



2022 STATE OF THE INDUSTRY REPORT

# Plant-based meat, seafood, eggs, and dairy

# Editors' note

Meat production is projected to nearly double by 2050 to meet growing global demand. But the way the world currently produces meat cannot scale to meet this demand and still achieve global climate, health, food security, and biodiversity goals. Making meat differently via alternative proteins can help feed a growing world safely and efficiently, and will be as essential to mitigating climate change as the global transition to renewable energy. When compared to conventional meat production, alternative protein production dramatically reduces emissions, requires far less land, eliminates the use of antibiotics in our food system, and feeds more people with fewer resources.

By reimagining protein, we can produce food that people love and usher in a more sustainable, secure, and just food future. Countries have committed to halve emissions and protect 30 percent of global land and ocean ecosystems by 2030. With just seven years to go, investing in alternative ways of making meat, seafood, eggs, and dairy is essential.

GFI's annual State of the Industry Reports equip food system stakeholders with a solid, in-depth understanding of the alternative protein market, issues, and opportunities. These reports also serve as a global call to action:

*Alternative proteins are a scalable solution that, with proper levels of public, private, and civil society support, can help address the biggest challenges of our time and transform our global food system for the better.*

Making meat from plants offers a powerful way to tackle these challenges while also advancing personal, public, and planetary health. Across multiple studies, data increasingly points to plant-based meats as healthier than their animal-sourced counterparts—higher in fiber, lower in saturated fats, lower in calories, and zero cholesterol. In the public health arena, a shift toward alternative proteins can significantly reduce global risks including antibiotic resistance and pandemics. Plant-based meat can also cut emissions by 90 percent, and use 99 percent less land and water than conventional meat—actions critical for planetary health.

This report details some of the promising developments that moved the plant-based alternative protein field forward in 2022. The sector still has miles to go, however, to reach full potential. Funding and workforce constraints pose two of the biggest bottlenecks for scientific innovation and scaling. The industry is still early in its development, with growth patterns similar to other emerging markets and technologies. As companies continue to innovate, and as more talent, research funding, and investments flow into alternative proteins, the entire sector will accelerate, offering the world a fundamentally different and far more sustainable food future.

With gratitude and deep respect to all those on this journey, we invite you to dig deep into our 2022 State of the Industry Report, *Plant-based meat, seafood, eggs, and dairy*.

Best,



**Caroline Bushnell**  
VP of Corporate Engagement



**Liz Specht, PhD**  
VP of Science and Technology



**Jessica Almy**  
VP of Policy

## About GFI’s State of the Industry Report series

GFI’s State of the Industry Report series serves as our annual alternative protein sector deep-dive. The series compiles business developments, key technologies, policy updates, and scientific breakthroughs from around the world that are advancing the entire field. This year’s reports include:

- *Cultivated meat and seafood*
- *Fermentation: Meat, seafood, eggs, and dairy*
- *Plant-based meat, seafood, eggs, and dairy*
- *Global policy: Public support, regulation, and labeling*

The *Plant-based meat, seafood, eggs, and dairy* report synthesizes 2022 updates across the global industry focused on plant-based alternatives to conventional animal products. For a full primer on the latest science and technological developments of plant-based alternative proteins, please visit GFI’s [science of plant-based meat deep dive](#) page.

### Symbols to look for

Throughout the 2022 State of the Industry Report series, look for symbols highlighting how developments in the past year advanced the alternative protein sector in the areas of health and nutrition, sustainability, and path-to-market progress. Dig deeper and opportunity icons are calls to action for researchers, investors, and others seeking to learn more and advance the field.



**Health**



**Sustainability**



**Opportunity**



**Path-to-market**



**Dig deeper**

*Please note that The Good Food Institute is not a licensed investment or financial advisor, and nothing in this report is intended or should be construed as investment advice.*

# About the Good Food Institute

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As a nonprofit think tank and international network of organizations powered by philanthropy, GFI works alongside scientists, businesses, and policymakers to make alternative proteins as delicious, affordable, and accessible as conventional meat. In Asia Pacific, Europe, Brazil, India, Israel, and the United States, our teams are mobilizing the international community to use markets and technology to replace harmful practices with ones that are better for the climate and biodiversity, for food security, and for global health.

We focus on three programmatic priorities:

## Cultivating a strong scientific ecosystem

GFI's science and technology teams map out the most neglected areas that will allow alternative proteins to compete on taste and price. We develop open-access research and resources, educate and connect the next generation of scientists and entrepreneurs, and fund research that benefits alternative protein development across the sector.

## Influencing policy and securing government investment

GFI's policy teams ensure that alternative proteins are a part of the policy discussion around climate change mitigation and global health. In every region where we have a presence, we advocate for government investment in alternative proteins and are paving the way for the approval of novel proteins such as cultivated meat.

## Supporting industry to advance alternative proteins

GFI's corporate teams are replicating past market transformations and 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.

## Stay connected

- **Newsletters** | GFI's suite of expertly curated newsletters puts timely news, insights, and opportunities right in your inbox, Check out [gfi.org/newsletters](https://gfi.org/newsletters) to find the ones most suitable for your interests.
- **Monthly seminar series** | Each month, we host [online seminars](#) with leading experts from around the world: The *Business of Alt Protein* series is geared toward a commercially focused audience on topics related to starting and scaling a good food business. The *Science of Alt Protein* series addresses a technical audience and focuses on cutting-edge research developments that enable alternative protein innovation.

This State of the Industry Report series, as well as all of GFI's work, is made possible by gifts and grants from our global family of donors. If you are interested in learning more about giving to GFI, please visit [here](#) or contact [philanthropy@gfi.org](mailto:philanthropy@gfi.org).



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# **Executive summary**

# Executive summary

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In 2022, the plant-based meat and seafood retail industry generated \$6.1 billion in global sales, growing eight percent by dollars and five percent by weight. Combined plant-based milk, cheese, and yogurt hit \$21.6 billion on the global stage, up seven percent from 2021. Amid challenging macroeconomic and market conditions, this rapidly evolving industry made major strides across the areas of science, sustainability, and public and private sector support. As consumer engagement with, and interest in, plant-based proteins increases around the world, retailers and manufacturers are leaning in, introducing new products, developing strategic partnerships, and building new production facilities. Public sector participation is also increasing, with more governments around the world investing in plant-based proteins as a research and commercialization priority.

*Plant-based meat, seafood, eggs, and dairy*, part of our 2022 State of the Industry Report series, takes a field-wide, global view of the progress made over the past year.



# Commercial landscape

## New products and categories.

Hundreds of new plant-based alternatives to conventional animal products hit retail shelves in the U.S. market in 2022, including in emerging categories like plant-based steak, salmon, foie gras, fish balls, and schnitzel.

## Retail and foodservice trends.

- Large food companies released plant-based versions of popular branded products, including dairy-free **Philadelphia** cream cheese and **Babybel** cheese, and **Kellogg's** plant-based chicken waffle **Eggo** sandwich.
- **Burger King** launched two new Impossible burgers in the U.S. and trialed its first fully plant-based location and default plant-based location in Europe.

## New partnerships.

Companies continued to collaborate to develop new products and scale production: we tallied 25 new strategic partnerships in 2022.

## Manufacturing capacity.

Six companies opened new or expanded production facilities, and 11 new plant-based contract manufacturers were added to GFI's database, bringing the total number of known plant-based contract manufacturers to 127.

# Sales

**Table 1: U.S. retail plant-based food sales metrics, 2022**

	Dollar sales	1-yr. dollar growth	3-yr. dollar growth	Dollar share	Unit sales	1-yr. unit growth	Unit share	Household penetration	Repeat rate
Total plant-based foods	\$8.0 B	7%	44%	1.4%*	1.9 B	-3%	1.2%*	60%	80%
Plant-based meat	\$1.4 B	-1%	43%	1.3%**	255 MM	-8%	1.7%**	18%	63%
Plant-based milk	\$2.8 B	9%	36%	15.3%	749 MM	-2%	14.7%	41%	76%

Sales data 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. \*Share values for the total plant-based foods category out of total edibles sales (frozen, grocery, refrigerated, and protein powders/bars). Share values of individual plant-based categories are out of their respective total plant-based plus animal-based category. \*\*SPINS does not report non-UPC animal-based meat counter sales. To calculate the plant-based meat share of the total meat category, dollar and unit volume assumptions for non-UPC animal-based meat counter sales are added to SPINS' UPC animal-based meat sales. Household data note: SPINS uses a separate process from the sales data to pull household panel data which may result in minor category differences.

Source: Sales data - SPINS Natural Grocery Channel, SPINS Conventional Multi Outlet Channel (powered by Circana, formerly IRI & NPD) | 52 Weeks Ending 1-1-2023. Household data - NCP, All Outlets, 52 weeks ending 1-1-23

Total U.S. retail plant-based food dollar sales reached \$8 billion in 2022.

- Price increases drove dollar sales up 7% while unit sales declined 3% for total plant-based foods, a trend mirrored across many plant-based categories, total food and beverage, and animal-based food.
- Plant-based milk dollar sales grew 9% to \$2.8 B while unit sales declined 2%.
- Plant-based meat dollar sales decreased 1% and unit sales declined 8%.
- Notable categories that saw both dollar and unit sales growth included plant-based eggs, plant-based seafood, plant-based creamers, and plant-based protein liquids and powders.

# Investments

Plant-based meat, seafood, eggs, and dairy companies raised \$1.2 billion in 2022 (representing 15 percent of all-time investment\*), bringing total investments to \$7.8 billion. The number of unique investors in plant-based companies grew by 17 percent to more than 1,500 investors.

\*investment since 1997

**Table 2: Invested capital in plant-based meat, seafood, eggs, and dairy**

Category	2022	1997–2022	Highlights
<b>Total invested capital</b>	\$1.19B	\$7.78B	2022 invested capital represented 15% of all-time investment.
<b>Invested capital deal count</b>	145	935	2022’s largest investment was \$135.6 million raised by Redefine Meat.
<b>Unique investors</b>	222 (new)	1,521	The number of unique investors grew by 17% in 2022.
<b>Liquidity event capital</b>	\$119MM	\$26.9B	PlantPlus Foods, a joint venture of ADM and Marfrig, acquired Sol Cuisine for \$102 million in 2022.
<b>Liquidity event count</b>	15	121	
<b>Other financing capital</b>	\$15MM	\$146MM	The vast majority of other financing events are private investments in public equity (PIPEs).
<b>Other financing count</b>	4	20	

# Science and technology

## Crop diversification and manufacturing.

Companies increased R&D efforts for ultra-high protein chickpeas, fava beans, mung beans, and cowpeas. Diverse plant protein ingredients are gaining traction, with progress being made to increase their production and reduce their costs.

## Health and nutrition.

In 2022, a literature review of 43 studies on the healthiness and environmental sustainability of plant-based meat alternatives compared to animal products underscored numerous personal health benefits of plant-based meat.

## Environmental and social impact.

Valorizing sidestreams for alternative proteins continued to gain momentum, including protein extraction from leaves destined for waste and upcycling of sunflower, canola, and barley proteins.

# Government and regulation

## Government support.

Europe led investments in plant-based protein with commitments from Denmark, Sweden, and Switzerland to invest more than \$150 million in R&D. Canada emerged as a global leader in public support for plant-based proteins in R&D, commercialization, and regulatory policy. Singapore's government launched a number of programs to support alternative protein startups and accelerate innovation. In the U.S., support for alternative protein R&D was secured at both the federal and state levels, with Congress allocating nearly \$6 million to USDA and California allocating \$5 million to three universities.

## Label censorship.

In 2022, the French legislature passed a decree banning the use of many meat terms on plant-based labels, but the country's highest court temporarily suspended the enactment of the ban. In the U.S., a federal court found an Arkansas food label censorship law to be unconstitutional and permanently blocked enforcement of the law against Tofurky when the company uses terms like "sausage" and "burger" accompanied by words like "vegan" or "plant-based."

Section 1

# Commercial landscape

# Section 1: Commercial landscape

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## Overview

The plant-based meat, seafood, egg, and dairy industry—currently striving to create delicious, healthier, affordable, and more sustainable alternatives to conventional animal products—is just getting warmed up.

In 2022, according to Euromonitor data, total global retail sales of plant-based meat, seafood, milk, yogurt, and cheese reached \$28 billion. (Euromonitor does not report on plant-based eggs.) While impressive, the global plant-based market today is a tiny fraction of the multi-trillion-dollar market for conventional animal products. On the road ahead to mass market adoption, advances are needed on multiple fronts—and taste and price parity are among the biggest opportunities.

Notably, consumer interest in plant-based proteins is on the rise around the world. Retailers and manufacturers are introducing new products, new strategic partnerships, and new facilities. Intellectual property for plant-based meat has grown three times in the last decade. In 2022 alone:

- Quick-service restaurant chains including **Starbucks, Burger King, and KFC** expanded plant-based options in a number of regions. Burger King opened their first fully plant-based location and a default plant-based location.
- Large food brands developed plant-based versions of familiar products, like Philadelphia cream cheese, Kit Kat bars, and Babybel cheese.
- Companies launched new product formats to retail, like plant-based steak, foie gras, luncheon meat, and schnitzel.
- Companies continued to collaborate to develop new products and scale production to lower costs: we tallied 25 new strategic partnerships in 2022.
- Eleven new plant-based contract manufacturers were added to GFI's database, and six companies opened new or expanded production facilities.

## Check out our monthly Alternative Protein Opportunity newsletter for updates

Across the globe, plant-based products launch or expand distribution every week. GFI's monthly Alternative Protein Opportunity newsletter tags and categorizes notable plant-based distribution updates, new product launches, partnerships, facility openings, and more, helping you keep up with the fast-moving plant-based landscape. [Sign up here.](#)

## Plant-based ventures

Tables 1 and 2 provide alphabetized lists of plant-based meat and milk brands by U.S. retail dollar sales in 2022. GFI and the Plant Based Foods Association commissioned the sales data from SPINS and refined it using custom coding. The list of 10 brands with the most dollar sales in each of these categories did not change from 2021 to 2022.

**Table 3: Brands with the most total plant-based meat dollar sales in U.S. retail (alphabetized)**

Brand	Parent company	Country	Year founded
<a href="#">Beyond Meat</a>	n/a	United States	2009
<a href="#">Boca</a>	<a href="#">The Kraft Heinz Company</a>	United States	1979
<a href="#">Dr. Praeger's</a>	n/a	United States	1994
<a href="#">Field Roast</a>	<a href="#">Maple Leaf Foods</a>	Canada	1997
<a href="#">Gardein</a>	<a href="#">Conagra</a>	United States	2003
<a href="#">Impossible Foods</a>	n/a	Canada	2011
<a href="#">Lightlife</a>	<a href="#">Maple Leaf Foods</a>	United States	1979
<a href="#">MorningStar Farms</a>	<a href="#">Kellogg's</a>	United States	1975
<a href="#">Quorn</a>	<a href="#">Monde Nissin</a>	United Kingdom	1985
<a href="#">Tofurky</a>	<a href="#">Morinaga</a>	United States	1980

Source: GFI analysis of SPINS Natural Grocery Channel, SPINS Conventional Multi Outlet Channel (powered by Circana, formerly IRI & NPD) | 52 Weeks Ending 1-1-2023. © 2022 The Good Food Institute, Inc.

**Sales data note:** The data presented in this table 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.

**Table 4: Brands with the most total plant-based milk dollar sales in U.S. retail (alphabetized)**

Brand	Parent company	Country	Year founded
<a href="#"><u>Blue Diamond</u></a>	<a href="#"><u>Blue Diamond Growers</u></a>	United States	1910
<a href="#"><u>Califia Farms</u></a>	n/a	United States	2010
<a href="#"><u>Chobani</u></a>	n/a	United States	2005
<a href="#"><u>Dream Brands</u></a>	<a href="#"><u>SunOpta</u></a>	Canada	1982
<a href="#"><u>Oatly</u></a>	n/a	Sweden	1994
<a href="#"><u>Planet Oat</u></a>	<a href="#"><u>HP Hood LLC</u></a>	United States	2018
<a href="#"><u>Ripple</u></a>	n/a	United States	2014
<a href="#"><u>Silk</u></a>	<a href="#"><u>Danone</u></a>	United States	1977
<a href="#"><u>Simply</u></a>	<a href="#"><u>Coca-Cola</u></a>	United States	2001
<a href="#"><u>So Delicious</u></a>	<a href="#"><u>Danone</u></a>	United States	1987

Source: GFI analysis of SPINS Natural Grocery Channel, SPINS Conventional Multi Outlet Channel (powered by Circana, formerly IRI & NPD) | 52 Weeks Ending 1-1-2023. © 2022 The Good Food Institute, Inc.

*Sales data note:* The data presented in this table 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.



More information on these and other companies is available in GFI's [company database](#).



# Product launches

Around the world, new plant-based products launch or gain distribution across retail, food service, and e-commerce channels regularly. While not a comprehensive list of every launch in 2022, the following are notable product introductions that illustrate how this sector is growing, diversifying, and innovating.

## Retail

One significant retail trend in 2022 was large food companies releasing plant-based versions of longstanding, popular, branded products. This is exciting news for consumers who want more sustainable versions of their favorite foods, and a signal that companies are betting on plant-based alternatives by lending valuable household brand names to plant-based products.

- **Kraft-Heinz's** cream cheese brand Philadelphia launched their first dairy-free cream cheese in the United Kingdom and the United States.
- **Kellogg's** released their first plant-based Eggo waffle in a plant-based chicken waffle sandwich product made with **MorningStar Farms'** chicken.
- Large CPG brand **Bel Group** launched a plant-based version of the company's popular Babybel wax-covered cheeses into retail stores in Canada, the United States, and the United Kingdom. The company stated that the launch was part of a strategy to make half their offerings plant-based by 2030.
- **Nestlé** rolled out a plant-based Kit Kat across 15 European countries.

Private label retail and convenience stores offer an opportunity to make plant-based products more accessible to consumers at lower price points. Private label innovation and convenience store distribution in plant-based foods continued in 2022:

- **Trader Joe's** launched a private label liquid plant-based egg.
- UK retailer **Asda** launched a range of private label plant-based barbecue products that included plant-based burgers, chicken wings, lamb, sausages, and seafood.
- Chinese convenience store **Lawson** added two plant-based meat brands—Haofood and Beyond Meat—to their stores in more than 2,000 locations across China. Plant-based meat brand Haofood gained a distribution agreement with Chinese convenience store Lawson.

While plant-based offerings have greatly expanded over the past four years, there is still significant room for innovation. While plant-based burgers are widely available across many geographies, a number of animal products still lack any plant-based alternative at retail. These are among the noteworthy new plant-based product offerings in 2022:

- **Beyond Meat** launched a sliced plant-based steak—the company’s first whole-cut product and one of the first plant-based steaks available in U.S. retail.
- **Vivera**, a plant-based meat brand acquired last year by **JBS**, launched a plant-based salmon in grocery chains in the Netherlands.
- **Garden Gourmet**, Nestle’s plant-based brand, announced the launch of Voie Gras, the brand’s plant-based alternative to foie gras, in supermarkets in Switzerland and Spain.
- Leading conventional seafood company **Thai Union** launched plant-based shrimp dumplings and expanded the distribution of their plant-based tuna.
- **Century Pacific**, the largest branded food company in the Philippines, launched plant-based canned ham in select grocery stores in the Midwest, East Coast, and Texas, before launching to Walmart stores across the U.S. in 2023.
- **v2food** launched new plant-based chicken products in Woolworths stores across Australia, including a breaded chicken schnitzel.



*“In an effort to reduce the impact of our ice cream and food products on the environment, we are moving to more plant-based products and are exploring other alternative proteins as ingredients. Fermentation may become an important technology in the production of alternative proteins to build a more resilient supply chain and to reduce greenhouse gas emissions in our journey to net zero.”*

– Manfred Aben, Nutrition & Ice Cream R&D Head of Science and Technology at Unilever

## Foodservice

After an unprecedented contraction in 2020, foodservice has returned as an attractive go-to-market strategy for plant-based companies. Launching into foodservice allows companies greater control over how their product is prepared, and it also plays an important role in ensuring plant-based products continue to become more accessible and familiar to consumers across regions. In 2022, plant-based products expanded into every level of foodservice, from fast food chains to upscale restaurants to settings like airlines and schools:

- **Starbucks** added plant-based meat to menus in several geographies, including an **OmniFoods** plant-based fish sandwich in Hong Kong, a plant-based sausage croissant roll in collaboration with **Imagine Meats** in India, a plant-based crab cake brioche sandwich in Thailand, and several menu items using **JUST Egg** and **Daring Chicken** in a trial in the United States. Notably, Starbucks also dropped their plant-based milk surcharge in the United Kingdom.
- **KFC** launched several plant-based chicken options in different regions. KFC UK made the plant-based chicken burger a permanent menu item, KFC U.S. expanded the Beyond Fried Chicken test to every KFC location for a limited time, and KFC Canada partnered with **Lightlife** to trial a plant-based chicken entree.
- **Burger King** increased their commitment to plant-based offerings with new product launches in a number of regions.
  - Burger King U.S. launched two more Impossible burgers (the Impossible King and Southwest Bacon Impossible Whopper) and trialed an Impossible plant-based chicken patty.
  - Burger King UK launched plant-based chicken nuggets in partnership with **The Vegetarian Butcher** (owned by **Unilever**).
  - Burger King Israel launched a plant-based Whopper and chicken nuggets in partnership with Israeli plant-based startup **Meat. The End.**
  - Burger King Germany began offering plant-based versions of everything on their standard menu.
  - Burger King has also taken impressive strides to place plant-based options at the heart of their offerings: Burger King UK announced that half their menu items would be plant-based by 2030 (reportedly in a bid to lower the chain's carbon emissions), and the chain has tested both entirely plant-based and default plant-based locations in Portugal, Spain, the United Kingdom, Switzerland, and Austria.



