billions, through December 31, 2021



[1] Source: U.S. Environmental Protection Agency (EPA), Food and Agriculture Organization of the United Nations FAO).
[2] Source: GFI analysis of PitchBook Data, Inc. Note: Data has not been reviewed by PitchBook analysts. Invested capital includes accelerator and incubator funding, angel funding, seed funding, equity and product crowdfunding, early-stage venture capital, late-stage venture capital, private equity growth/expansion, capitalization, corporate venture, joint venture, convertible debt, and general debt completed deals.

Science and technology

Crop breeding improves downstream processes

SOURCE SELECTION

Characterize new crop sources to diversify the available inputs for plant-based meat.

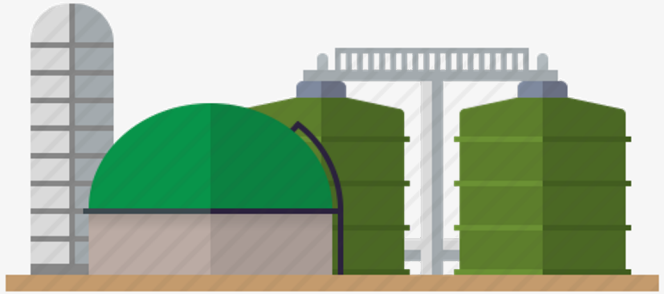
OPTIMIZATION

The source material is optimized via breeding or engineering.

Crop optimization

INGREDIENT PROCESSING

Raw materials are isolated and functionalized by mechanical and chemical processes to create optimal ingredients for the end product.

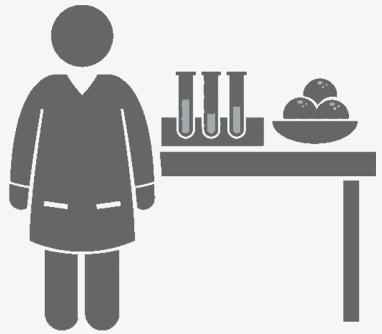


Isolation & functionalization

END PRODUCT FORMULATION AND MANUFACTURING

The correct mix of ingredients and processes are established to create the desired taste, texture, smell, and structure

Texturization

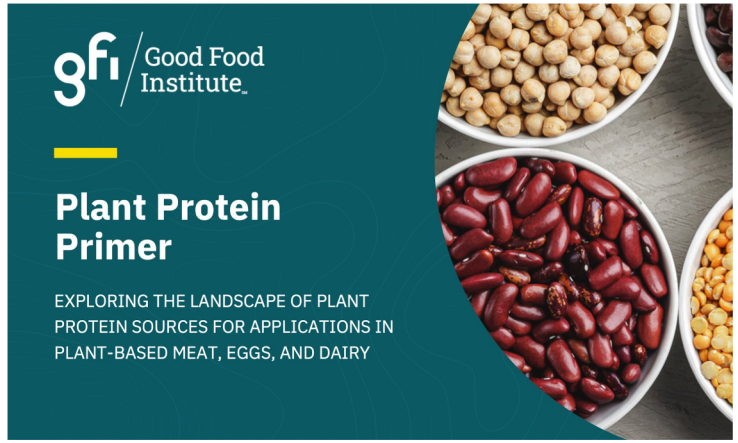


Formulation & manufacturing

Novel crop sources for protein ingredients

Protein source	Protein concentration	Nutrition	Allergenicity	Commercial stage	Flavor	Functionality	Cost	Global crop supply
Soy	●	●	●	●	●	●	●	●
Pea	●	●	●	●	●	●	●	●
Wheat	●	●	●	●	●	●	●	●
Mung bean	●	●	●	●	●	●	●	●
Chickpea	●	●	●	●	●	●	●	●
Lupin	●	●	●	●	●	●	–	●
Sunflower	●	●	●	●	●	●	●	●
Fava bean	●	●	●	●	●	●	●	●
Peanut	●	●	●	●	●	●	–	●
Rice	●	●	●	●	●	●	●	●

Legend	Protein concentration	PDCAAS*	Allergenicity	Commercial stage	Flavor	Functionality	Cost (/kg protein)	Global crop volume (MMT†)
● Excellent	>30%	>0.08	Usually mild, low pop.	Commodity	Flavorless	Low conc. effect	<$2	>100
● Good	20-30%	0.60-0.79	↕	Large	↕	↕	$2-4	10-99
● OK	10-20%	0.40-0.59	↕	Small	Acceptable	↕	$5-9	1-9
● Low	5-10%	0.20-0.39	↕	Start-up	↕	↕	$10-19	0.1-0.9
● Poor	<5%	<0.20	Severe in sig. pop.	R&D	Objectionable	Water insoluble	>$20	<0.1