## Making plant-based items the default can nudge consumers to choose plant-based and lower a company's emissions

In the past year, **Burger King** announced developments largely unprecedented by a major fast-food chain. **Burger King Austria** ran a limited-time campaign defaulting their menu to plant-based—consumers were given plant-based options by default unless they specified otherwise. [GFI analysis of several consumer research studies](#) indicates that changing the default menu option to plant-based is a powerful lever for increasing plant-based consumption.

In addition, **Burger King** tested entirely plant-based locations in Spain, the United Kingdom, Portugal, Austria, and Switzerland before permanently transitioning their menu to plant-based in one Vienna location. Starbucks is the only other top 10 global quick-service restaurant to have trialed an entirely plant-based location, which the company did in Seattle in 2021.

Changing default options can also be an effective strategy for noncommercial foodservice locations, like corporate cafeterias, school dining halls, and hospitals. In 2022, LinkedIn corporate offices piloted a default plant-based menu strategy with the support of **Greener By Default**, an organization that works with institutions to adopt plant-forward menu strategies.

While quick-service restaurant (QSR) launches help bring plant-based food to mass markets, many new products start in upscale/specialty restaurants. This can be an attractive go-to-market strategy because it allows companies to showcase products in specialty dishes and earn revenue before production is scaled up enough to supply thousands of distribution points. Select examples of restaurant launches in 2022 include:

- **Chunk Foods** debuted their marbled plant-based steak, one of the first plant-based meat whole-cut products commercialized in the United States, at Coletta, an upscale Italian restaurant in New York City.
- Israeli plant-based protein startup **Redefine Meat** announced a distribution deal with **Giraudi Meats**, a distributor specializing in high-end cuts in Europe's foodservice sector. The company is also launching plant-based tenderloin, striploin, pulled beef, pulled pork, and pulled lamb products.

- U.S.-based startup **Umario Foods** launched their seaweed-based bacon at restaurants in San Francisco, New York City, and Nashville.
- Plant-based company **Black Sheep Foods** secured an agreement with specialty foods distributor **The Chef's Warehouse** to launch plant-based lamb at restaurants throughout New York City.

In addition to commercial foodservice channels like QSR and specialty restaurants, plant-based distribution made strides in noncommercial foodservice, including institutional channels like airlines and school cafeterias:

- **Aramark**, the largest foodservice provider in the United States, announced a commitment to make 44% of their residential dining menu offerings plant-based by 2025 (up from 26 to 30% today).
- **Delta Airlines** added **Impossible Foods** meatballs and burgers and **Black Sheep Foods** meatballs to their menu for select flights.
- Taiwan-based **China Airlines** debuted a new plant-based inflight menu featuring plant-based fish filet, plant-based meat with cream sauce, and braised plant-based meat with rice.
- **Impossible Foods** launched a new pre-cooked Impossible Burger patty for distribution in K-12 cafeterias.
- **Rebellyous Foods**, who distributes plant-based chicken in 46 school districts, announced the development of a production system that the company says **can produce plant-based meat at price parity with conventional meat.**



## E-commerce

E-commerce is another popular go-to-market channel for plant-based companies. E-commerce tends to attract younger consumers who are more likely to be interested in alternative proteins. It can also give manufacturers more control over their time to market compared to retail or foodservice channels, where brands need to work with external partners to get their products on shelves or menus. E-commerce developments in 2022 include:

- Plant-based seafood company Kuleana rebranded as **Current Foods** and launched their plant-based tuna and salmon direct to consumer before their first retail launch at Berkeley Bowl market in San Francisco.
- Plant-based steak company **Juicy Marbles** debuted their plant-based filet mignon steak and whole-cut loin directly to consumers in the United States and Europe.
- Vienna-based **Revo Foods** (previously Legendary Vish) announced that their plant-based smoked salmon slices made with pea protein and algae extracts are now available via UK e-commerce website **GreenBay**.
- Beyond Meat launched their plant-based sausage on the popular Chinese e-commerce platform Pinduoduo.
- **Love Handle**, Asia's first plant-based butcher, partnered with online retailer **RedMart** to offer plant-based meat products for delivery in Singapore, including a co-branded meatball product: Love Handle x Impossible Butcher Meatballs.

## Facilities

Manufacturing capacity remains one of the most significant barriers to achieving price parity for plant-based proteins. Plant-based companies typically use contract manufacturers or build facilities to manufacture in-house (or some combination of the two), and there is an urgent need for capital to construct additional facilities optimized for plant-based food production.

In 2022, GFI added 11 new contract manufacturers to our database of known contract manufacturers, bringing the total to 127. The number of company-owned facilities dedicated to producing plant-based protein in-house also modestly increased in 2022.

## Facilities that opened in 2022:

- Danish plant-based company **Naturli Foods** opened a new manufacturing facility in Sydney, Australia.
- **Purefield Ingredients**, the largest domestic supplier of wheat protein in the United States, completed an expansion of their Kansas facility. The expansion will increase Purefield's annual production by 50 percent.
- Ingredients company **NUTRIS** opened a €30 million (\$32.1 million) fava bean and potato protein processing facility in Novi Senkovac, Croatia.
- India-based **BVeg Foods** unveiled their new plant-based production facility, which can currently produce 4,000 metric tons of plant-based meat a year, with plans to scale up to 12,000 metric tons/year.
- **Lactalis Canada**, maker of **Siggi's** yogurt, announced that they would transition their Ontario dairy plant to a dedicated plant-based production facility to meet the demand for the company's plant-based yogurts and milks.
- **Harvest B**, a plant-based food technology company based in Sydney, opened a facility that will be capable of producing up to 1,000 metric tons of plant-based protein made from Australian-grown grains. The company received \$1 million in assistance from the Australian government's Advanced Manufacturing Growth Centre and is Australia's first facility dedicated entirely to plant-based meat ingredients.
- **Cremer Sustainable Foods**, a joint venture between Cremer and Temasek-owned **Nurasa** (formerly known as Asia Sustainable Foods Platform) opened their first plant-based protein contract manufacturing facility in Singapore. The 11,000-square-foot facility can manufacture up to 1,300 tons of plant-based protein per year.

## Facilities that broke ground in 2022:

- California-based **Eat Just** broke ground on their new production facility in Singapore. The \$120 million facility will produce plant-based JUST Egg.

## Facilities that were announced in 2022:

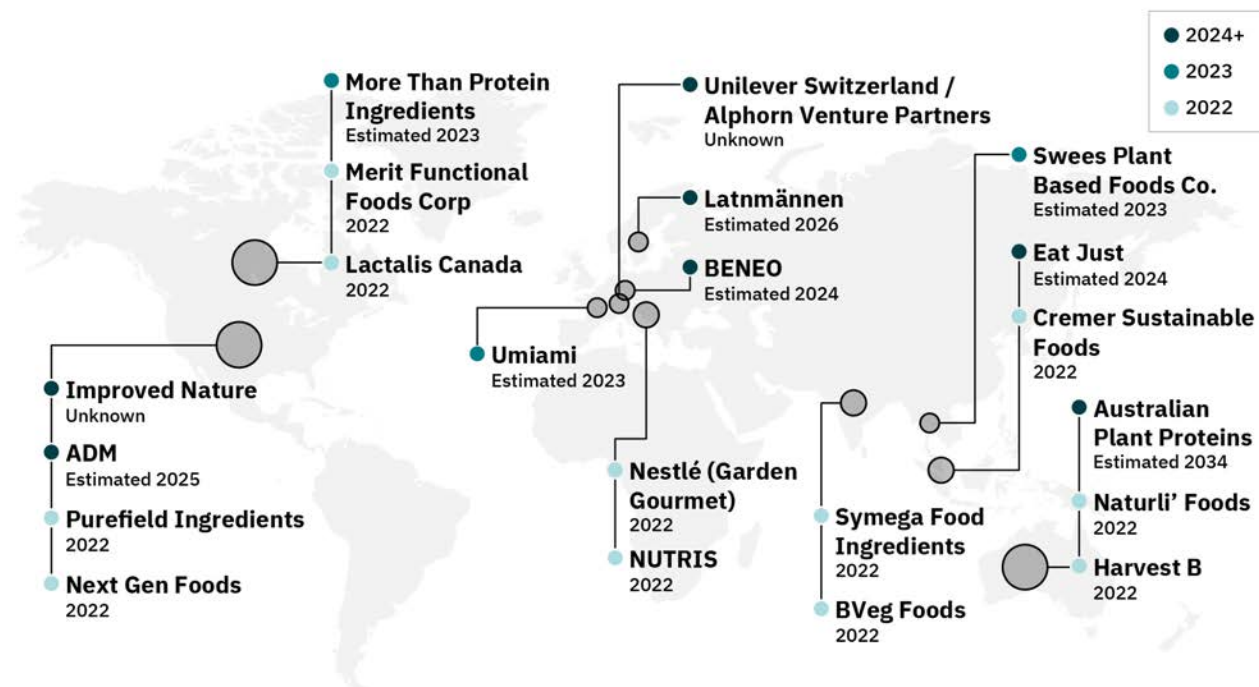
- **Nestlé** announced plans for a \$73 million production plant in Serbia. The facility will be used solely to produce Nestlé's plant-forward **Garden Gourmet** line.
- Plant-protein processing company **Australian Plant Proteins** will construct three new production plants for AU\$378 million (\$285.2 million). The project is funded by the Australian federal and state governments as well as several large meat and ingredients companies including **Thomas Foods International**, a major red meat producer, and the **Australian Milling Hub**.
- Ingredients company **ADM** announced plans for a \$300 million expansion of its Illinois-based soy protein concentrate facility. ADM expects to double the facility's extrusion capacity and will also open a new Protein Innovation Center.
- Ingredient manufacturer **BENEQ** will invest \$54 million to build a new pulse processing facility in Offstein, Germany. The facility will initially process protein concentrate, flour, and hulls from fava beans, with the option to expand to other types of pulses in the future.
- India-based food manufacturer **Symega Food Ingredients** is investing Rs. 100 crore (\$10.3 million) to build a dedicated plant-based production facility with an on-site R&D laboratory located in Kochi, India.
- **Merit Functional Foods Corp.** received funding from the Canadian government to construct a 94,000-square-foot plant protein processing facility in Winnipeg.
- Swedish agricultural cooperative **Lantmännen** is investing \$91 million to construct a new pea protein facility in Lidköping, Sweden that will be completed in 2026.
- Thailand-based plant-based cheese startup **Swees Plant Based Foods Co.** will open Thailand's first plant-based cheese factory in early 2023.
- Plant-based ingredient company **More Than Protein Ingredients** is constructing a new processing facility near Bowden, Alberta, with support from Protein Industries Canada. The facility is scheduled to be operational by spring 2023.
- **Improved Nature**, a plant-based meat manufacturer based in North Carolina, announced plans to build a new facility in Smithfield, North Carolina to produce their soy-based meat products. The facility is expected to employ 96 people at full operation.





Notably, several facilities including those of **Harvest B**, **Australian Plant Proteins**, **Merit Functional Foods Corp**, and **More Than Protein Ingredients** have been financially supported by governments. Funding plant protein infrastructure—one of the biggest bottlenecks in the sector—allows governments to contribute to climate goals while supporting local manufacturing and job creation.

**Figure 1: New plant-based facilities announced in 2022**



*“Exploration of opportunities across the plant-based space continues to be an important focus area in our innovation and R&D work. This is true for retail products, as well in the out-of-home space. Coming out of the pandemic, restaurant operators believe plant-based meats have the ability to drive sales and traffic through their doors. We’re seeing this trend firsthand through our Nestle Professional Sweet Earth business; over 2000 locations are now serving Sweet Earth’s plant-based recipes out-of-home.”*

– Mel Cash, Chief Marketing & Innovation Officer, Nestlé USA

# Involvement by conventional meat and food companies

Most of the leading global consumer packaged goods (CPG) and meat companies are involved in the plant-based industry in some capacity. Involvement by large conventional food companies—through investment, acquisitions, partnerships, and developing and manufacturing products—can support the growth of the industry, as these companies already have funding, infrastructure, and distribution partnerships that can be leveraged to improve the accessibility of alternative protein products.

- A number of large meat and food companies have made investments in or acquisitions of plant-based food companies. Notable acquisitions include **Nestlé's** [acquisition](#) of Sweet Earth in 2017 and **JBS's** [acquisition](#) of Vivera Foods in 2021.
- Notable partnerships between international conventional meat and food companies and plant-based companies include **PepsiCo's** [joint venture](#) with **Beyond Meat**, **Kraft Heinz's** [joint venture](#) with **NotCo**, and **Cargill's** [partnership](#) with **Bflike**.
- Several large global meat and food companies manufacture their own plant-based products. Examples of plant-based brands owned by large food companies include **Garden Gourmet** and **Sweet Earth**, owned by Nestlé, **BOCA**, owned by Kraft Heinz, **Morningstar Farms**, owned by Kellogg's, and **The Vegetarian Butcher**, owned by Unilever.


**Table 5: Conventional companies with involvement in alternative proteins**

	CPG Companies					Meat Companies				
Investment	✓	✓	✓		✓	✓		✓		
Acquisition		✓	✓				✓			
Partnership	✓	✓	✓	✓			✓			✓
Manufacturing and R&D		✓	✓	✓	✓	✓	✓	✓	✓	✓

✓ Cultivated meat   
 ✓ Fermentation   
 ✓ Plant-based

**Table 6: Conventional companies with involvement in plant-based**

	CPG Companies					Meat Companies				
Investment	✓	✓			✓	✓		✓		
Acquisition		✓	✓				✓			
Partnership	✓		✓				✓			
Manufacturing		✓	✓		✓	✓	✓	✓	✓	✓



Another opportunity for conventional meat companies to become involved in the alternative protein industry is by incorporating plant protein and vegetables into meat products. In the last few years, several meat companies have launched blended meat products, including **Perdue**, **Hormel**, and **Tyson**. Communicating the benefits of blended products to consumers may require nuanced product positioning, as this is a relatively new and subtle category that requires a clear value proposition. Targeting the right consumer groups will be critical—for example, parents who want to incorporate more vegetables into their children’s meals. Indeed, blended products may provide value to health-focused consumers looking to increase their consumption of vegetables and plant proteins (or reduce their consumption of meat), and have a relatively lower environmental impact than conventional meat products, which could help manufacturers reach their sustainability goals.

*“Adding new blended vegetable and meat products to the PERDUE® brand portfolio helps us meet the needs of consumers who are increasingly looking to incorporate more vegetable nutrition in their diets—without sacrificing taste or quality. We’ve blended family favorites, like nuggets and tenders, with high-quality plant protein to meet the evolving needs of consumers today. Our blended product line has been extremely successful since launching in 2019, and we’ve since expanded the line by adding new flavors and snacking options.”*

– Jon Swadley, Vice President of Marketing, Perdue Premium Prepared Foods



# Partnerships

Strategic partnerships are another important tool to support industry growth. Partnerships allow companies to access one another’s expertise or infrastructure, including in product development, manufacturing capacity, or distribution channels. Partnerships in the plant-based industry developed rapidly in 2022. While not comprehensive of all plant-based partnerships in 2022, the list below highlights some of the most notable partnerships propelling the industry forward.

## Product development partnerships

Product development partnerships are very common for plant-based companies. Such partnerships allow companies to leverage one another’s ingredients, R&D capacity, and product portfolios.

Companies/organizations	Details
<a href="#"><u>Above Food and Umiami</u></a>	Developing whole-cut, plant-based meat products
<a href="#"><u>Upfield and OGGS</u></a>	R&D in liquid plant-based eggs
<a href="#"><u>Kroger and Impossible Foods</u></a>	Private label product development
<a href="#"><u>Nestlé and Corbion</u></a>	Developing microalgae ingredients for plant-based foods
<a href="#"><u>Evo Foods and Ginkgo Bioworks</u></a>	Developing animal-free eggs
<a href="#"><u>Innovopro and Milkadamia</u></a>	Developing chickpea-based ice cream
<a href="#"><u>International Flavors and Fragrances and SimpliiGood</u></a>	Developing spirulina-based smoked salmon products
<a href="#"><u>Republic Polytechnic and SoiLabs</u></a>	Developing plant-based cheese from okara
<a href="#"><u>UNLIMEAT and Bayerische Fleischerschule Landshut</u></a>	Developing plant-based deli products
<a href="#"><u>Nomoo and Nestlé</u></a>	Developing plant-based meat product lines
<a href="#"><u>Barvecue and Arbiom</u></a>	Developing plant-based meat products

Companies/organizations	Details
<u>Mirai Foods and Rügenwalder Mühle</u>	Developing hybrid plant-based and cultivated meat products
<u>Peas of Heaven and Mycorena</u>	Developing plant-based products with mycelium ingredients
<u>Meatable and Love Handle</u>	Establishing a Future of Meat Innovation Center to codevelop plant-based and cultivated meat hybrid products
<u>Next Meats, Dr. Food, and ImpacFat</u>	Codevelop plant-based products with cultivated fat
<u>Sophie’s Bionutrients and Danish Technological Institute</u>	Developing chlorella-based ice cream

## Joint ventures

Joint ventures allow companies to access one another’s brand equity along with manufacturing and distribution infrastructure.

Companies/organizations	Details
<u>Kraft Heinz and NotCo</u>	The Kraft Heinz Not Company distributes co-branded plant-based products
<u>Cale &amp; Daughters and Vgarden</u>	Vgarden Australia Pty Ltd involves an IP exchange and joint product production
<u>PepsiCo and Beyond Meat</u>	Distributing cobranded plant-based jerky products

## Scale-up

Manufacturing capacity is one of the most significant barriers to growth in alternative proteins. Partnerships focused on scaling up ingredients allow companies to access one another's infrastructure and process expertise.

Companies/organizations	Details
<u>ADM and Benson Hill</u>	Scaling production of soy protein
<u>Planet Based Foods and Cedarlane Natural Foods</u>	Manufacturing partnership

## Distribution

Securing product distribution is another key challenge for startups, many of whom must enter distribution channels from scratch, using cold outreach to distributors, foodservice companies, and retailers. Partnering with an established company can offer a shortcut to growing a company's distribution network.

Companies/organizations	Details
<u>Upfield and OGGS</u>	Leveraging Upfield's distribution network and Upfield Professional foodservice channel
<u>Beyond Meat and Pinduoduo</u>	Selling Beyond products via e-commerce in mainland China
<u>Vandersterre and Max &amp; Bien</u>	Leveraging Vandersterre's distribution and marketing channels
<u>Thai Union, Chicken of the Sea, and The ISH Food Company</u>	Leveraging conventional seafood producers' distribution channels

# Consumer insights

## Global trial and demand

In the United States, 40 percent of all shoppers have purchased plant-based meat or dairy in the past six months, according to consumer research from [Acosta](#). Yet just 10 percent of those shoppers purchasing plant-based products report adhering to a fully plant-based diet. It's clear that omnivore shoppers are the largest market for plant-based proteins. Indeed, one study analyzing household purchasing data found that 86 percent of households that purchased meat alternatives also purchased conventional meat.

Globally, consumers report increased engagement with plant-based proteins:

- A [recent study conducted by GFI Europe](#) surveyed consumers across four European countries finding that between 27 and 50 percent reported eating plant-based meat at least once a month.
- A [survey from GFI Brazil](#) shows that the percentage of respondents who say they are reducing their meat consumption grew from 50 percent in 2020 to 67 percent in 2022.

According to [CONAB 2022](#), meat consumption in Brazil decreased by 4.4 percent between 2021 and 2022. Drivers of this decline could include shifting consumer behavior as well as less availability (and thus higher prices) of conventional meat products, given the preference of producers for exportation.

- A [survey conducted by BCG and Blue Horizon](#) found that 60 percent of consumers surveyed across seven countries reported at least having tried alternative proteins.
- When we look at young consumers (ages 16–40) across 10 countries, 66 percent plan to spend more on plant-based meat and dairy alternatives in the future.

## Motivations

When it comes to what consumers are looking for, according to FMI, taste, quality, and value rise to the top when considering all grocery purchases. This holds true when consumers are considering their overall protein purchases as well as plant-based food consumption.

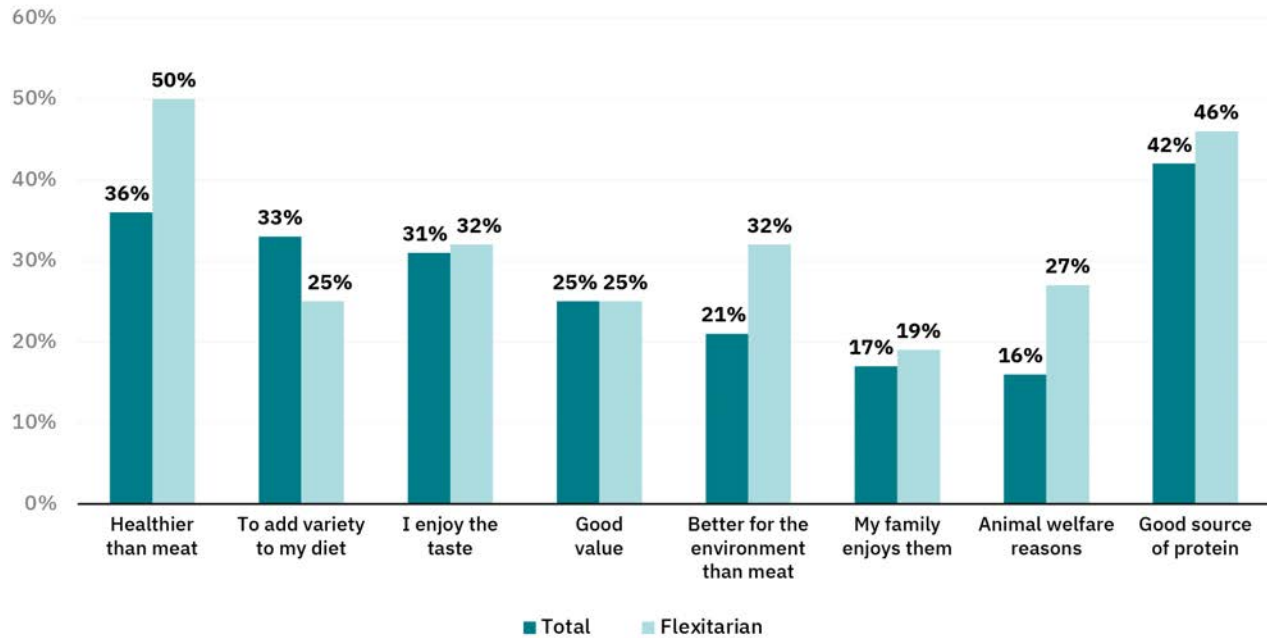
[Consumer research](#) commissioned by GFI in Singapore, Thailand, Japan, and South Korea found that taste was the top motivator for consuming alternative seafood, but that a guaranteed lack



of mercury and other heavy metal contamination was also a driver of interest in alternative seafood across all four countries.

In addition to these motivators, consumers continue to identify health as a top reason for purchasing plant-based proteins, including meat alternatives.

**Figure 2: Plant-based protein motivators by dietary preference**



Source: Mintel Reports US, Plant-based Proteins, 2022.

Questions: What are the main reasons you eat plant-based proteins? Which of the following dietary preferences best describes you?

As discussed in a [recent migration analysis released by PBFA, in partnership with Kroger](#), consumers who are limiting their consumption of animal-based foods in favor of plant-based items cite health-related factors as a top motivator.

Notably, the environmental and animal welfare benefits of plant-based foods often take a back seat to the previously mentioned considerations. **However, certain consumer groups including flexitarians and younger cohorts tend to voice these considerations more frequently than the general consumer. Between 60 and 90 percent of young consumers (ages 16–40) across 10 countries say they consider the environmental sustainability of their food purchases.**





*“Highlighting sustainability alone will not be enough: only a small group of consumers make food purchasing decisions based on sustainability, and most consumers—the “mainstream”—are concerned about sustainability in food but are not yet acting on it.*

*To win with mainstream consumers, alternative protein companies must connect their products to top needs that drive consumer behavior in food choices (typically taste and health). First, consumers want to see innovations that improve taste, texture, and price, where gaps relative to traditional meat remain. Second, brands need to tailor their messaging and marketing to clearly connect existing products to consumers’ emotional and functional needs.”*

– Neeru Ravi, Principal, Boston Consulting Group

## Barriers

Despite stated consumer interest in plant-based foods, key barriers remain, limiting the growth of the industry:

- FMI found that consumers identified taste as the top reason why consumers who have tried meat alternatives didn’t continue to do so. Additionally, preemptive perceptions about the taste of plant-based products may limit initial trials.
- Mintel’s 2022 report further validates taste and flavor concerns as primary barriers. Taste, and specifically replicating the flavor, texture, and aroma of conventional meat, is critical for consumer adoption of plant-based meat alternatives, with 53 percent of individuals agreeing that plant-based meat products should taste just like meat. Additionally, among U.S. consumers not eating plant-based proteins (including beans, legumes, nuts, tofu, meat alternatives, etc.), 49 percent state they haven’t tried them because of taste and flavor concerns. Additional consumer perceptions and concerns include the idea that “meat is a better source of nutrients” and that plant-based proteins are “too expensive.”
- Notably, FMI found a possible decline in health as a motivator for plant-based food consumption. In 2020, **50 percent of consumers stated “I think they are healthy” as a top motivator for preparing plant-based meat alternatives compared to 38 percent in FMI’s latest 2022 survey.**

- Beyond consumer-based preferences and perceptions, institutional factors affect the growth of the alternative protein industry. In early 2023, an [article](#) published by Insper, one of Brazil’s top business schools, unpacked the barriers and enablers of sustainable protein innovation in Brazil. The study found that tax incentives, access to funding, and entrepreneur network expansion are important external factors that drive alternative protein innovation. In addition, the acknowledgment that alternative proteins are a pathway for the private sector to create shared value and address public problems (e.g., climate, biodiversity, food security) can be a driver, as ESG-driven decision making becomes the norm.

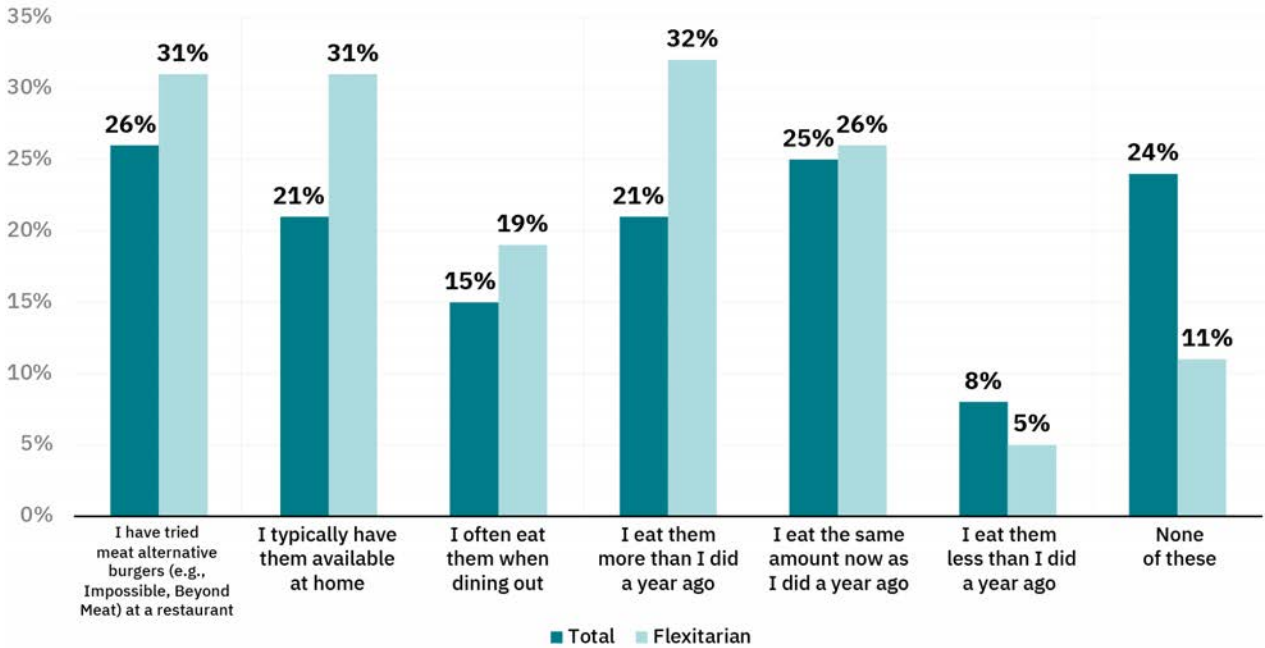
Prioritizing sensory characteristics like taste and texture, ensuring that consumer needs are met, improving access and variety, and incentivizing innovation and partnerships will be key to driving not only interest and trial but also sustained growth for years to come.




## A note on foodservice

The foodservice industry is a critical avenue for growth within alternative proteins. Roughly one in four consumers reports having tried a meat alternative burger at a restaurant while 15 percent of consumers say they eat plant-based meat alternatives often when dining outside of the home.

**Figure 3: Meat alternative behaviors by dietary preference**



Source: Mintel Reports US, Plant-based Proteins, 2022  
 Questions: Which of the following statements about plant-based meat alternatives (e.g., Gardein, Impossible Burger) do you agree with? Which of the following dietary preferences best describes you?




Notably, consumers are looking for more. **Half of omnivores and 8 in 10 flexitarians agree that more restaurants should serve plant-based meat alternatives.** GFI commissioned a plant-based meat alternative buyer analysis from Circana covering 2019 through 2022. This analysis captures consumers' foodservice purchases via uploaded receipts, specifically those of consumers who purchase plant-based meat alternatives. The key insights are captured below. For more on the methodology [see box 5 below](#).

Key insights:

- The percentage of U.S. consumers buying plant-based meat in commercial foodservice over each of the last four years has remained steady at around 9 percent. However, the average frequency of purchase has increased by 30 percent since 2019.
- Opportunities remain to drive repeat purchases: 63 percent of alternative meat buyers purchased these items just once in 2022 and 37 percent purchased these items two times or more within the year.
- Plant-based meat buyers are valuable to operators. They make 30+ more foodservice visits and spend over \$400 more annually compared to the average buyer.
- Demographically, plant-based meat items are more likely to attract buyers aged 18–24, male buyers, and multicultural buyers.

Foodservice environments are important avenues for driving consumers to try plant-based proteins because taste and flavor experiences are often elevated relative to home cooking, and price sometimes plays a lesser role as a barrier to consumption. Consumers and operators are showing an increased interest in plant-based proteins out of the home, but **opportunities remain for industry players to drive product innovation and renovation to meet consumer needs and preferences, bring down costs, and increase distribution to make these products more appealing and accessible to consumers across all channels and markets.**





*“What we’ve witnessed is that our consumer base is similar around the globe, particularly in urban locations. Many of our consumers are between 18-35 years old and are often seeking experiences with food that are noteworthy and memorable. Our consumer base in Singapore, for example, is not unlike our customers in New York City or London or Munich. For some in this group, there’s a growing awareness that there’s a connection between meat production and environmental impacts, but it’s not completely obvious yet. It’s even more important as a brand and young company for us to focus on education of the food and planet connection—and partner with some of the best chefs and restaurants in the world to help communicate that plant-based dining can be both exciting and delicious (and not offer any compromise).”*

**– Andre Menezes, CEO and Co-Founder, TiNDLE**

*Are we missing your company? Did we get something wrong in this Commercial Landscape section? We’d appreciate your feedback via [this form](#).*

Section 2

# Sales

# Section 2: Sales

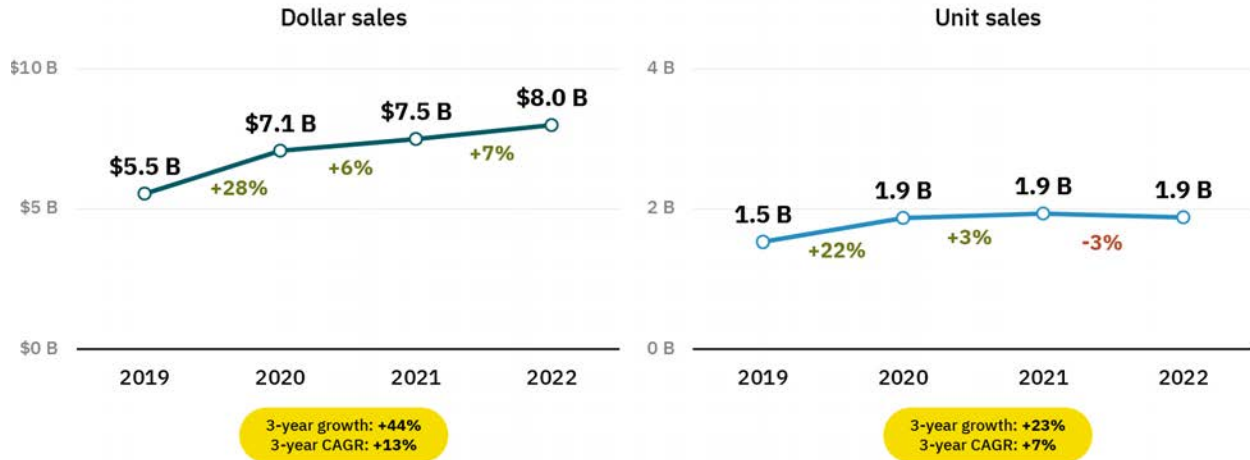
## U.S. retail sales overview

Insights released by the Good Food Institute (GFI) and the Plant Based Foods Association (PBFA) based on retail sales data commissioned from SPINS show that the plant-based food market in U.S. retail in 2022 is worth \$8 billion, with dollar sales up seven percent from 2021, and unit sales down three percent, mirroring total food and beverage and animal-based food. While dollar sales are up across several categories due to price increases, notable plant-based categories that saw unit sales growth in 2022 despite challenging market conditions include plant-based eggs, plant-based seafood, plant-based creamers, and plant-based protein liquids and powders. Yet, with inflation and consumer spending concerns affecting the retail market in 2022, many plant-based categories saw overall dollar sales increases and unit declines.

Key insights:

- **As with total food and beverage at retail in 2022, several plant-based categories saw dollar volume growth alongside unit volume declines.**  
However, a few notable categories grew in both dollar and unit sales in 2022, including plant-based creamers, eggs, and protein liquids and powders.
- **Plant-based milk is the most developed of all plant-based categories.**  
Plant-based milk dollar sales were \$2.8 billion in 2022, making up over a third of all plant-based sales.
- **Plant-based meat dollar sales are down slightly by 1% and unit sales are down 8%.** This indicates an opportunity to further attract and retain consumers in the category by delivering great-tasting, affordable products that meet consumer needs.
- **The smallest category, and the fastest-growing, is plant-based eggs.** At \$45 million in dollar sales in 2022, plant-based eggs is a modest category that has grown 4x its size in 2019, albeit on a very small base. Plant-based eggs have also seen a significant closing in the price gap with animal-based eggs, driven by both price increases for animal-based eggs and price per unit decreases for products in the plant-based egg category.

**Figure 4: Plant-based foods market, U.S. retail (2019–2022)**



*Sales data 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 Grocery Channel, SPINS Conventional Multi Outlet Channel (powered by Circana, formerly IRI & NPD) | 52 Weeks Ending 1-1-2023

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## Inflation

Inflation was a major story across the globe in 2022, particularly in the food sector. In the U.S., from December 2021 to December 2022, food-at-home prices rose 12 percent, which influenced how consumers shopped. According to IRI’s December primary shopper survey as reported by 210 Analytics, 8 in 10 consumers reported making changes to their shopping behavior as a result of price increases. Full-year 2022 data on total edibles shows a decline in total food and beverage consumption with unit sales down three percent and dollar sales up 11 percent versus the prior year. Notably, categories like conventional meat and plant-based meat experienced gaps between dollar sales changes and unit sales changes, representing significant price-per-unit increases.

In addition to price increases for a given category, inflation cuts into consumer budgets and tends to influence consumers to trade down from existing premium categories—almost all plant-based categories continue to sell at a price premium per pound compared to their animal-based counterparts.

Reaching price parity with conventional meat remains a large barrier to mass adoption for the plant-based meat category. According to Mintel, 26 percent of consumers who don’t eat



plant-based proteins today say the products are too expensive. Research from FMI shows that cost is a major factor identified by almost a third of consumers who stop buying plant-based meat or dairy. Overall, the premium prices of plant-based foods present a barrier to reaching more consumers and with more frequency, particularly given that consumers are likely to be increasingly mindful of prices in the current economic environment.

## Supply chain disruptions

A major contributor to the decreased affordability and availability of food in 2022 was continued ingredient shortages and supply chain disruptions. Events including the war in Ukraine, extreme weather, continued pandemic impacts like labor shortages, and avian flu outbreaks have had ripple effects across the global food network.

Neither plant-based nor animal-based foods have been entirely immune to these challenges. Both plant- and animal-based proteins were impacted by lower-than-anticipated global pea and soybean yields, sanctions on Russia—the world’s largest fertilizer exporter—and elevated energy costs, all of which drove up costs of production. Rising sea and rail freight costs also contributed to price increases for both plant and animal proteins. Yet the environmental benefits, production efficiencies at scale, and minimized supply chain vulnerabilities compared to the animal agriculture industry make plant-based foods a powerful tool in building a stable food supply. The plant-based industry is still small relative to the total food industry. Plant-based milk has a 15 percent dollar share of total milk, plant-based meat has a 1.3 percent dollar share of total meat, and the plant-based egg category has a 0.5 percent dollar share of overall eggs in U.S. retail. Continued public and private investments are needed to scale the industry, improve taste and price parity with conventional meat, egg, and dairy products, and improve the industry’s ability to attract and retain consumers.

## Lingering impacts of the pandemic

Looking at the retail channel alone risks missing the larger picture of plant-based food sales in the U.S. given individual channel volatility across retail, foodservice, and e-commerce in the past four years. In 2020, due to the pandemic, a large portion of foodservice dollars shifted to retail. Across categories, this resulted in unprecedented retail growth—and high bars for lapping this growth. Both 2021 and 2022 have seen the foodservice channel earn back much of its prior volume, and retail volume has started to settle. Meanwhile, e-commerce sales have grown rapidly, although on a very small base, stimulated by the pandemic.

Today, although restrictions have continued to lift and purchases have stabilized, the pandemic continues to have lasting impacts on the broader food industry and consumer behavior. A brief example of an opportunity for plant-based foods at retail is consumers buying in bulk, which is one of the pandemic's lasting impacts on shoppers' habits. However, many plant-based products are not available in bulk sizes, which can offer consumers greater efficiencies in per-pound prices.

## Box 1: U.S. retail market data collection

### Point-of-sale (POS) data

To size the U.S. retail market for plant-based foods, GFI and PBFA commissioned retail sales data from the market research firm SPINS. The firm built the dataset by first pulling in all products with the SPINS “plant-based positioned” product attribute, followed by adding plant-based private label products. Inherently, plant-based foods, such as chickpeas and kale, are not included. **Due to the custom nature of these categories, the retail data presented on this page may not align with standard SPINS categories.** Additionally, SPINS pulled in relevant mainstream subcategories (excluding plant-based positioned products) to create the conventional categories discussed above. Finally, the total edibles category pulled in all grocery, frozen, and refrigerated edible items across the retail grocery landscape as well as protein powders and bars. SPINS obtained the data over the 52-week, 104-week, 156-week, and 208-week periods ending January 1, 2023, from the SPINS Natural Grocery Channel and Conventional Multi-Outlet Channel (powered by Circana, formerly IRI & NPD).

SPINS defines these channels as follows:

- **Conventional Multi Outlet (MULO):** More than 110,000 retail locations spanning the grocery outlet, the drug outlet, and selected retailers across mass merchandisers, including Walmart, club, dollar, and military.
- **Natural Enhanced:** More than 1,900 full-format stores with \$2 million+ in annual sales and 40% or more of UPC-coded sales from natural/organic/specialty products.

This is generally considered the broadest available view of retail food sales, although not all retailers are represented. Some companies, such as Whole Foods Market, Trader Joe's, and Costco, do not report their scan data to SPINS or Circana (formerly IRI & NPD). Please note that this methodology has changed compared to that used in previous reporting by GFI. We do not recommend comparing data released in prior years to the data included here.

### Consumer panel data

To understand consumer purchasing dynamics and demographics, GFI and PBFA also commissioned consumer panel data from SPINS. The process for pulling the panel data was separate from that for the POS data, which may result in minor category differences. SPINS acquires its panel data through the National Consumer Panel, a Nielsen and Circana (formerly IRI & NPD) joint venture composed of roughly 100,000 households. SPINS obtained the data over the 52-week, 104-week, 156-week, and 208-week periods ending January 1, 2023, from all U.S. outlets.