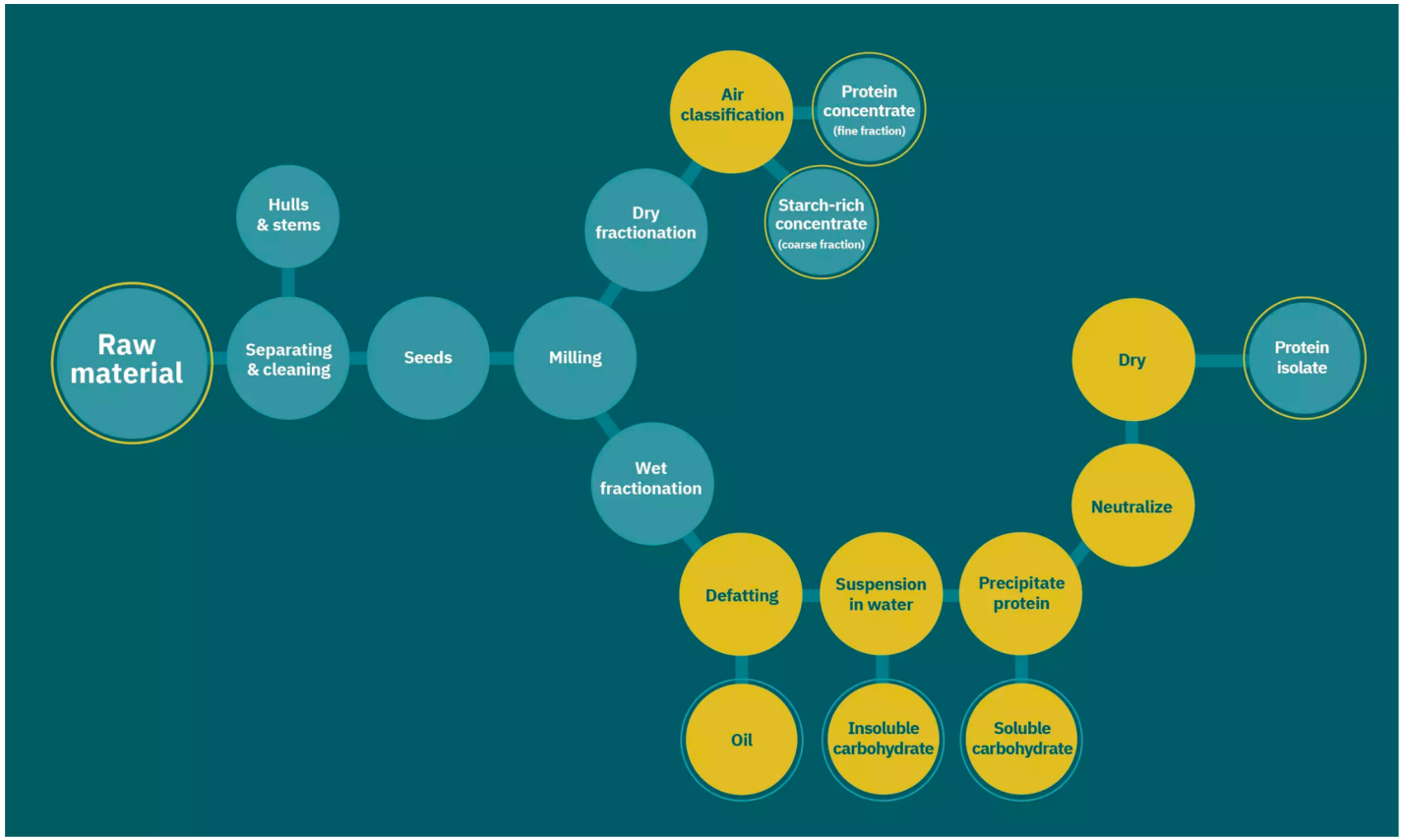


gfi.org/resource/plant-protein-primer

Novel crops used in alternative protein products

Protein source	Product use	Company update in 2021
Seaweed		New Wave, Maverick, Akua
		LIVEKINDLY with The Dutch Weed Burger
Duckweed		Plantible
Rice		Birds Eye
Peanut		HaoFood
Mung bean		WTH Foods
		JUST
Lentil		Evo Foods
Lupin		Nabati Foods
Fava bean		Perfeggt
Chickpea		InnovoPro, Peggs
		Wellme
Sesame		The Planting Hope Co.
Sorghum		alt foods (with millet, amaranth, and oats)
Bambara groundnut		WhatIF Foods BamNut Milk
Potato		Loca Food, So Delicious
Hemp		Sustainable Foods, Sweet Earth Foods (with fava bean and pea proteins)
		Grounded Foods
Spent grain		Terra Bio
		AB InBev with EverGrain
Sunflower		Planted

Plant protein fractionation scalability improves



Crops are **fractionated** to separate macromolecules.