# Categories

Plant-based food categories are in various stages of development. Plant-based milk is a multi-billion-dollar category with a 15 percent market share of total milk dollar sales, while small but emerging categories such as plant-based eggs saw continued growth in 2022.

**Table 7: Plant-based food category dollar sales, dollar sales growth, unit sales, and unit sales growth 2022**

Category	2022 dollar sales	1-year dollar sales growth (2021–2022)	3-year dollar sales growth (2019–2022)	2022 unit sales	1-year unit sales growth (2021–2022)	3-year unit sales growth (2019–2022)
Plant-based milk	\$2.8 B	9%	36%	749 MM	-2%	19%
Plant-based meat	\$1.4 B	-1%	43%	255 MM	-8%	20%
Plant-based creamer	\$645 MM	24%	119%	137 MM	12%	77%
Plant-based meals	\$531 MM	1%	49%	112 MM	-7%	33%
Plant-based ice cream and frozen novelty	\$437 MM	-4%	25%	83 MM	-9%	14%
Plant-based yogurt	\$425 MM	5%	39%	174 MM	-5%	16%
Plant-based protein liquids and powders	\$341 MM	14%	39%	24 MM	13%	35%
Plant-based butter	\$311 MM	15%	55%	71 MM	-11%	10%
Plant-based ready-to-drink beverages	\$239 MM	17%	76%	57 MM	11%	62%
Plant-based cheese	\$233 MM	-2%	51%	47 MM	-5%	44%
Plant-based bars	\$202 MM	13%	-2%	47 MM	-8%	-30%
Tofu, tempeh, and seitan	\$185 MM	4%	41%	65 MM	-0%	26%
Plant-based cream cheese, sour cream, and spreads	\$129 MM	7%	104%	24 MM	2%	86%
Plant-based condiments, dressings, and mayo	\$89 MM	6%	47%	16 MM	-3%	32%
Plant-based eggs	\$45 MM	14%	348%	10 MM	21%	611%
Plant-based baked goods	\$35 MM	13%	38%	6 MM	3%	-3%
<b>TOTAL</b>	<b>\$8.0 B</b>	<b>7%</b>	<b>44%</b>	<b>1.9 B</b>	<b>-3%</b>	<b>23%</b>

*Sales data 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 Grocery Channel, SPINS Conventional Multi Outlet Channel (powered by Circana, formerly IRI & NPD) | 52 Weeks Ending 1-1-2023


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## Closing the price gap

The majority of plant-based categories and every animal-based category had positive dollar sales growth in 2022. However, all animal-based categories and most plant-based categories experienced unit sales declines, indicative of the trends in U.S. retail of increasing average price-per-unit.

Plant-based products tend to be sold at a significant price premium compared to conventional products. Closing this price gap represents an opportunity to appeal to more consumers and position products as more feasible swap-outs for conventional products. GFI analysis of multiple data sources indicates that, in 2022, pound for pound, the overall price premium for plant-based meat was 67 percent, and for plant-based eggs was 122 percent. Gallon for gallon, the overall price premium for plant-based milk was 87 percent.

The plant-based egg category made notable progress toward price parity in 2022. In 2021, plant-based eggs cost about \$5 more per pound than animal-based eggs. This gap shrank to \$3.50 in 2022, driven primarily by animal-based egg price increases and secondarily by decreases in plant-based egg prices.

 For a comprehensive overview of U.S. retail sales data, including coverage of all plant-based categories and additional detail on the plant-based meat and plant-based milk categories, as well as consumer purchase dynamics, check out [GFI's market data page](#).

## U.S. consumer dynamics and research











Mainstream consumer awareness of and interest in plant-based foods is a critical factor in growing this emerging market. Plant-based meat, eggs, and dairy continue to gain mainstream status but improvements on key consumer drivers like taste and price will be crucial to increasing repeat purchases and expanding household penetration.

### Consumer demographics for overall plant-based foods

Plant-based food consumption over indexes among several consumer groups. Compared to the average consumer, purchasers of plant-based products tend to be younger and from higher income brackets and tend to have college or graduate degrees. Asian consumers are more likely to be buyers of plant-based foods.

In addition to sales data, other key metrics including household penetration and repeat purchase rate demonstrate growth opportunities for plant-based categories.

**Table 8: Purchase dynamics of plant-based foods 2022**

	 Total plant-based foods	 Milk	 Meat	 Yogurt	 Cheese	 Eggs	 Ice cream & frozen novelties	 Tofu, tempeh, and seitan
 Household penetration	60%	41%	18%	9%	5%	2%	12%	7%
 Repeat rate	80%	76%	63%	55%	50%	45%	51%	56%

Household data note: SPINS uses a separate process from the sales data to pull household panel data which may result in minor category differences.

Source: NCP, All Outlets, 52 weeks ending 1-1-23

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- **Six in ten households purchased plant-based foods in 2022.** The majority of U.S. households are purchasing plant-based products, similar to in 2021.
- **Plant-based milk continues to lead plant-based categories in household penetration.** 41 percent of U.S. households purchased plant-based milk in 2022, the highest household penetration among plant-based categories, followed by plant-based meat (18%) and plant-based ice cream and frozen novelties (12%).
- **In line with overall sales trends, several plant-based categories saw slight (two points or less) declines in the portion of households purchasing in 2022.** These included plant-based meat, milk, ice cream and frozen novelty, and yogurt. This was consistent across the retail space, as several analogous animal-based categories had similar slight declines in households purchasing.
- **Other plant-based categories had a relatively steady percentage of households purchasing.** Plant-based cheese, eggs, and tofu and tempeh had similar proportions of households purchasing them in 2022 as in 2021.

- **Plant-based meat shoppers are major consumers of other plant-based categories.** Of households that purchased both plant-based and conventional meat in 2022, 65 percent also purchased plant-based milk and 26 percent purchased plant-based ice cream and frozen novelties. This was higher than the baseline rates of total households purchasing in those categories, which was 41 percent for plant-based milk and 12 percent for plant-based ice cream, demonstrating the many consumers cross-purchase across multiple plant-based categories.
- **Dollar sales per buyer for households that purchase both plant-based meat and animal-based meat is higher than for the average household.** These households spent 19 percent more than the average household, and 21 percent more than an average household that purchases animal-based meat but not plant-based meat.

## Global retail sales overview

The plant-based food industry has established itself around the globe, with plant-based meat and dairy products accessible to consumers on every continent. Global sales data from Euromonitor International provide a perspective on the growth of global plant-based sales.

- Global dollar sales of plant-based meat grew eight percent in 2022 to \$6.1 billion. Meanwhile, sales by weight grew five percent.
- Global dollar sales of plant-based milk grew six percent to \$19.1 billion. Sales by liters grew at a slightly lower rate of three percent versus 2021.
- Featured for the first time in Euromonitor data, plant-based yogurt grew 11 percent to \$1.7 billion. Sales by weight grew six percent in 2022.
- Also tracked for the first time, plant-based cheese grew 22 percent to \$869 million. Sales by weight grew 11 percent.

Weight sales growth trailing or slightly trailing dollar sales growth in 2022 was consistent with the macroeconomic environment in which prices-per-pound or prices-per-liter increased across the retail sector. Below are more details on plant-based meat and seafood, milk, yogurt, and cheese dollar sales at the regional scale.

## Box 2: Global retail market data collection

Euromonitor is one of a few providers of standardized retail sales data across global regions. The company assembles data through a combination of desk research, store checks, trade surveys and company analysis.

### Desk research relies on data and insights from a variety of sources:

- Euromonitor
- Governmental and official sources
- National and international trade press
- National and international trade associations
- Industry study groups and other semiofficial sources
- Company financials and annual reports
- Broker reports
- Online databases
- Financial, business, and mainstream press

### Store checks are used to gather data on these key factors:

- **Place:** products tracked in all relevant channels—selective and mass, store and non-store
- **Product:** innovations in products, pack sizes, and formats
- **Price:** brand price variations across channels and comparison with private label pricing
- **Promotion:** marketing and merchandising trends, offers, discounts, and tie-ins

### Trade surveys supply additional or missing data:

- Fill gaps in available published data per company
- Generate a consensus view of the size, structure, and strategic direction of a category
- Access year-in-progress data where published sources are out of date
- Evaluate expert views on current trends and market developments

### Company analysis:

At a global level, Euromonitor's research combines a mix of industry interaction and use of secondary sources such as annual accounts, broker reports, financial press and databases. From a data perspective, the aim is to build "top-down" estimates of major players' total global and regional sales. At a country level, in line with local reporting requirements, Euromonitor accesses annual accounts, national-specific company databases and local company websites. These are all invaluable sources in building a view of each domestic player's size and position within very specific categories of the industry.

Combined, these methods enable Euromonitor to assemble a rigorous dataset that provides a global perspective on sales for various plant-based categories.

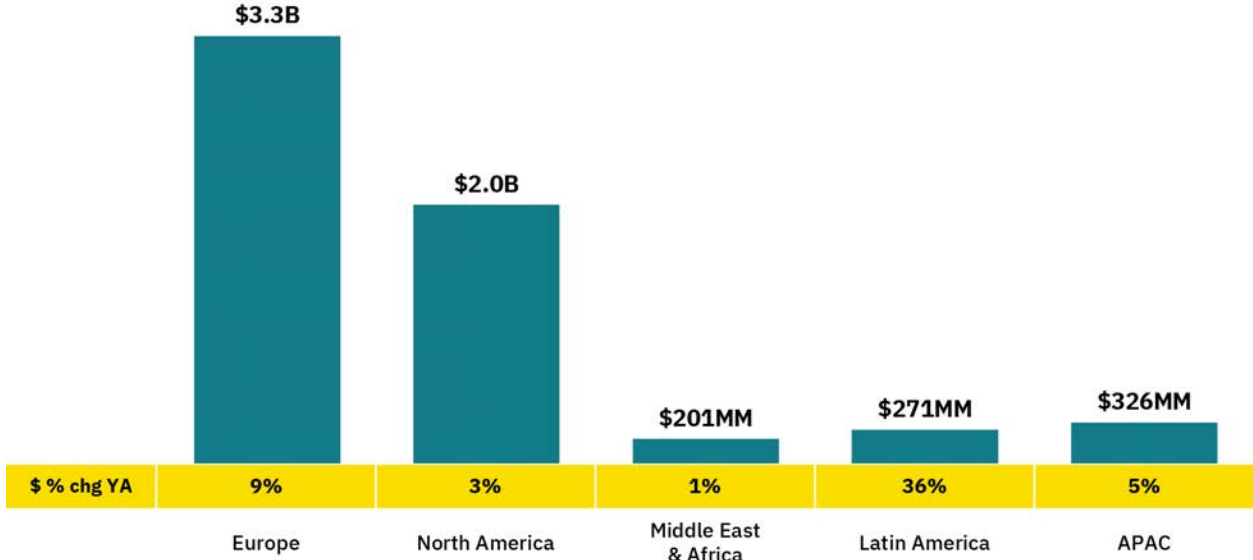
### Data validation:

All data is subjected to an exhaustive review process, at country, regional and global levels.

The interpretation and review of sources and data inputs forms a central part of the collaboration between industry teams and country researchers. Numbers are delivered to regional and global offices with an audit trail of sources and calculations to allow for a thorough evaluation of data sense and integrity. Upon completion of the country review phase, data is then reviewed on a comparative basis at regional and then at a global level. Comparative checks are carried out on per capita consumption and spending levels, growth rates, patterns of category and subcategory breakdowns and distribution of sales by channel. Top-down estimates are reviewed against bottom-up regional and global market and company sales totals. Where marked differences are seen between proximate country markets or ones at similar developmental levels, supplementary research is conducted in the relevant countries to confirm and/or amend those findings. This process ensures international comparability across the database, that consistent category and subcategory definitions have been used and that all data has been correctly tested. Euromonitor makes sure that possible discrepancies between different published sources have been reconciled and that our interpretation of opinion and expectation from each country's trade sources has been applied to form a coherent international pattern.

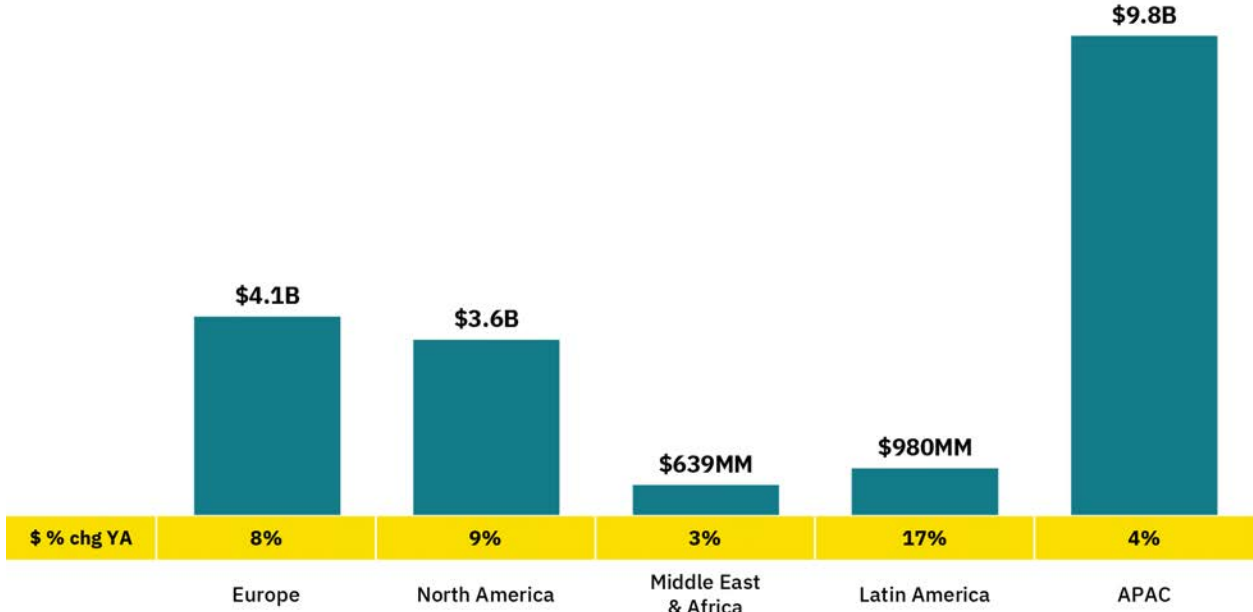
**Note: Data is based on Euromonitor's "meat and seafood substitutes" category, which includes chilled, frozen, and shelf-stable products. Note that data may differ from previous reports. In previous reports, this Euromonitor category also included tofu (now a standalone subcategory) and previous reports refined graphs to display only estimated plant-based meat sales.**

**Figure 5: Global plant-based meat and seafood retail dollar sales and dollar sales growth by region**



Source: Euromonitor International Limited, Fresh Food 2023, retail value RSP incl sales tax, US\$, fixed 2022 exchange rate, constant terms. © 2023 The Good Food Institute, Inc.

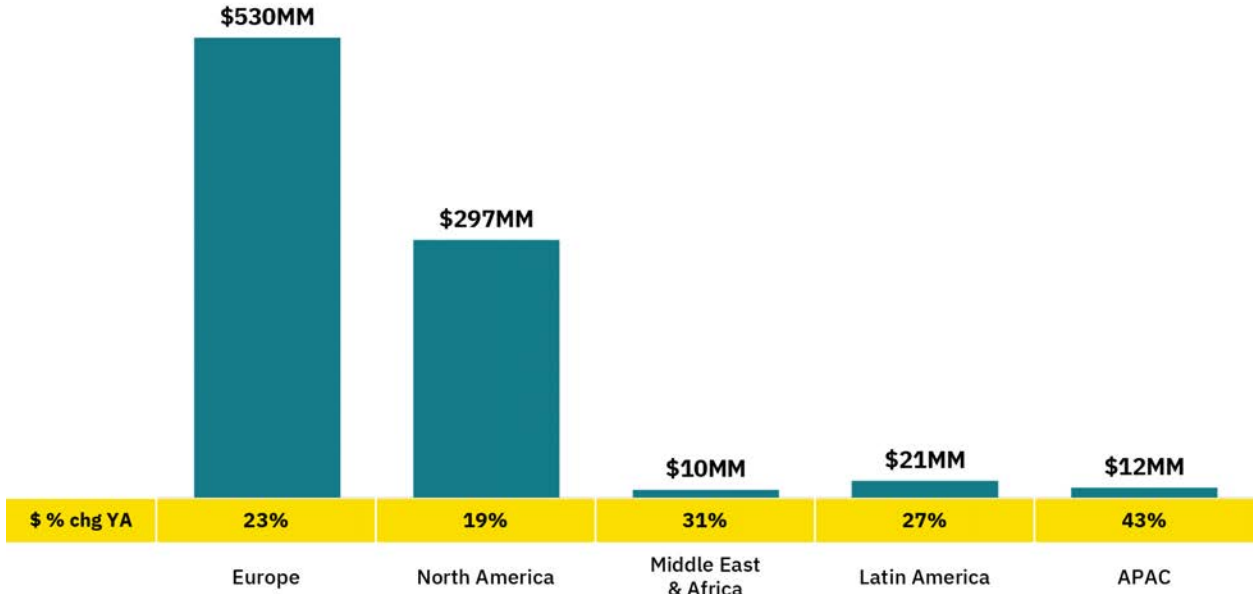
**Figure 6: Global plant-based milk retail dollar sales and dollar sales growth by region**



Source: Euromonitor International Limited, Fresh Food 2023, retail value RSP incl sales tax, US\$, fixed 2022 exchange rate, constant terms. © 2023 The Good Food Institute, Inc.

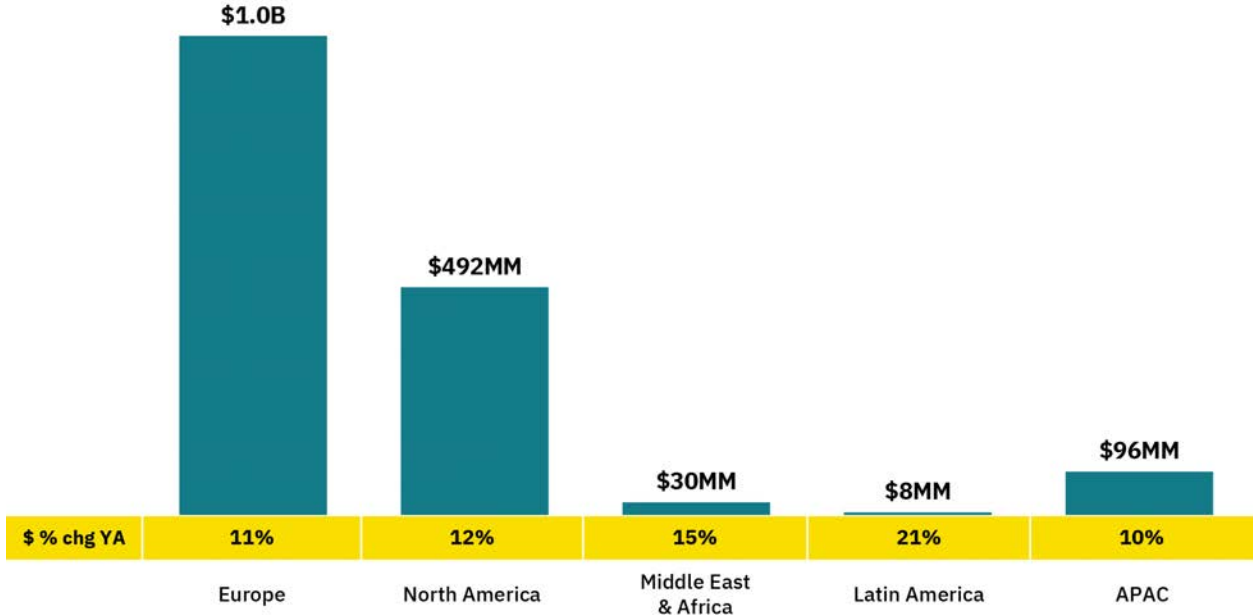


**Figure 7: Global plant-based cheese retail dollar sales and dollar sales growth by region**



Source: Euromonitor International Limited, Fresh Food 2023, retail value RSP incl sales tax, US\$, fixed 2022 exchange rate, constant terms.  
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**Figure 8: Global plant-based yogurt retail dollar sales and dollar sales growth by region**



Source: Euromonitor International Limited, Fresh Food 2023, retail value RSP incl sales tax, US\$, fixed 2022 exchange rate, constant terms.  
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# U.S. foodservice sales overview

## Overall foodservice context

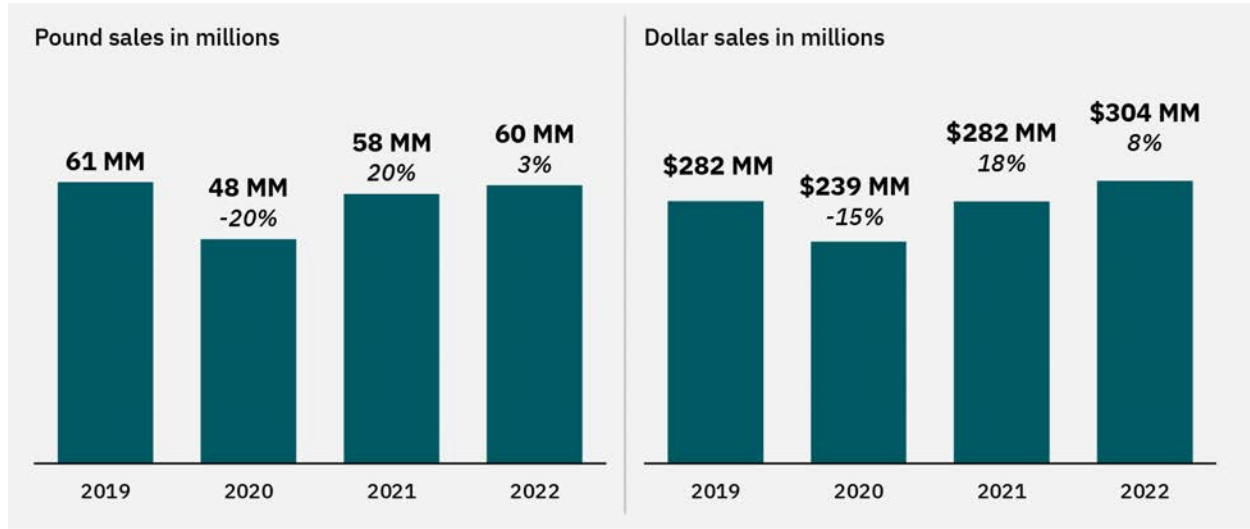
Although in-home food purchases from retail environments make up a significantly larger mass of the total food consumed in the United States, the share of total food expenditures is increasingly earned by food-away-from-home purchases. The year 2020 however represented a shift when food-away-from-home reached its lowest expenditure share (51 percent) since 2012 due to consumers turning to at-home consumption during the height of the pandemic. In 2021, shares began to normalize with total food-away-from-home expenditures representing 55 percent of total expenditures, just shy of pre-pandemic levels in 2019 (56 percent). Circana's data on both plant-based and animal-based proteins shows that 2022 dollar volumes have eclipsed 2019 levels, however pound sales remain below their pre-pandemic mark, signaling more progress to be made with consumers returning to foodservice environments.

Despite foodservice sales beginning to return to pre-pandemic levels, in 2022 the foodservice industry felt several pain points also experienced by the retail sector. Macroeconomic effects like inflation, during which consumers tend to shift spending to more affordable choices, can lead to overall revenue decline as well as smaller margins. In the United States, food prices away-from-home rose eight percent from December 2021 to December 2022. While striving to recover from the pandemic foodservice dip, operators remain challenged by labor shortages, supply chain disruptions, and inflation.

## U.S. plant-based protein foodservice sales

The year 2022 marked an important milestone in foodservice as plant-based protein dollar sales recovered to their pre-pandemic heights. Plant-based protein sales by weight grew three percent year-over-year to 60 million pounds, while plant-based protein dollar sales grew eight percent year-over-year to an all-time high of \$304 million in 2022. Dollar sales outpacing sales by weight, however, is a signal of inflation. In the last year, per-pound prices for plant-based proteins in broadline distribution increased by 21 cents per pound, or four percent. Notably, this is significantly less than price increases for conventional meat in foodservice, which increased by 29 cents per pound, or eight percent. Conventional meat inflation was more comparable to average overall price increases across retail (11.4%) and foodservice (7.7%) sectors.

**Figure 9: Plant-based protein foodservice sales**



Source: Circana, formerly IRI & NPD/SupplyTrack, 12 ME Dec 2022

**Additional key insights:**

- In sales by weight of plant-based meat products, plant-based beef is the largest subcategory at 33 percent of total plant-based meat sales, followed by tofu, veggie-forward products, plant-based chicken, and then plant-based pork. Plant-based chicken (+39%) and seafood (+40%) experienced high year-over-year growth in pound sales.
- Similar to retail, analogs that closely mimic conventional meat are growing both by dollar and volume sales, while non-analog product sales are declining. This is indicative of consumers' desire for products that have the taste and texture of conventional meat.
- In terms of format, patties dominate the space at 43 percent of the total category volume by weight. Tenders and nuggets are two of the fastest-growing product formats.
- Conventional meat dollar and volume trajectories from 2019 to 2022 have a similar shape as those for plant-based proteins. Conventional meat also saw a notable decline in both dollar and volume sales in 2020 due to the pandemic shift away from foodservice. Similar to plant-based proteins, conventional meat dollar sales have recovered but weight volume was still down in 2022 compared to 2019.
- GFI analysis of this data suggests that plant-based beef represented almost one percent of overall beef dollar sales in U.S. foodservice in 2022. But, notably, the largest conventional meat subcategory by dollar sales is poultry, which represents almost half of all conventional meat sales by weight in U.S. foodservice. Compared to plant-based beef, plant-based poultry represents an even smaller fraction of overall category sales.

Foodservice is a critical sector for plant-based category success, given the often heightened experience of taste, a sense of novelty, and the element of expert preparation in restaurant environments. Whether for startups entering the market or for established companies looking to broaden their reach, the foodservice industry represents a key opportunity for plant-based food companies to drive initial awareness, trial, and loyalty, particularly as consumers return to eating food away from home and experimenting with new flavors. There is also notable work being done in foodservice settings to use behavioral nudges to promote plant-based menu items. **It's important to note that, in addition to supply-side innovations like technological advances and product formulation, demand-side innovations like behavioral nudges can accelerate consumer uptake of plant-based products.**



## Box 5: U.S. foodservice data collection

### Distributor to operator sales data

GFI commissioned foodservice sales data from Circana, formerly IRI & NPD focusing on the plant-based proteins category. Circana collects point-of-sale data from selected broadline distributors for their SupplyTrack Tracking Service. This data reflects itemized sales from broadline distributors shipped to foodservice operators. The SupplyTrack service currently tracks 17 participating broadline distributors and 80+ individual subscribing manufacturers, data from 280+ categories, and collects 700k+ purchases monthly. SupplyTrack covers ~41% of the total foodservice landscape (86% of all broadline distribution). Broadline distributor sales generally skew toward small/medium-sized chains and non-commercial operators and away from large chains, however the data reaches both commercial and noncommercial operators across sizes and the following segment types:

- **Commercial:** QSR, FSR, Convenience Stores, Food Stores, and Other Retail
- **Noncommercial:** Education, Government, Health Care, Business & Industry, Lodging/Casino, Recreation, and other noncommercial environments.

The SupplyTrack data obtained from Circana covers plant-based protein sales across the U.S. market for the four years 2019, 2020, 2021, and 2022, all 12 months ending in December.

### Plant-based protein definitions:

- **Includes:** Meat alternatives or meat analogs, meat substitutes or non-meat or vegan/vegetarian protein products that are substitutes that approximate certain aesthetic qualities (texture, flavor, appearance) and characteristics of specific types of meat, e.g., beef and burgers, bacon slices, chicken, turkey, pork, sausage, hot dogs, crab, fish, shrimp, jerky. These proteins are made from non-meats such as various beans, including soy, black beans, chickpea/garbanzo beans, mushrooms, seitan\*/vital wheat gluten, TVP\* (textured vegetable protein), tempeh (fermented soybeans), and other vegetable-based proteins. Some products, like those marked vegan, are made without other animal products such as dairy.
- **Excludes:** Any animal-derived meat-type proteins. Vegan or vegetarian items that are not meat substitutes. Entrees containing alternative, non-meat proteins. Pizza containing alternative meats. All bacon bits. Vegan or vegetarian meat-flavored gravy or sauces. Vegan or vegetarian replacements for dairy products (e.g., eggs, milk, butter, cheese, mayo, sour cream), veggie corn dogs.

### Consumer panel data

To understand consumer purchasing dynamics and demographics in foodservice, GFI also commissioned a buyer analysis leveraging Circana's CheckOut platform. Circana's CheckOut consumer panel features 150K+ active panelists uploading their receipts across retail and foodservice chains, capturing 9 million foodservice receipts annually. More than 550 foodservice chains are captured across QSR, FSR, fast casual, and convenience stores.

This buyer analysis looks at shoppers who purchased plant-based meat alternatives, specifically analog items meant to replicate the taste and texture of conventional meat in captured foodservice environments. This data looks at related purchases over the latest year 2022, 12 months ending in December as well as trended purchases versus 2019, 2020, and 2021.

*Did we get something wrong in this Sales section? We'd appreciate your feedback via [this form](#).*



Section 3

# Investments


# Section 3: Investments

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## Overview

From 2010 to 2022, alternative protein companies raised \$14.2 billion, nearly doubling investments on average every year, though with high variance from year to year. This rapid growth slowed in 2022, with funding for both alternative proteins generally and plant-based companies specifically slowing alongside a broad global deceleration in investment across multiple sectors.

Plant-based meat, seafood, eggs, and dairy companies raised \$1.2 billion in 2022, bringing total investments to \$7.8 billion and representing a deceleration of 41 percent year-over-year (YOY). This modestly underperformed the overall global venture funding decline of 35 percent YOY. Funding in certain regions accelerated, rising in APAC (by 30%), Europe (15%), and the Middle East & Africa (223%). Overall, fewer investments took place amid challenging macroeconomic and market conditions, including falling public equity markets, steeply rising interest rates driven by extreme inflation, the ongoing pandemic, severe climate events, and the invasion of Ukraine. In fact, public equity markets fell by the most since the great financial crisis of 2008. Venture-capital-backed public companies performed especially poorly, with the PitchBook VC-backed IPO Index falling by more than 60 percent in 2022.



While this challenging market environment may continue for some time, the downturn itself and alternative proteins' status as an increasingly important environmental, social, and governance (ESG) opportunity provide potential upside for investors and the industry. Deal valuations are starting to come down, and startups are more willing to make deal term concessions, shifting dealmaking in investors' favor. Moreover, ESG interest remains high, and private impact funds have \$113 billion in dry powder (funds that have yet to be invested), creating a tailwind for alternative proteins, which are increasingly being viewed as an ESG-aligned sector.

The alternative protein industry is still nascent and is experiencing challenges that align with its early stage. As plant-based companies continue to innovate and fill major existing white spaces (such as whole-cut meat and seafood), as well as scale and optimize production to improve the taste and affordability of products, sales will likely accelerate and drive additional investment—particularly when macroeconomic and market conditions normalize. Plant-based companies will be supported on this path by the increasing involvement of large food companies and food service providers, such as **Kraft Heinz, PepsiCo, Nestlé, ADM, Kroger,** and **Pinduoduo**, through launches and partnerships (see the Commercial Landscape section

for more), which also serve as de-risking events for a new set of investors who are increasingly taking notice of the category. The number of unique investors in plant-based companies grew by 17 percent to more than 1,500 investors in 2022.



Despite alternative proteins' clear ESG benefits, they currently face underinvestment as a climate, biodiversity, public health, and food security solution. Countries have committed to halve emissions and protect 30 percent of global land and ocean ecosystems by 2030. With just seven years to go, investing in alternative ways of making meat, seafood, eggs, and dairy is essential. In their paper [What gets measured gets financed](#), the Rockefeller Foundation and Boston Consulting Group (BCG) identified alternative proteins as a critical climate mitigation solution and estimated that alternative proteins have an annual unmet funding need of more than \$40 billion. Plant-based meat, seafood, eggs, and dairy are some of the most capital-efficient ways to address climate change. A [report](#) by BCG and Blue Horizon states that "investment in plant-based proteins has the highest [carbon dioxide equivalent] savings per dollar of invested capital of any sector." Both private investors and governments have a critical role to play to ensure that alternative protein companies have the funding they need to help alleviate multiple global crises.



## New ESG frameworks raise the bar on the sustainability transparency of meat

In 2022, GFI and FAIRR developed a new, gap-filling set of ESG frameworks for the alternative protein industry that equips companies to assess and report environmental and social impacts of their business practices and their products, helping meet demand from investors, governments, and consumers for greater transparency.

The first-of-their-kind frameworks enable greater disclosures of the climate, water and land use, biodiversity, labor, and food security impacts of companies and their products, encouraging improvements in company practices and enabling comparisons between companies involved in alternative proteins and companies involved in animal protein products. The frameworks also enable investors to source high-quality ESG data from companies regarding their alternative protein offerings.

By 2025, an estimated third of global assets will be managed for ESG value. And while ESG reporting is currently voluntary, mandatory and globally standardized reporting is likely only a matter of time, with government-mandated climate reporting anticipated by 2025. As ESG considerations are increasingly integrated into risk mitigation and decision making, a greater need exists for standardized industry-specific assessments that enable data validation and comparability. While such frameworks exist for many other industries, the new GFI & FAIRR ESG frameworks now play that role for the alternative protein sector.

Increased visibility of the long-term environmental and social impacts of alternative proteins compared with conventional proteins can catalyze further investments that meet global sustainability goals and accelerate the transition to a more secure and equitable protein production system.

**Investors and companies interested in exploring how they can adopt the GFI & FAIRR frameworks to enhance their ESG assessment and reporting practices are encouraged to reach out to GFI's Corporate Engagement team for support.**





*“The recent slowdown in sales of plant-based proteins reflects the common teething problems associated with many nascent industries. On the one hand, the early success of next-generation plant-based products demonstrates solid consumer interest in foods that solve the challenge of feeding a larger global population while preserving the environment. On the other hand, the combination of higher-price points than animal meat and products that don't yet quite deliver as craveable a taste and texture as animal products have thus far disappointed both consumers and investors. However, these pioneering efforts have paved the way for further technology-driven cost and product-quality improvements. Combining this with the advent of hybrid products that combine plant-based structures and cultivated fats and muscle, the commercialization of a burgeoning alternative protein sector over the coming years and decades seems ever more viable.”*

– Alexia Howard, Senior Research Analyst, U.S., Bernstein

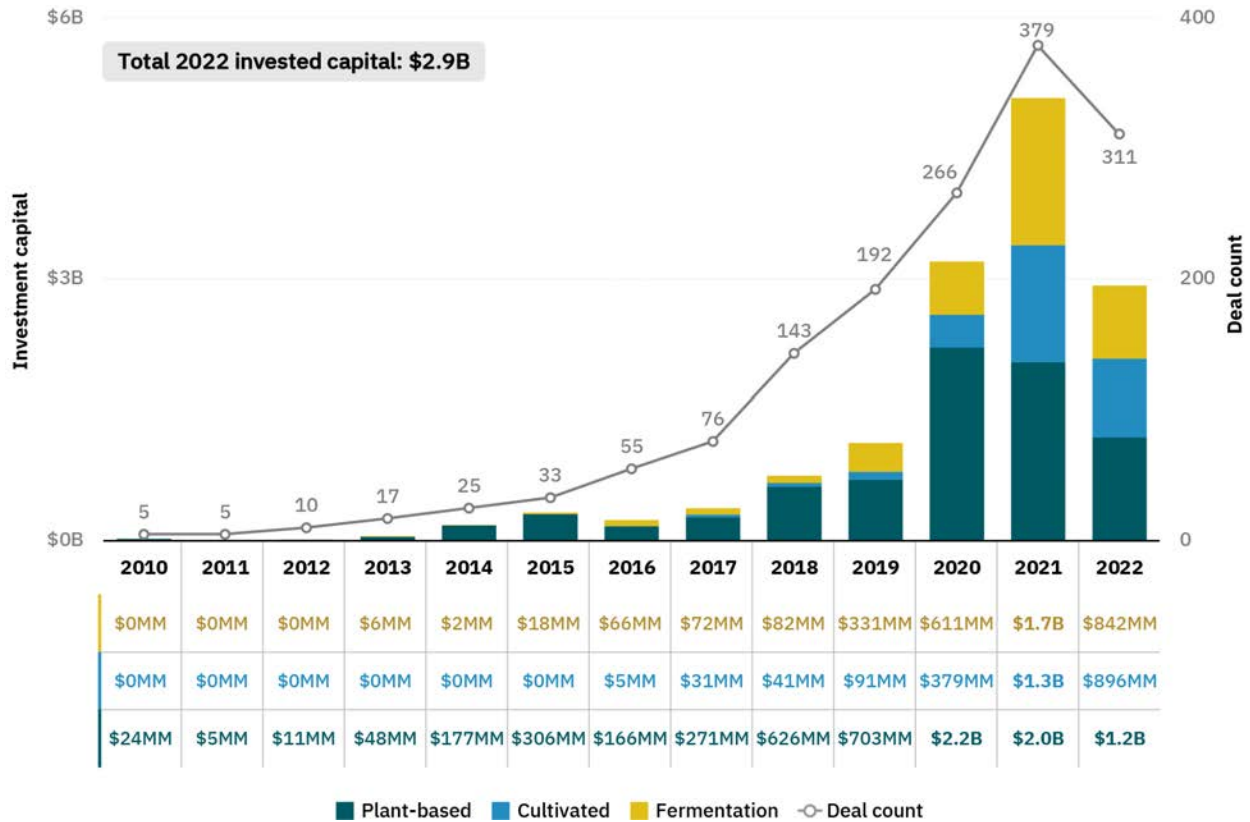
**Table 9: Plant-based companies global investment (1997–2022)**

	2022	1997–2022	Highlights
<b>Total invested capital</b>	\$1.19B	\$7.78B	2022 invested capital represented 15% of all-time investment.
<b>Invested capital deal count</b>	145	935	2022's largest investment was \$135.6MM raised by Redefine Meat.
<b>Unique investors</b>	222 new	1,521	The number of unique investors grew 17% in 2022 from 2021.
<b>Liquidity event capital</b>	\$119MM	\$26.9B	PlantPlus Foods, a joint venture of ADM and Marfrig, acquired Sol Cuisine for \$102MM in 2022.
<b>Liquidity event count</b>	15	121	
<b>Other financing capital</b>	\$15MM	\$146MM	The vast majority of other financing events are private investments in public equity (PIPEs).
<b>Other financing count</b>	4	20	

Source: GFI analysis of data from PitchBook Data, Inc.

Note: Data has not been reviewed by PitchBook analysts. See Box 5 for GFI's data collection methodology and definitions of "invested capital," "investment," "liquidity event," and "other financing."

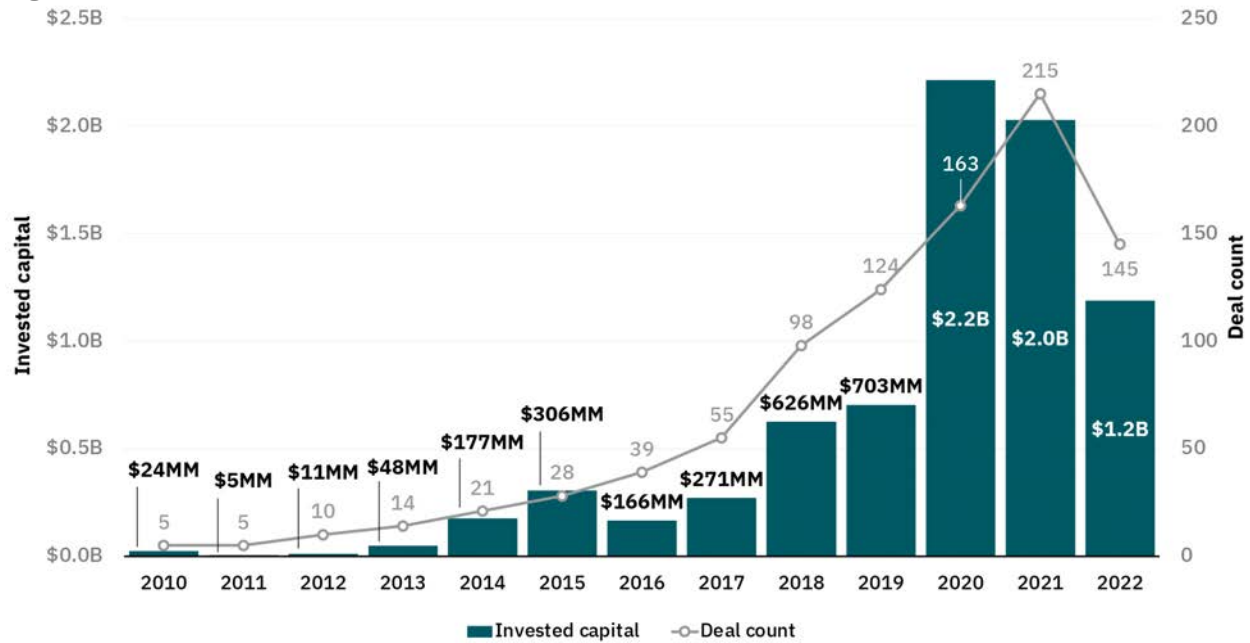
**Figure 10: Annual global alternative protein investment trend (2010–2022)**



Source: GFI analysis of data from PitchBook Data, Inc.