Protein enrichment also removes small impurities like antinutrients and off-flavors.

Fractionation strategy effects protein:

- Protein types recovered
- Properties
- Yield

Mechanical innovation in whole-muscle products

EXISTING

Mixing, molding, forming

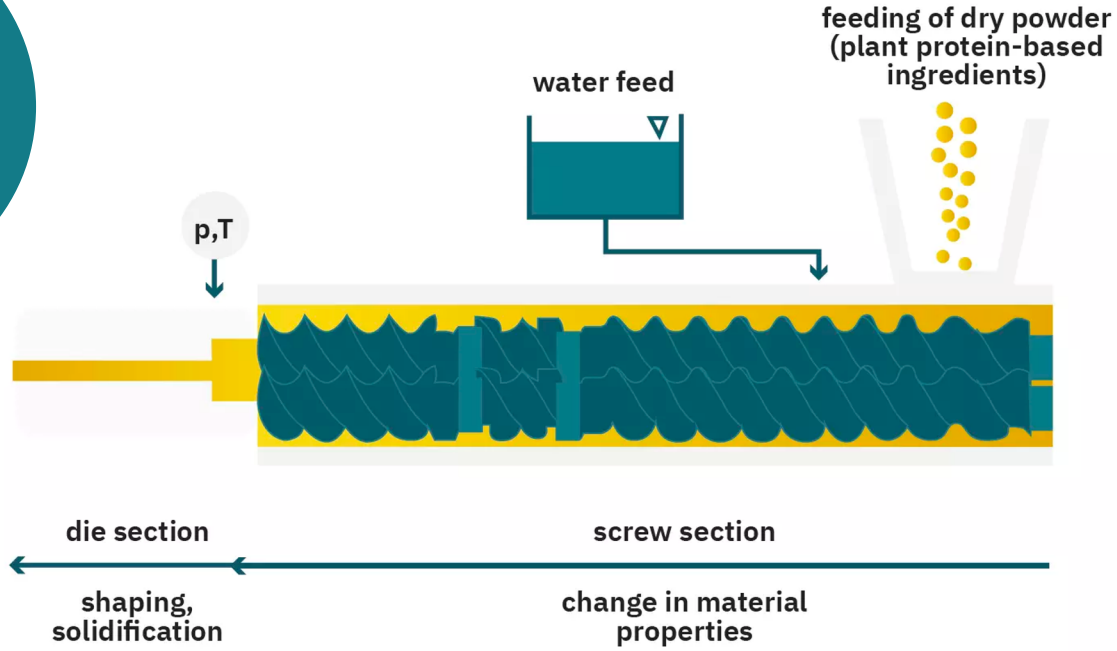
Twin screw high moisture extrusion

Low moisture extrusion

MECHANICAL INNOVATION

3D printing & electrospinning

Shear cell technology



Better alternative fats for plant-based products

Plant-based fats

Bflike

motif FOODWORKS

EPOGEE®

Fermentation-derived fats

Melt&Marble

cultivated BIOSCIENCES

nourish INGREDIENTS

yali bio

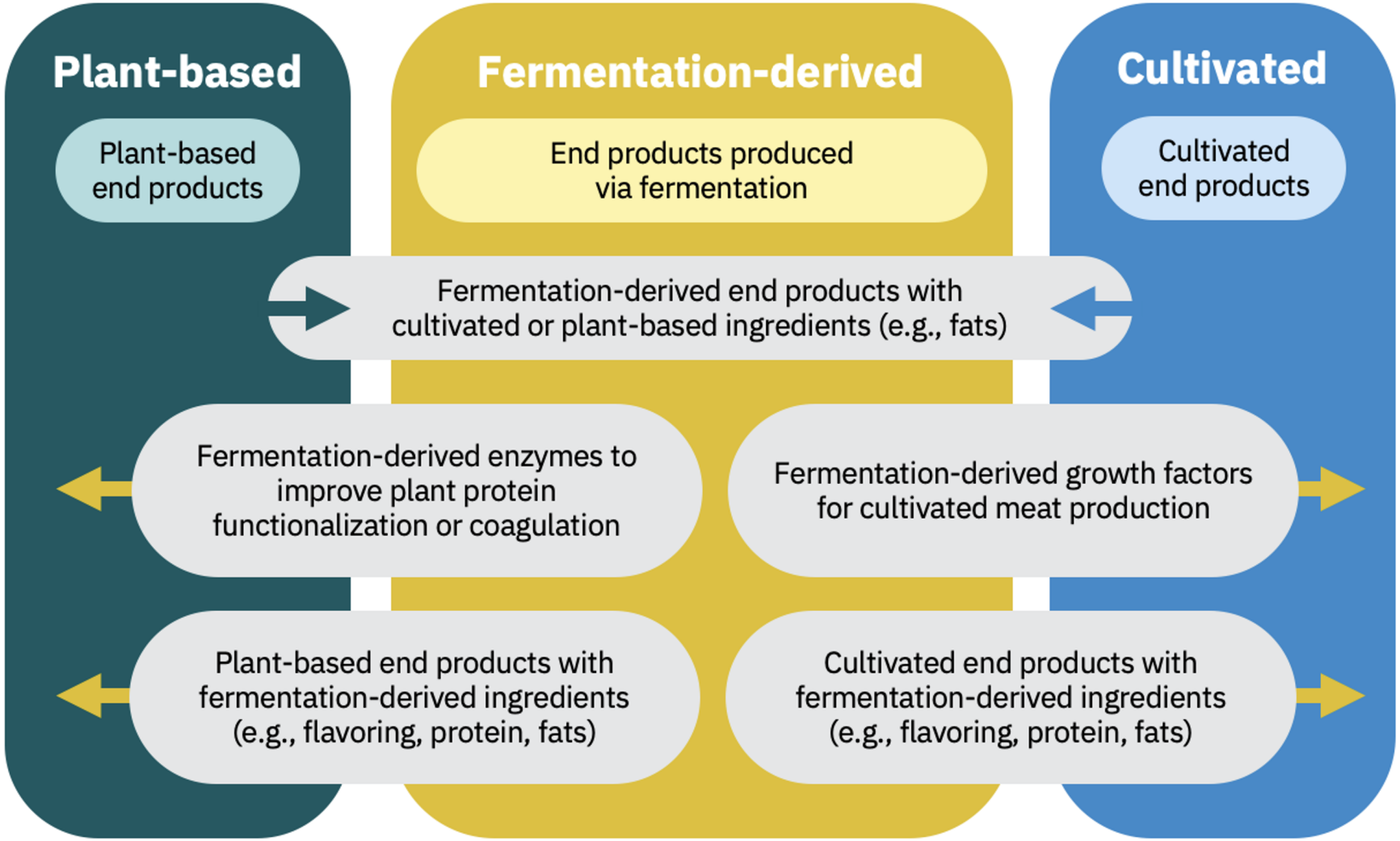
MYCORENA

Cultivated fats

MISSION BARNS

HOXTON FARMS

Emergence of hybrid products



GFI's 2021 competitive research grantees

GFI's 2021 CRG plant-based grantee cohort:

Connective tissue from plant fibers	Dr. Xiaonan Sui
3D printing pulses into fish	Dr. Luciano Paulino Silva
Stacking plant protein sheets	Dr. Hanry Yu
Self-aggregating proteins	Dr. Lutz Grossmann
Melt-spinning marbled meat	Dr. Jay Park

Check out our **research grants** page to explore grant opportunities and meet the scientists leading open-access fermentation research for applications in meat, eggs, and dairy.

GFI's 2021 white space research grantees

Enzymatic conversion of oils into functional fats using glycerolysis

Research highlight: Dr. Alejandro Marangoni, a researcher in food science at University of Guelph is leading a project to **enzymatically convert triacylglycerides into mono- and di-acylglycerides, which have higher melting points without modifying lipid saturation.**

Production of omega-3 enriched plant-based adipose tissue using advanced emulsion technology

Research highlight: Dr. Jiakai Lu, a researcher in the Department of Food Science at University of Massachusetts, Amherst, is leading a project to leverage **oil-in-water emulsions to create omega-3-rich adipose tissue alternatives.**

Check out our **research grants** page to explore grant opportunities and meet the scientists leading open-access fermentation research for applications in meat, eggs, and dairy.