Note: Data has not been reviewed by PitchBook analysts. The total deal count includes deals with undisclosed amounts.

**Figure 11: Annual investment in plant-based companies (2010–2022)**



Source: GFI analysis of data from PitchBook Data, Inc.

Note: Data has not been reviewed by PitchBook analysts. The total deal count includes deals with undisclosed amounts.

### Box 3: Data collection methodology

GFI conducted a global analysis of plant-based meat, egg, and dairy companies using data from PitchBook. Our analysis uses a list we custom built in PitchBook of companies that focus primarily on plant-based meat, egg, or dairy products or provide services to those who produce them. Our analysis excludes companies involved in plant-based products but not as their core businesses as well as companies using plant-based ingredients other than to create or enable alternative meat, egg, and dairy products. Some companies included in our list may also offer products or services that apply to another protein category. For example, the \$200 million that **Eat Just** raised in March 2021 for use across their product lines and the \$267 million raised for their GOOD Meat division in the funding round completed in September 2021 are categorized under cultivated meat. All other Eat Just funds raised are categorized under plant-based. **Cocuus**, who produces both cultivated and plant-based meat, was included in the plant-based meat dataset. Companies focused primarily on plant molecular farming are excluded (they are included under fermentation).

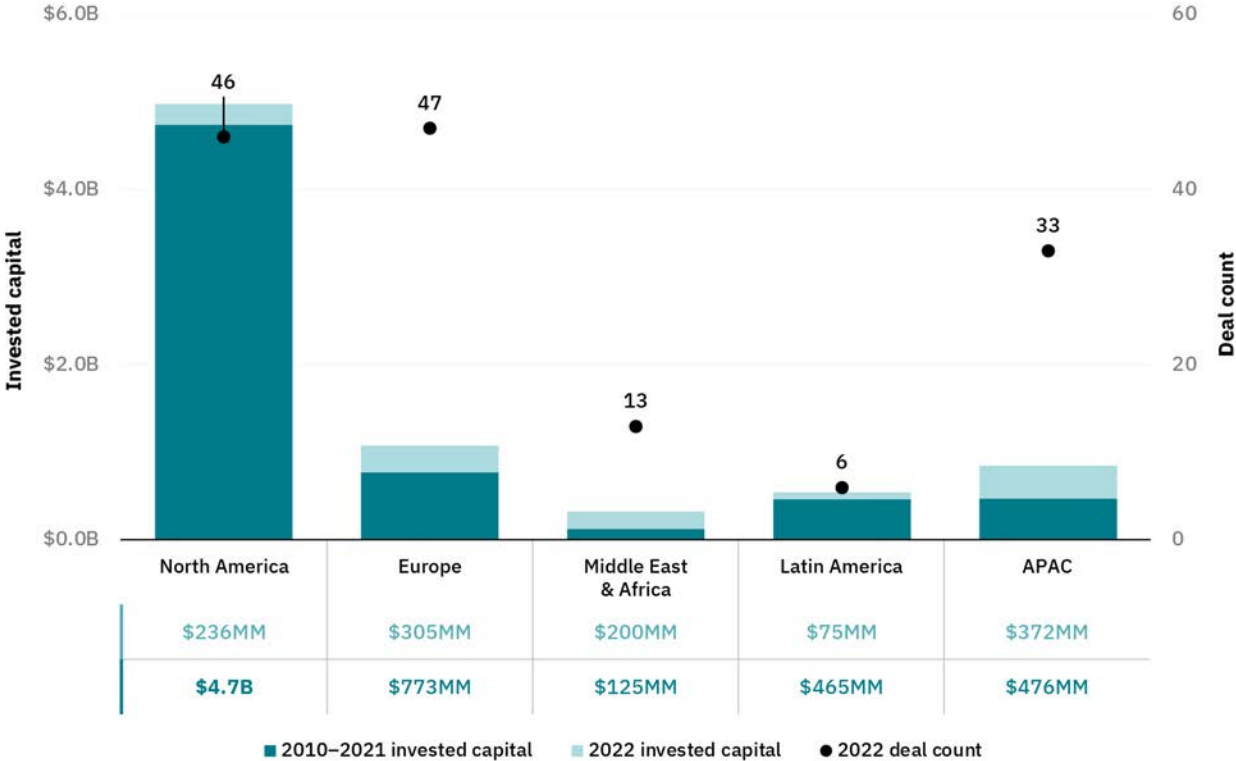
PitchBook profiled 689 plant-based companies, of which 450 have disclosed deals. Of these 450 companies, 358 have deals with publicly disclosed amounts. Because these aggregate calculations account for only companies with deals and deal sizes disclosed to PitchBook, they are conservative estimates.

For the purposes of this report, *invested capital/investment* refers to 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. *Liquidity events* refer to mergers, acquisitions, reverse mergers, buyouts, leveraged buyouts, and IPOs, while *other financing* refers to subsequent public share offerings and private investment in public equity. We do not include capital raised through a SPAC IPO until the entity has merged with or acquired a target company.

Please note that the figures published in this report may differ from prior figures published by GFI as we and PitchBook continually improve our dataset.

# Geographical distribution

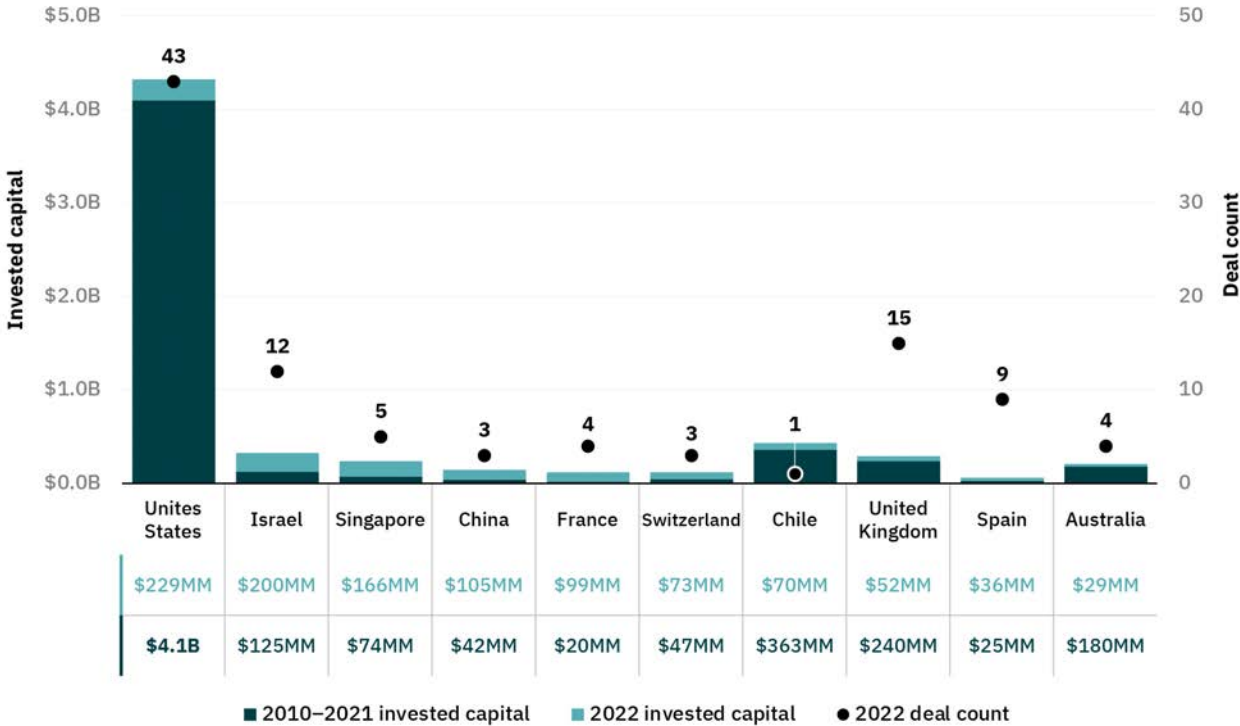
Figure 12: Investments in plant-based companies by region (2010–2022)



Source: GFI analysis of data from PitchBook Data, Inc.

Note: Data has not been reviewed by PitchBook analysts. North America includes Canada and the United States only. Latin America includes Mexico, South America, and Central America. The total deal count includes deals with undisclosed amounts.

**Figure 13: Investment in plant-based companies: Top 10 countries (2010–2022)**



Source: GFI analysis of data from PitchBook Data, Inc. The total deal count includes deals with undisclosed amounts.

Note: Data has not been reviewed by PitchBook analysts. The top 10 countries were selected based on 2022 invested capital. We are aware of additional investments in these countries, including China, that are not captured by our methodology.

# Deal types and key funding rounds

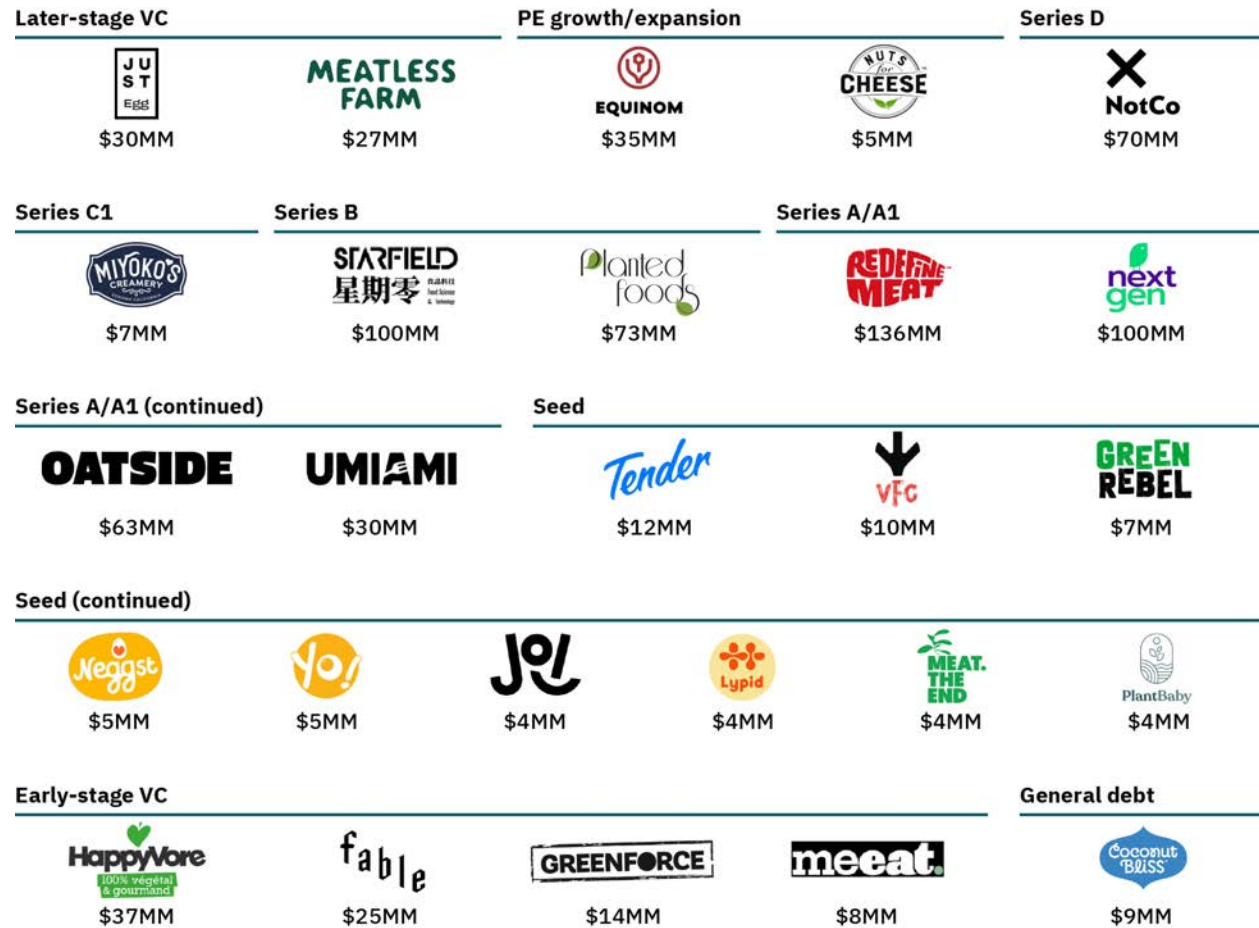
**Table 10: Deal type summary statistics (2010–2022)**

Deal type	Median 2010–2020	Median 2021	Median 2022	Maximum (all years)	Deal Count (all years)
Angel	\$230K	\$285K	\$660K	\$6.1MM	50
Seed	\$1.3MM	\$1.8MM	\$2.2MM	\$30MM	183
Early-stage VC (uncategorized)	\$1.3MM	\$1.2MM	\$2.5MM	\$37.2MM	215
Series A/A1/A3	\$4.3MM	\$7.3MM	\$8MM	\$136MM	90
Series B/B1/B2/B3	\$12.5MM	\$26.4MM	\$30.7MM	\$335MM	34
Series C/C1	\$38.2MM	\$23.9MM	\$7MM	\$90MM	17
Series D	\$77.9MM	\$235MM	\$70MM	\$235MM	7
Series E/E1	\$25.6MM	\$57.3MM	N/A	\$300MM	7
Series F/G/H	\$55MM	\$500MM	N/A	\$500MM	6
Late-stage VC (uncategorized)	\$2.3MM	\$5.6MM	\$11.5MM	\$189MM	144
PE growth/expansion (uncategorized)	\$10.7MM	\$14.8MM	\$20.2MM	\$200MM	41
Corporate	\$6.8MM	\$300K	N/A	\$75MM	16
Equity and product crowdfunding	\$30K	\$565K	\$330K	\$5.7MM	57
General debt	\$3MM	\$1.6MM	\$9MM	\$80MM	23

Source: GFI analysis of data from PitchBook Data, Inc.

Note: Data has not been reviewed by PitchBook analysts. These figures represent summary statistics of invested capital rounds with disclosed deal amounts. Deal count includes rounds with undisclosed amounts. Due to their limited number and/or size, this table excludes accelerator and incubator, capitalization, convertible debt, Series 1, Series 2, and joint venture rounds. It also excludes uncategorized rounds. The total deal count includes deals with undisclosed amounts.

**Figure 14: 2022 key funding rounds**



Source: GFI analysis of data from PitchBook Data, Inc.

Note: Data has not been reviewed by PitchBook analysts. “2022 key funding rounds” includes investments in the 75th percentile or higher for each funding round category that includes more than three deals. For funding round categories that include three deals or fewer, all deals are included.



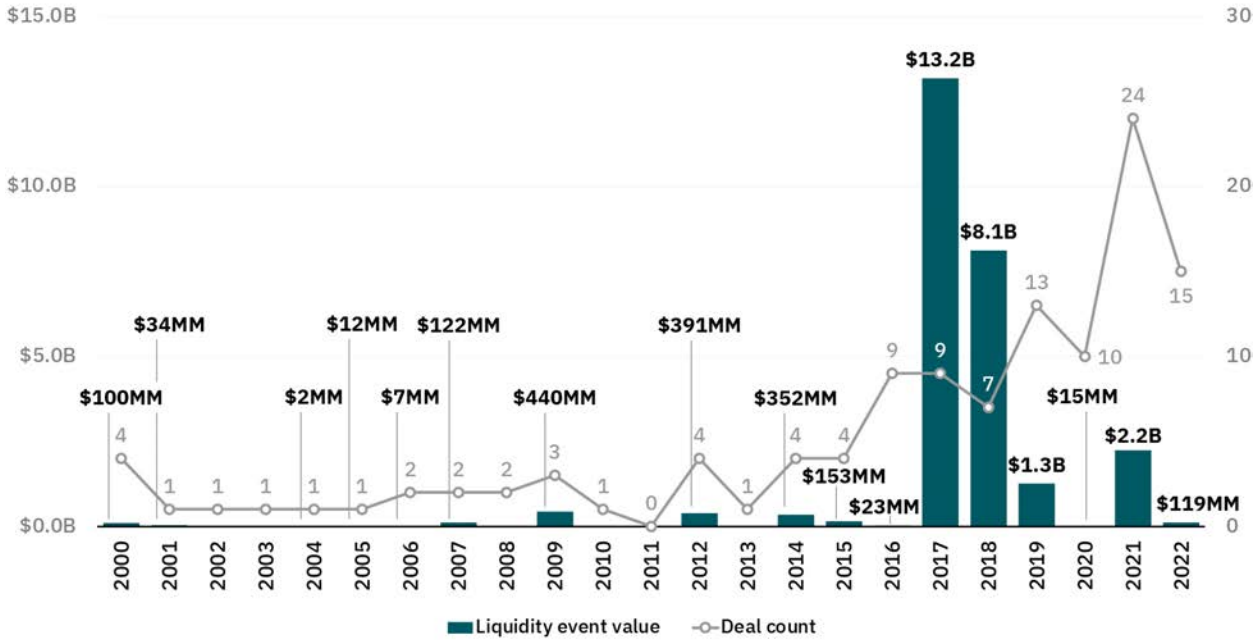
# Liquidity events

Fifteen liquidity events—also known as exits, representing the sale of an equity owner’s interest in a company typically through a merger, acquisition, buyout, or IPO—took place in 2022, though only four deals’ values were disclosed.

The most notable event was **Sol Cuisine**, a Canadian plant-based food producer, being acquired by **PlantPlus Foods**, a joint venture of ingredient giant **ADM** and major meat company **Marfrig**. The \$102 million acquisition took place as part of the joint venture’s strategy to gain a “strong foothold” across the Americas and “expand aggressively” according to PlantPlus Foods CEO John Pinto.

We expect to see an increased number of mergers and acquisitions in the coming year as companies with stronger financial footing—incumbents and startups alike—acquire firms with valuable technologies, manufacturing processes, and talent that are struggling to maintain a financial runway.

**Figure 15: Plant-based companies’ global liquidity events (2010–2022)**



Source: GFI analysis of data from PitchBook Data, Inc.  
 Note: Data has not been reviewed by PitchBook analysts. The total deal count includes deals with undisclosed amounts.

## Other financing

In addition to more traditional financing methods, some public companies pursue financing paths such as subsequent public share offerings and private investment in public equity (PIPE). Plant-based meat, seafood, egg, and dairy companies raised a disclosed \$15.3 million across four PIPE deals in 2022, bringing total other financing for the segment to \$146 million across 20 deals (14 with disclosed amounts).

**Table 11: Plant-based food other financing events (2019–2022)**

Company	Year	Amount (\$MM)	Financing type
<b>Burcon Nutrascience</b>	2015	\$1.7	PIPE
<u>Else Nutrition Holdings</u>	2019	\$5.6	PIPE
<u>Beyond Meat*</u>	2019	\$40	Public investment second offering
<u>The Very Good Butchers</u>	2020	\$10.1	PIPE
<u>The Very Good Butchers</u>	2020	\$8.5	PIPE
<u>Else Nutrition Holdings</u>	2020	\$3.8	PIPE
<u>Else Nutrition Holdings</u>	2020	\$6	PIPE
<b>Burcon Nutrascience</b>	2020	\$11.5	PIPE
<u>The Very Good Butchers</u>	2021	\$30	PIPE
<u>Else Nutrition Holdings</u>	2021	\$13.8	PIPE
<u>The Very Good Butchers</u>	2022	\$6.5	PIPE
<b>Plant Veda Foods</b>	2022	\$0.2	PIPE
<b>Global Food and Ingredients</b>	2022	\$2.8	PIPE
<u>Else Nutrition Holdings</u>	2022	\$5.8	PIPE

Source: GFI analysis of data from PitchBook Data, Inc.









Note: Data has not been reviewed by PitchBook analysts. The total deal count includes deals with undisclosed amounts.

\*Of the total \$520 million raised by Beyond Meat through a public investment secondary offering in 2019, the total proceeds to the company were \$40 million and to the selling shareholders \$480 million. We have used only proceeds to the company in this table.

# Investors

**Table 12: Most active investors in plant-based by deal count (2022)**

Investor	Logo	Investor type	Headquarters	2022 deal count	Total deal count
Big Idea Ventures		Venture capital	New York, USA	15	52
SOSV / IndieBio		Venture capital	Princeton, USA	8	34
Unovis Asset Management		Venture capital	New York, USA	5	41
AGFunder		Venture capital	San Francisco, USA	4	9
Lever VC		Venture capital	Brooklyn, USA	4	19
Siddhi Capital		Venture capital	Cherry Hill, USA	4	17
Sustainable Food Ventures		Venture capital	Raleigh, USA	4	12
Trellis Road		Venture capital	Stockholm, Sweden	4	9
VegInvest		Venture capital	New York, USA	4	20
Alwyn Capital		Venture capital	Brooklyn, USA	3	8
BayWa Venture		Corporate venture capital	Munich, Germany	3	4

Better Bite Ventures		Venture capital	Christchurch, New Zealand	3	7
Clear Current Capital		Venture capital	Vero Beach, USA	3	20
FoodHack		Corporation	Lausanne, Switzerland	3	3
Good Startup		Venture capital	Singapore, Singapore	3	9
Green Generation Fund		Venture capital	Berlin, Germany	3	3
Kale United		Venture capital	Stockholm, Sweden	3	24
Stray Dog Capital		Venture capital	Leawood, USA	3	32
Temasek Holdings		Sovereign wealth fund	Singapore, Singapore	3	12

Source: GFI analysis of data from PitchBook Data, Inc.