Policy

United States: Federal regulation

- FDA has regulatory authority
- Guidance on labeling plant-based milk expected soon
  - GFI has urged FDA to permit use of common dairy terms on PB products, so long as modifiers are used (e.g., “soy yogurt” or “oat milk”)
  - Generally, 60 days to comment on draft guidance
- FDA plans to begin work this year on draft guidance for “plant-based alternatives to animal-derived foods”

United States: State label censorship laws

- **Louisiana**
  - Recent victory
- **Arkansas**
  - Initial victory but still pending, waiting for court to decide whether injunction applies to all companies
- **Oklahoma**
  - New case recently filed
- **Missouri**
  - Still pending after request for injunction denied

United States: Label censorship enforcement

- **California**
  - California Department of Food and Agriculture instructed Miyoko's Kitchen not to use "dairy" terms on vegan butter
  - State argued "butter" is defined under federal law, other terms implied that product was bovine
  - Miyoko's sued and won
  - Court held:
    - Use of term "butter" not prohibited just because the Govt has defined it
    - Other terms not misleading
    - Protected by the First Amendment

United States: Government support

- GFI led coalition asking Congress to prioritize AP research in FY22
- House Approp. Committee chair Rosa DeLauro has championed APs for their climate and food security benefits
- 15 House members alled on John Kerry to promote APs as a key climate solution
- 16 members of Congress asked House Agriculture Committee to include AP research funding in budget reconciliation
- 11 members of Congress sent a letter to Secretary of Agriculture urging USDA to include AP research funding in agency's FY 2023 budget request

Europe: Label censorship

- European Parliament withdrew amendment that would have banned “evocation” of dairy, including images and packaging that resembles animal milk and words like “creamy” or “buttery”
- But terms like “milk” and “yoghurt” remain restricted to animal-based products
- France and Belgium proposed new restrictions on PB meat and seafood labeling in 2021
- GFI Europe is working with allied organizations at EU and national levels to fight these proposals

Europe: Government support

- Denmark: >$190 million to advance plant-based foods
- Germany's Fraunhofer Society: project focused on novel AP ingredients
- EIT Food: funding project to identify and assess new AP ingredients from underutilized plant sources
- UK: two PhD studentships for research in ingredient optimization and optimizing plants for molecular farming
- UK: $140,000 grant to Plant Meat Limited and University of Leeds & $217,000 to SPG Innovation Limited
- Sweden: several grants for plant-based research
- Research Council of Norway: funding for a four-year project titled "Green technology for plant-based food"

Brazil

- Dep’t of Inspection of Plant Products at Ministry of Agriculture and General Food Office at National Health Agency co-leading regulatory process
- Conducting regulatory impact analysis for alternative proteins
  - 10-step process
  - GFI expects next 8 in 2022
  - Once completed, draft standards will be published for public consultation (expected 2023)
- GFI Brazil hired Food Technology Institute to develop analysis to guide government’s approach to regulation.
  - Study released in March 2022 provides science-based arguments and comparative analysis of regulatory experiences abroad

India

- Food Safety and Standards Authority of India (FSSAI) set up task force on “vegan foods” in 2020 and issued draft rules in 2021
  - Food products marketed as vegan must display vegan logo
  - Final regulation will be published after review of public comments

- Ministry of Food Processing Industries (MoFPI) announced production of plant-based meat is eligible for financial assistance under PMKSY
- Government provided financial assistance and incentives for production of soy milk and coconut milk
- Several government agencies and departments are involved in plant-based meat R&D
  - NIFTEM
  - Central Food Technological Research Institute Mysore
  - Defense Food Research Laboratory Mysore

Global product approvals

- Impossible Foods approval for heme from Food Standards Australia New Zealand (FSANZ) finalized in February 2021
- In 2021, European Food Safety Authority (EFSA) published scientific opinion concluding Eat Just's mung bean protein is safe for consumption
- In April 2022, European Commission approved mung bean protein as an authorized novel food
- In December 2021, Motif FoodWorks received "no questions letter" from FDA in response to GRAS notice for their heme protein derived from yeast, called HEMAMI™
  - Expected to be used in plant-based meat products

Codex

- Creates nonbinding standards for food safety, labeling, trade
- Influences global food policy
- GFI granted observer status
- Currently beginning work on APs and other new foods and production systems
  - Circular letter issued requesting information
  - GFI responding
- Interested stakeholders should contact Maddie Cohen or Laura Braden at GFI

Q&A

For more resources, sign up for GFI's Alternative Protein Opportunity newsletter:

https://gfi.org/resource/opportunity

Photo: The Plant-Based Seafood Co.

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Contact us at **corporate@gfi.org** with any questions!

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