Note: Data has not been reviewed by PitchBook analysts. “Most active investors in 2021” includes any organization that made three or more publicly disclosed investments in a plant-based food company during the calendar year 2021. The total deal count includes deals with undisclosed amounts.

\*Indicates funders that made disclosed investments in plant-based meat, eggs, and dairy for the first time in 2021.



*“Continued growth of the plant-based category will be enabled by innovation that results in delicious and appealing options. As consumers increasingly seek out alternative proteins for personal health and environmental reasons, winners will be created in the category and generate strong returns for investors.”*

**– Alice Raksin, Investor, L Catterton**

*The Good Food Institute is not a licensed investment or financial advisor, and nothing in the state of the industry report is intended or should be construed as investment advice.*

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Section 4

# Science and technology


# Section 4: Science and technology

## Overview

Strengthening both ingredient and manufacturing capacity for plant-based meat remains a top priority for this still-emerging industry. As GFI’s [“Plant-based meat: Forecasting ingredient, infrastructure, and investment needs in 2030”](#) report outlined, to keep pace with plant-based meat demand in the coming decade, the plant-based protein industry will need to make significant investments to expand manufacturing capacity and scale the ingredient supply chain.

Throughout 2022, it became clear that the plant-based food industry is employing science and technology to help alleviate these potential bottlenecks. Specifically, advancements in protein sourcing, ingredient and formulation optimization, and end-product manufacturing methods and collaborations across the supply chain continued to help plant-based products aim for taste, cost, and convenience parity with animal products. Companies focused on:

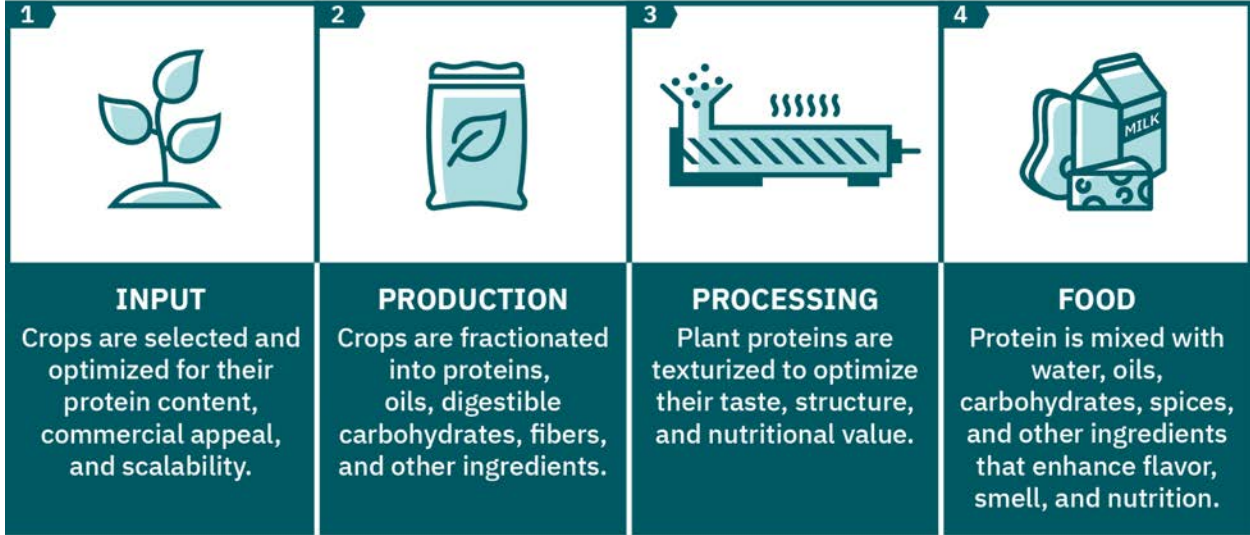
- Enhancing downstream processing by starting at the source: Crop breeding and diversity are being optimized for protein content and functionality.
- Improving and scaling plant proteins while exploring other key ingredients, such as alternative fats and binders.
- Advancing and scaling extrusion while improving the commercial feasibility of more novel texturization methods, such as 3D printing and spinning.
- Continually adjusting ingredients and product formulations to enhance some of the drivers for plant-based food consumption—environmental and health benefits.
- Collaborating with governments, academia, and other industry partners, paving the way for a robust agriculture and food system transformation.



For more detailed information about the technologies described below, refer to [GFI’s science of plant-based meat explainer](#), including deep dives into [crop development](#), [ingredient optimization](#), and [end-product formulation and manufacturing](#).

# Research across the technology stack

Figure 16: Plant-based meat process





## Crop development: Enhancing plant diversity and protein content for optimal downstream production

To feed and fuel a rapidly growing population, many industry crop breeding programs focus on optimizing agronomic traits associated with high overall crop yield and resistance to environmental stresses. In addition, enhancing plant protein content and functionality can further generate economic and nutritional value for crops. In 2022, companies that have traditionally focused on plant protein breeding efforts furthered their strategies by:

- Diversifying beyond soy and pea: **NuCicer**, with an investment from the venture arm of Bayer AG, continued developing their non-GMO, high-protein chickpea strains. Equinom is increasing their R&D efforts for ultra-high protein chickpeas, fava beans, mung beans, and cowpeas, in addition to creating a non-GMO, minimally processed, 75 percent protein content ingredient with their cross-bred pea varieties.



- 
- Accelerating commercialization efforts: **Benson Hill** focused on downstream partnerships with large-scale ingredient manufacturer **ADM** and Kellogg's plant-based product producer **MorningStar Farms**. **Equinom** secured a partnership with seed company **Peterson Farms**, while also directing their attention toward downstream commercialization by partnering with large-scale pulse ingredient supplier **AGT Food and Ingredients**. **Enhancing production scale through collaborations along supply chains is a strategy that will appreciably lower plant-based food costs.**



Along with improving product affordability, these advances demonstrate the potential of breeding techniques to significantly reduce downstream processing efforts and the environmental footprints of plant-based food production. **Accompanying the launch of their TruVail non-GMO Ultra-High Protein soybeans in 2022, Benson Hill announced the crop's resulting protein ingredient requires up to 70 percent less water and emits up to 50 percent less CO<sub>2</sub> than traditional soy protein ingredients.** For more information about environmental metrics, see the environmental and social impact of plant-based foods section of this report.

Breeding crops to generate non-native proteins, such as animal protein casein, is a strategy that continued to gain traction in 2022. For more updates on this strategy, see the plant molecular farming section of GFI's 2022 Fermentation State of the Industry report.

Beyond breeding, the industry should continue optimizing cultivation and harvesting conditions of alternative protein crop sources. In 2022, **Crop One Holdings**, an indoor vertical farming company, and **Cold Spring Harbor Laboratory** received a \$1.5 million grant from the Foundation for Food and Agriculture Research to efficiently grow high-quality Lemna (duckweed) protein in controlled environmental conditions. Efforts like these explore novel production methods for growing sustainable and protein-rich sources for plant-based foods.

## Ingredient optimization: Advancing the functionality and scalability of proteins and other plant-based ingredients

A key to unlocking the affordability of plant-based foods will be increasing the scale of production, eventually achieving economies of scale, across the entire value chain. For plant-based meat, dairy, and eggs, scaling plant protein production is a top priority of the industry. Diverse plant protein ingredients are gaining traction, with progress being made to increase their production and reduce their costs:

- **NUTRIS** opened a fava bean and potato ingredient processing factory in Croatia, claiming the title of Europe's first fava bean protein isolate manufacturing facility.
- **Eat Just** announced plans to build a mung bean protein production factory in Singapore within the next two years to create thousands of tons of ingredients per year.
- **Lantmännen** began designing a large-scale pea protein isolate production facility in Sweden, which is expected to be completed in early 2026.

Through good facility planning and collaborations, economies of scale for plant-based ingredients will be reached at an accelerated rate. In 2022, companies leveraged these strategies to design more seamless supply chains and plant-based ecosystems:

- **Bunge** plans to construct a fully integrated soy protein concentrate and textured soy protein facility in Indiana by 2025, allowing them to process an additional 4.5 million bushels of soybeans per year.
- **Protein Industries Canada** established a \$7.3 million project with **Lupin Plantform Inc., Hensall Co-op, Lumi Foods,** and **PURIS** to create an integrated ecosystem to increase the production and processing of lupin in Canada.

While scaling plant protein production is a priority for the alternative meat, seafood, eggs, and dairy industry, other ingredients are also being optimized to bolster the taste, texture, and nutrition of end products. In particular, 2022 was a banner year for alternative fat research and product development:

- **Givaudan** launched PrimeLock+, a plant-based replacement for beef and pork fats, made from encapsulating coconut oil and flavors.
- **Lypid** is continuing to develop their PhytoFat plant-based fat ingredient, also made by encapsulating plant oils to create fat replacements.

- **Good FoodTech's** AROMAX fat technology uses a konjac matrix to lock flavors and aromas in their plant-based pork fat replacement. They launched this technology in a plant-based pork dumpling under their brand, Plant Sifu.
- **Cargill** also recognized the importance of these alternative fat technologies, committing to bring **Cubiq's** alternative fats to market in 2023. Cubiq creates vegetable oil emulsion, encapsulated omega-3 fatty acid, and cell-based omega-3 fatty acid ingredients.
- **Paragon Pure** debuted their plant-based fat, OléPBM, an oleogel made from upcycled rice bran oil and rice bran wax.
- Using their new Fat 2.0 technology made from olive oil, **THIS** launched their first plant-based beef alternatives.
- **Thrilling Foods** patented their fat-streaked plant-based bacon made with protein-bound fat.
- **OmniFoods** launched their OmniNano™ Vegan Fat patented product which is composed of emulsified unsaturated fats and will be included in their 2023 plant-based beef, chicken, and pork products.

Encapsulation, emulsion, and oleogelation technologies all reduce the separation of plant oils from the product by protecting them so they gradually release during cooking and consumption. This controlled release creates a flavorful, juicy, textured mouthfeel for end products. Nutritional plant-based omega-3 fatty acid ingredients are also being developed—the use of **DSM life's™ OMEGA** algae-derived omega-3 fatty acid ingredients in meat and fish products was approved in the European Union in 2022.

Beyond proteins and fats, other ingredients are essential to enhancing end-product organoleptic properties. This year, several advances were made in optimizing other important plant-based ingredients. In particular, company innovations demonstrated consumers' appetite for a clean-label binder to replace methylcellulose:

- **Fiberstar** is planning to commercialize their citrus fiber ingredient, Citri-Fi, with the help of Givaudan. Citri-Fi functions as a texturizer, adding juiciness and texture to plant-based meat alternatives. Moreover, Citri-Fi, in combination with agar, native starch, and psyllium, can potentially be used as a binder capable of replacing methylcellulose.
- **Merit Functional Foods** also claimed that combining their Peazazz pea protein isolate ingredient with transglutaminase enzyme creates a binder capable of replacing methylcellulose.
- **Meala** created protein-based hydrogels that function as binding and gelling agents to replace methylcellulose and other gums.

In addition to the scaling and sourcing of ingredients, new ingredient processing technologies are also being developed. While conventional ingredient and food processing typically apply chemical strategies, such as wet extractions, precipitations, and drying, plant ingredient and food manufacturers have begun exploring physical and biological methods to improve their products:

- **Physical treatment strategies:** **Above Food** plans to apply hydrodynamic cavitation technology to create their clean label oat protein concentrates—the technology can ease processing conditions and improve protein functionality and digestibility. Black Sheep Vegan Cheeze applied **Feel Foods Ltd.**'s high-pressure pasteurization technique to double their cheese's shelf stability.
- **Biological treatment strategies:** Food manufacturer **Foodiq** launched a fermented fava bean ingredient, Fabea+, in which fermentation reduces the beany taste and odor traditionally associated with legumes. **DSM** launched their enzyme ingredient, Delvo Plant Go, which is marketed to improve the taste, sweetness, texture, and nutritional value of starch-based dairy alternatives.

## End-product formulation and manufacturing

A substantial bottleneck in the plant-based protein industry is the lack of scalable technology to produce thick, finely textured meat products that mimic whole-cut meat products like chicken, salmon filet, and steak. In 2022, companies focused on ramping production scale and efficiencies and exploring novel texturization methods.

Extrusion is the typical method used to create textured plant protein. While companies such as **Food Evolution**, **SIMULATE**, **Lus Oasis**, and **Planted** advanced their product lines with high-moisture extrusion this year, achieving economies of scale and structural parity with animal meat will require extrusion advancements beyond traditional methods.

Singapore-based **Growthwell Foods** is leveraging automation to scale their extrusion capabilities, while large manufacturers continue to expand their extrusion capacity in new regions, including **ADM**'s expansion in Serbia and in the United States and **MGP Ingredients'** new extrusion facility in the United States dedicated to their ProTerra wheat and pea protein line of ingredients.

Extrusion technologies that expand beyond the traditional low- and high-moisture processes have the potential to drive texture parity to conventional whole-cuts. Scientists from ETH Zurich are revamping extrusion by including two separate extrusion attachments (i.e., dies) for

pea proteins and emulsion-based fats and then combining them to create 3D, marbled plant-based meats. If commercially scalable, advances such as these could propel alternative protein's consumer acceptance due to improved sensory characteristics of plant-based meat.

3D printing is increasingly being applied to create plant-based protein products to enhance texture and overall structure beyond the current capabilities of extrusion. Demonstrating its increased popularity, several companies that focus on 3D-printed plant protein products secured funding this year, including **Redefine Meat**, **Novameat**, **Mooji Meats**, **Revo Foods**, and **Cocuuus**. The commercial feasibility of these products is being tested as several companies are launching their products in restaurants and supermarkets:

- Revo Foods began selling their 3D-printed plant-based salmon through the online vegan supermarket, **GreenBay**.
- Redefine Meat partnered with plant-based manufacturer and distributor, **MeEat**, to distribute their 3D-printed plant-based meats in restaurants in Finland. Michelin chef Marco Pierre White also added Redefine Meat's 3D-printed lamb and beef to his menus across the United Kingdom.
- **SavorEat** is collaborating with the BBB hamburger chain to create a robot chef which designs 3D-printed burgers personalized to customer nutrition specifications. The burgers use potato, pea, and chickpea protein sources as their base.
- Plantish demonstrated a prototype of their 3D-printed plant-based salmon filet and plans to launch the whole-cut product in 2024.

Another emerging technology that has the potential to create finer fibers than extrusion is plant fiber spinning. The technology hasn't made waves in recent years, but in 2022, **Tender** announced that they plan to spin plant fibers to develop realistic plant-based meat products. The technology was initially designed to create scaffolding for cultivated meat, but the pivot will provide novel insight into applying spinning technology to texturize plant-based meats.

Other companies that have developed alternatives to extrusion include **Plantagusto** who has developed a proprietary process using existing animal meat processing machinery to manipulate plant textures to replicate animal fibers.

Beyond texturization methods, artificial intelligence (AI) and machine learning (ML) are being increasingly applied to expedite research and development for plant-based end products. Harnessing these technologies can improve supply chain management, optimize manufacturing processes, provide ingredient and formulation recommendations, and sift through consumer acceptance data. In 2022, companies, including **Propel Foods**,

**Tastewise, The PlantEat, Live Green, Mars, and NotCo with Kraft Heinz**, bolstered their use of AI and ML to create better plant-based foods. NotCo is particularly focused on creating plant-based meat, eggs, and dairy using AI and plans to create a [B2B platform](#) for other companies to access their algorithm.

By including animal-free ingredients other than plant-based, end products are being refined further. Hybrid products leverage the best components of plant-based, fermentation, and cultivated technologies to improve their taste, texture, and cost. The relative affordability of plant-based products makes them particularly suitable to combine with the functionality of fermentation and cultivated technologies. For example, **Yali Bio** is creating [designer fermentation-derived fats](#) for plant-based foods. For hybrid plant-based and cultivated products, plant-based ingredients are being used as scaffolds or protein bases with specialty cultivated ingredients:

- **Plant-based scaffolds for cultivated meat:** University of Lisbon spinoff, **Algae2Fish**, aims to create cultivated seabass fillet using a [3D-printed scaffold from algae and plants](#). Similarly, **Seawith** is planning to [scaffold their cultivated steak](#) with algae ingredients.
- **Plant-based protein base for cultivated ingredients:** **Mission Barns** continues to innovate by [mixing plant proteins](#) with their cultivated fat ingredients. With the [recent green light](#) from the U.S. FDA for a cultivated meat product, **UPSIDE Foods**'s cultivated chicken, they are even closer to releasing their products to market. **SCiFi Foods, TissenBio Farms, and Meatable** are using plant-based ingredients to drive down the costs of their cultivated meat.

Traditional plant-based companies, such as **Maple Leaf Foods, Thai Union Group, and Revo Foods**, are also exploring how their technologies can be applied to the fermentation and cultivated meat and seafood industries.


Multiple technical challenges remain for plant-based alternative proteins. [GFI's database of solutions outlines current challenges, potential solutions, and anticipated impacts of various high-impact opportunities](#). A few key solutions gathering momentum in the coming year include retrofitting facilities for alternative protein manufacturing, optimizing hybrid products, upcycling sidestreams, and building interdisciplinary research centers of excellence at universities.



# Research for environmental and social impact

Research methodologies such as life cycle analyses (LCAs) can measure the environmental impacts of specific plant-based ingredients, processing methodologies, and manufacturing technologies. [A recent LCA comparing alternative and conventional meat](#) from the German Institute of Food Technologies (DIL e.V.) compared beef burgers to selected alternative burgers available on the market in Germany, with results indicating that alternative burgers based on plant and mycoprotein biomass would be more environmentally friendly than beef burgers. As an indicator of increased scientific rigor in this growing field, a first-of-its-kind [plant-based life cycle review](#) from McGill University and the National Research Council Canada pooled together numerous LCA studies on plant-based proteins to assess the methodologies used and better understand the sustainability potential of alternative proteins.

The efficiencies in plant-based food production will lead to environmental benefits even without optimized raw materials, ingredient processing, and manufacturing technologies. As research across the technology stack optimizes taste, texture, price, and scale of plant-based foods, ongoing environmental assessments can help companies understand how the adoption of specific innovations affects their environmental footprint. Additionally, LCAs can identify areas across the production pipeline where additional research can maximize environmental benefits. Examples include upcycling sidestreams as plant-based meat ingredients, minimizing processing steps and water use, and reducing energy requirements for manufacturing textured protein products.



## Upcycling sidestreams to further enhance plant-based food sustainability

The current food manufacturing sector is responsible for 39 percent of food losses. As a result, the United Nations (UN) Sustainable Development Goals (SDG) includes SDG Target 12.3, “By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.” One strategy to improve food losses during plant-based food manufacturing is valorizing whole crops and processes for human consumption. Upcycling sidestreams for alternative proteins continued to gain momentum in 2022, including the following key highlights:

- **DSM** launched their upcycled canola protein isolate, CanolaPRO, which boasts excellent functionality and digestibility.
- **Gavan Technologies** is developing a novel continuous extraction method to valorize crops, which they claim utilizes 100 percent of the raw material.
- **Leaft Foods** is exploring RuBisCo protein extraction from leaves, a common agricultural residue typically destined for waste.
- **EverGrain**, backed by **Anheuser-Busch InBev**, opened their barley protein production facility, which is capable of producing 7,000 tons of protein isolate per year from brewer’s spent grain that AB InBev produces.
- **Apparo Foods**, who developed the barley protein used by ABInBev now, is now looking to commercialize their upcycled sunflower protein isolate, noting that a key to making the functional protein from the oil production sidestream involves beginning with a more benign sunflower oil extraction process.
- New Zealand’s **Off-Piste Provisions** partnered with Singapore-based food experts to produce plant-based protein from fermented agricultural byproducts.

In addition to providing more sustainable routes toward plant-based food production, valorizing sidestreams also has the potential to improve production revenue.






## Research on health and nutrition

While taste, cost, and convenience remain primary drivers for plant-based food consumer demand, health and nutrition are also on consumers' minds. (see [consumer insights section](#)).

Individual health and nutrition can be flashpoint topics that are vulnerable to misinformation. Sharing clear, understandable nutrition data about plant-based meat is just as critical as product reformulation efforts that improve nutrition and research efforts that enable plant-based meat producers to use even more nutritious crops, ingredients, and processes.

Overall, [plant-based meats can be healthier](#) than their animal-sourced counterparts. Plant-based meat products on the market today generally have fewer calories and less saturated fat per pound compared to animal-based meat products. Plant-based meat products have zero cholesterol and almost always contain fiber. A Stanford medical school study on a small group of participants published in the *[American Journal of Clinical Nutrition](#)* in 2020 found that plant-based meat led to weight loss and reduced cardiovascular risk factors relative to the consumption of organic animal-based meat, causing statistically significant drops in overall weight and LDL cholesterol—both key drivers of diet-related illnesses. A [2021 randomized controlled trial](#) (also on a small number of participants) found that replacing conventional meat with plant-based meat about five times per week increased participants' weekly fiber consumption by an average of approximately 19 grams and increased fiber-metabolizing pathways in their gut microbiota—considered key to regulating blood pressure, blood glucose, and metabolism. And unlike processed meats (e.g., bacon or hot dogs), alternative proteins do not use nitrites and nitrate preservatives, which produce chemicals that can lead to [bowel cancer](#).

In 2022, the Gardner Lab from Stanford University School of Medicine continued their exploration of [the health effects](#) of substituting conventional meat products with plant-based meats, releasing a paper demonstrating that [athletes can maintain their performance standards](#) on both plant-based diets and omnivorous diets. Similarly, a study conducted by the Roschel Lab from the University of São Paulo demonstrated that protein source does not affect [muscle strength and mass accrual in resistance training](#). Specifically, the study compared habitual vegans and omnivores supplementing their diets with soy and whey proteins, respectively. Also in 2022, [a literature review](#) of 40+ studies on the healthiness and environmental sustainability of plant-based meat alternatives compared to animal products underscored the many benefits of plant-based meat. The in-depth review concluded that plant-based alternatives to animal products have been found to offer a wide range of health benefits, including lower cholesterol, improved gut health, and lower risks of cardiovascular disease.



Plant-based ingredient and food manufacturers continue to optimize their products for nutritional benefits. For example, **Roquette** demonstrated that their optimized pea protein isolate is complete, with equivalent quality and digestibility to casein protein in healthy humans. **Impossible Foods** reformulated their burger patty to reduce the saturated fat content by 25 percent and increase the protein digestibility score. **More opportunity exists for plant-based foods to improve on health and nutrition, including the incorporation of vitamin B12 and other nutrients, omega-3 fatty acids, and optimizing alternative fats. Nutritional modifications and improvements such as these that don't hinder end-product taste, cost, and convenience are critical to the industry's long-term success as they have the potential to unlock greater consumer interest in plant-based foods.**

## Scientific ecosystem growth

Collaborations across the plant-based scientific ecosystem can accelerate innovation and progress. They can also shorten product supply chains, provide opportunities for early innovators to enter the industry, and reduce duplicative efforts across the industry, spurring joint research and development. In 2022, there was a surge of promising collaborations across governments, academia, and industry:

- Analytical instrumentation company Waters Corp. partnered with the Plant Protein Innovation Center (PPIC), providing PPIC with technology and expertise to drive the development of new protein sources.
- Singapore's FoodPlant facility opened with the intention to increase manufacturing, research, and development capabilities for plant-based companies in Singapore. The facility is a joint venture between the **Singapore Institute of Technology, JTC Corporation, and Enterprise Singapore.**
- **Givaudan, Bühler, and Cargill** are working with the **FoodTech HUB Latam** and the **Food Technology Institute** to open a Tropical Food Innovation Lab in Campinas, Brazil. This innovation hub will have both wet and dry extrusion systems for plant-based proteins, along with a state-of-the-art demo kitchen.
- **Australian Plant Proteins** is planning to quadruple animal-free protein manufacturing capabilities in South Australia with funding from the government, **Thomas Foods International** (a leading red meat producer), and **Australian Milling Hub**. The Australian Government also sponsored Harvest B's facility dedicated to producing plant-based meat ingredients, the first of its kind in Australia.

- Denmark's **Novo Nordisk Foundation** launched **Plant2Food**, a platform that will accelerate Denmark's plant-based food development by strategically connecting academic and industry partners to tackle high-impact research gaps. Earlier in 2022, the Danish government invested \$100 million to promote climate-friendly plant-based foods

More collaborations like these are necessary to accelerate plant-based meat, seafood, eggs, and dairy innovation and production in the coming years. While significant bottlenecks still exist for the plant-based industry, strategic collaborations and open-access research can help address those bottlenecks, drive innovation, and elevate the industry as a whole.

*Are we missing something from the Science and Technology section? Did we get something wrong? We'd appreciate your feedback via [this form](#).*

## Section 5

# Government and regulation

# Section 5: Government and regulation

## Overview

Motivated by a diverse array of policy interests, governments around the world are investing in plant-based proteins as a research and commercialization priority.

Plant-based alternatives to animal products promise to reduce emissions from agriculture amid a warming climate, helping governments meet their commitments to reduce emissions and halt deforestation by 2030. Small, isolated, or densely populated nations without the agricultural resources to become self-sufficient are turning to plants as protein sources in a precarious global food system—but so are countries with advantages in producing the high-value peas, lentils, beans, and other crops that serve as inputs.

In 2022, more nations turned their focus to plant-based proteins as they assessed and helped create the food economy of the future.

## Global public funding

### European Union

In the European Union, Denmark led investments with the 2022 announcement of 675 million kroner (\$100 million) to advance plant-based foods through 2030. This investment in its Plant Fund comes in addition to its 2021 commitment of 1.25 billion kroner (\$190 million) and publicly stated intentions of becoming a leader in plant-based research and production. Seeking to meet its pledge to reduce agricultural emissions by 55 percent by 2030, Denmark's Plant Fund will work to expand the market for plant-based products and encourage farmers to produce more protein-rich input crops.

*“There is both a market in mass development and a great climate gain to be had if we in Denmark start to produce more plant-based foods. Never has so much money been spent on plant-based foods as there will be with the Plant Fund.”*

– Danish Minister for Food, Agriculture and Fisheries, Rasmus Prehn

Plant-based innovation momentum is building elsewhere in Europe as well. The European Union supported two major research initiatives into the development of plant-based products in 2022. The €11.9 million (\$12.3 million) LIKE-A-PRO project will develop 16 new alternative protein products from seven local protein sources to facilitate sustainable and healthy diets by mainstreaming alternative proteins and products. A €13.1 million (\$14.3 million) HealthFerm project will investigate the nutritional benefits of plant-based fermented foods, with the European Union's Horizon Europe Framework Programme for Research and Innovation providing €11.3 million (\$12.3 million) toward the project and the government of Switzerland funding the remaining €1.8 million (\$1.9 million). Beyond research and development, the Swedish Environmental Protection Agency partly financed a SEK \$1 billion (\$91 million) farmer-owned pea protein processing facility as part of their Klimatklivet ("the climate step") program, increasing plant-based protein production to counter emissions from animal agriculture.

## North America

In North America, Canada emerged as a global leader in public funding for plant-based foods in 2022, focusing on commercialization and market building in light of Canada's substantial production of protein-rich crops like yellow peas, chickpeas, and canola. In addition to running glowing *Globe & Mail* advertisements about plant-based foods' economic potential through Invest in Canada, its foreign direct investment arm, Canada has provided the industry with research, development, and commercialization funding on a growing scale.

Protein Industries Canada, a supercluster of nonprofits, schools, and companies, continued to fund 45 plant-based protein R&D projects, including \$1.6 million into a Regulatory Centre of Excellence to promote evidence-based regulatory policy for plant-based foods. The group will also create an online resource to help plant-based companies more easily navigate Canada's policies and access funding opportunities. The supercluster provided CAD 1.4 million (\$1 million) to help a British Columbia-based plant-based food producer increase production capacity of their 100-percent Canadian-grown chickpea tofu, and CAD 5.4 million (\$4 million) to enhance the Canadian plant-based cheese market by developing new products and testing grocery store placement strategies.

*“Canada has the potential—and is well on our way—of being a global leader in plant-based ingredients and finished food products... By building on our strength as an agricultural powerhouse, with more than 28 million hectares of arable land and a leading producer of high-protein crops such as peas and canola, we have the opportunity to turn this global demand into a long-term, sustainable economic driver for Canada.”*

– Bill Greuel, CEO of Protein Industries Canada, in [“Why alternative proteins are good for business and the environment”](#) by Invest in Canada

In the United States, the federal government continued to perform and fund research on plant-based proteins through the United States Department of Agriculture’s National Institute of Food and Agriculture (USDA-NIFA), including [three new projects](#) at the University of Massachusetts Amherst, Virginia State University, and Washington State University. In the FY23 Omnibus Appropriations Package, passed late in 2022, Congress directed the allocation of an additional \$1 million to alternative protein research over FY22 funding, for a new total of nearly \$6 million.

Progress toward greater uptake of plant-based proteins also continued at the state and local levels, with the state of California allocating \$5 million from its 2023 budget for alternative protein R&D, including plant-based protein research, and [\\$100 million](#) to expand plant-based and sustainable lunches in public schools. New York City also embraced plant-based food in two major initiatives: a new [Chefs Council](#) that will develop “delicious, nutritious, culturally relevant” plant-based meals for NYC public schools and a new [New York City Health + Hospital](#) policy making plant-based meals the default option for hospital lunches.

## Asia Pacific

The biggest Asian economies also boosted support for plant-based innovation. At the “Two Sessions” in March 2022, China’s most important annual political conference, [President Xi Jinping](#) explicitly called for protein diversification—including from plant-based and microorganism sources. China’s “Greater Food Approach,” a phrase recurring in important speeches and documents, emphasizes improving self-sufficiency, quality, and diversity of food sources, which is where developing the plant-based industry fits into China’s food security blueprint. South Korea, a growing hotbed of alternative protein innovation, selected **Intake**, a

startup specializing in plant-based pork belly, for [technology commercialization support](#). The two-year project will bring together researchers from three South Korean universities in search of more exact plant-based replications of the local staple. In Australia, the government announced AUS\$113 million (\$76 million) to support a project led by **Australian Plant Proteins** to create the [largest pulse protein ingredient manufacturing capability on the continent](#), expected to generate up to AUS\$4 billion (\$2.6 billion) in plant-based exports by 2032.

Across the world, governments are prioritizing the development of tastier, cheaper, and more easily scalable plant-based protein products. These products offer solutions to nations' growing food security concerns, allowing for the production of more protein-rich foods from existing resources while diversifying food sources, reducing pollution and emissions, and creating higher-value markets for local farmers. Policymakers seeking to reduce greenhouse gas emissions from food systems, especially methane and nitrous oxide, as well as those concerned about global health, childhood nutrition, and food security, are responding by supporting increases in market size and encouraging consumer uptake.

As publicly funded efforts to develop higher-quality products come to fruition, we expect to see more government action focused on supporting agricultural transitions, government procurement, and foreign direct investment.



### Public funding for alternative proteins

For the same reasons governments fund renewable energy and global health research, they should fund alternative protein research to achieve a more sustainable, secure, and resilient food system. [Learn more.](#)

## Regulatory and labeling updates

Food regulations and labeling laws worldwide affect where and how plant-based foods can be sold. In the United States and other countries, plant-based meat and dairy producers have faced censorship from national and local regulators. Some of these policies have been suspended, while others have been successfully challenged in court.



GFI continues to advocate for clear, fair, and sensible regulations that put plant-based foods on a level playing field. [Learn more.](#)





## United States

In the United States, several states have passed laws to censor using conventional meat and dairy terms on plant-based food labels, though many have been challenged in court or were amended to include safe harbor provisions that allow the use of meat terms along with an appropriate qualifier (e.g., “meatless” or “plant-based”). Several state legislatures have also introduced label censorship bills that would prohibit plant-based meat labels from including terms such as “meat,” “burger,” or “sausage.” In 2022, Kansas was the only state to pass such a bill. Fortunately, Kansas’s law contains a safe harbor provision that allows plant-based product labels to use meat terms so long as they include a qualifier or disclaimer indicating that the product is not made from conventional meat.

GFI, along with other organizations, continues to fight label censorship laws enacted in previous years that place unfair restrictions on plant-based products:

- In **Louisiana**, GFI and co-counsel the Animal Legal Defense Fund (ALDF) represented Tofurky in a lawsuit against the state that argued that the state’s label censorship law violates First Amendment free speech principles and the Fourteenth Amendment right to due process. In March 2022, the court granted Tofurky’s motion for summary judgment and enjoined Louisiana from enforcing the law, concluding that it “impermissibly restricts commercial speech.” The state has appealed the decision, and that appeal is pending.
- In **Arkansas**, a federal district court judge granted Tofurky a permanent injunction, preventing the state from enforcing its label censorship law against the company on the grounds that it violates Tofurky’s First Amendment right to free speech. The court also held that one provision of the law is unconstitutionally vague on its face and may not be enforced against any company.
- In **Oklahoma**, ALDF brought a new challenge to the state’s label censorship law on behalf of plaintiffs Tofurky and the Plant Based Foods Association after a judge had denied a motion to prevent enforcement of the law. The new complaint argues that Oklahoma’s law is vague, overly burdensome, and preempted by federal law. At the time of this report, the case remains pending in federal court.
- In **Missouri**, a federal district court declined to grant Tofurky and GFI a preliminary injunction on the grounds that Missouri’s label censorship law was not likely to apply to Tofurky’s product labels. In 2021, a federal appeals court upheld the ruling. The litigation is continuing in federal district court.

At the federal level, the U.S. Food and Drug Administration (FDA) is considering how to label plant-based milk and other plant-based foods. In 2022, FDA sent draft guidance on the labeling of plant-based milk alternatives to the Office of Information and Regulatory Affairs (OIRA), a department of the Office of Management and Budget that reviews significant regulatory actions. OIRA completed their review, and in early 2023, FDA issued draft guidance on plant-based milk labels. While enabling plant-based milks to keep the word milk in their names, the agency is also urging companies that use the word on their packaging to include a front-of-pack statement making clear the key nutritional differences between their products and cow's milk, even though FDA has never set nutritional requirements for cow's milk. This new labeling scheme burdens the use of milk-related terms on plant-based products.

*“GFI supports commonsense labels that use terms consumers understand and themselves use. The government's role is to ensure a level playing field. FDA should not impose de facto labeling requirements on plant-based milks while giving cow's milk a free pass.”*

– GFI senior regulatory attorney Madeline Cohen

Although the draft guidance is nonbinding and does not have the force of law, it reflects FDA's thinking on the laws and regulations it implements. Companies often interpret guidance similarly to binding FDA regulations. Moreover, draft guidance that sets forth a labeling scheme provides a hook for opportunistic class action lawsuits challenging any product label that does not comply with the scheme. Given these realities, companies are unlikely to risk noncompliance with FDA's draft guidance. FDA has also stated that it intends to draft guidance on the labeling of plant-based alternatives to other animal-derived foods.



## India

In June 2022, the Food Safety and Standards Authority of India (FSSAI), finalized the Vegan Foods Regulations, which establish a separate regulatory framework for foods and food ingredients that are free from animal products. Producers of plant-based foods must comply with the regulation and apply to FSSAI for

approval of their products to be labeled as vegan. Once approved, products must use the government-designated vegan logo.

FSSAI also amended their Food Safety and Standards (Approval for Non-Specified Food and Food Ingredients) Regulations which apply to novel foods, including novel plant-based proteins.



## Brazil

Through their Department of Inspection of Products of Vegetable Origin, the Brazilian Ministry of Agriculture and Cattle Raising is leading the regulatory agenda for plant-based products in the country. In 2022, the regulatory studies on plant-based products prepared throughout 2021 by the Institute of Food Technology at the request of GFI Brazil were finalized and delivered to the responsible authorities as a basis for the construction of regulatory text to be submitted for public consultation in 2023. This consultation should help ease the text through a new phase of discussions between organized civil society and the Ministry of Agriculture, culminating in a jointly built regulatory piece.



## Switzerland

In December 2022, Swiss-based company **Planted** won a legal victory after a local regulator instructed the company to stop using meat terms on its plant-based products. The Zurich Administrative Court held that Planted's labels were not deceptive, despite using terms like "chicken," because the labels as a whole indicated clearly that the products were meatless. In addition, the court indicated that using species names like "chicken" or "pork" on plant-based labels can provide consumers with the information they need to understand the nature of the product.



## European Union

In May 2021, the European Parliament withdrew a legislative amendment that would have severely restricted the use of dairy-related terms on plant-based products. The amendment would have banned terms such as "buttery" and "creamy," imagery that "evokes" dairy, and packaging forms that resemble existing dairy packaging (such as a carton of milk or a tub of butter). Unfortunately, the European Union still prohibits terms like "milk," "cheese," and "butter" on food labels unless products contain animal-derived dairy.

In addition, some countries within the European Union have unfairly targeted plant-based proteins at the national level. In 2022, the French legislature passed a decree banning the use of many meat terms on plant-based labels. The ban prohibits the use of "terminology traditionally associated with meat and fish," including "sausage" and "chicken." Fortunately, the country's highest court has temporarily suspended enactment of the ban, and the future of the ban remains unclear. Belgium has also proposed a similar ban on meat terms. GFI Europe has been working with allied organizations at both the EU and national levels to counteract these damaging proposals.



## United Kingdom

Although the UK is no longer part of the European Union, it has thus far retained the EU's novel food regulation. In December 2022, however, the UK Food Standards Agency launched a review of the UK's novel foods regulation, which aims to identify and evaluate a range of potential regulatory models for novel foods. Thus, we may see a new system for evaluating novel plant-based protein products in the future.



## Canada

In September 2022, Canadian company **Rawesome Raw Vegan** won a legal battle against the city of Montreal after being sued by the city for using the word "cheese" on their vegan cream cheese labels. The city alleged that the company violated provincial

and national regulations, including a regulation that sets forth a definition for cream cheese. The municipal court initially agreed with the city, but the order was overturned on appeal. The appellate court held that the regulatory definition for "cream cheese" applies to animal dairy products, but does not restrict labeling of plant-based products like those sold by Rawesome.



## South Africa

In June 2022, the South African Department of Agriculture, Land Reform and Rural Development announced that it would enforce a ban against meat and egg terms on plant-based products. In August 2022, a few days before the ban was to go into effect, the country's high court suspended enforcement until May 2023. It is unclear whether the ban will be enforceable in the future.

*Are we missing something from the Government & Regulation section? Did we get something wrong? We'd appreciate your feedback via [this form](#).*



Section 6

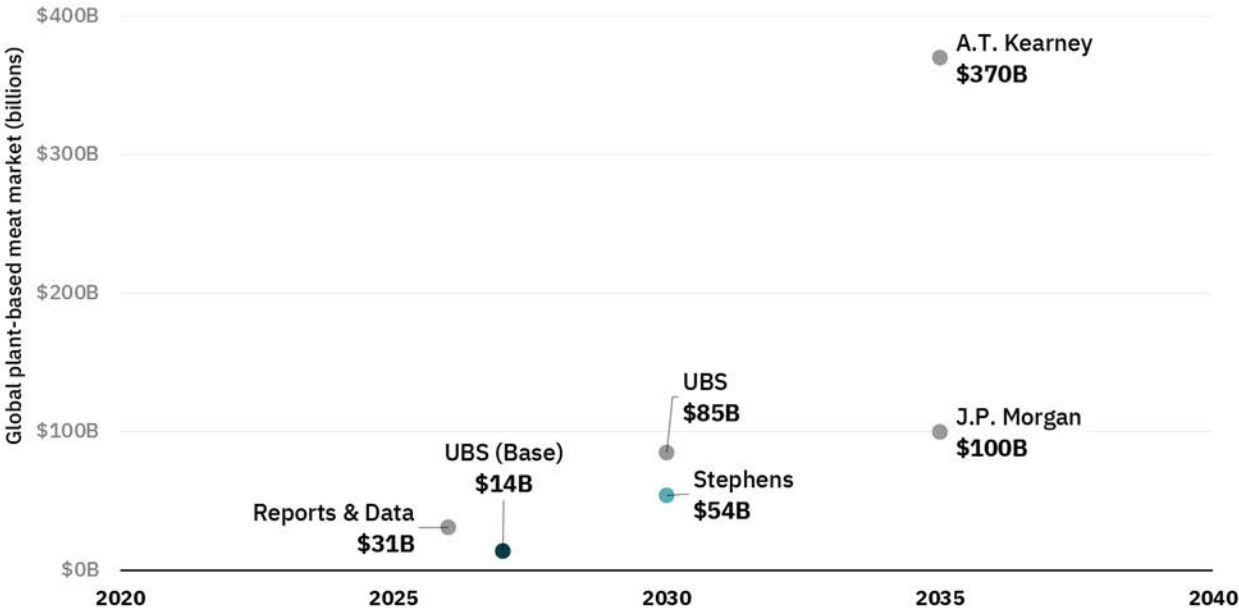
# Forecast

# Section 6: Forecast

## Plant-based forecasts

In general, the plant-based meat market forecasts released in 2022 projected slower growth than those published in previous years. UBS cut their plant-based market compound annual growth rate estimate for the coming years in half, lowering it from 30 percent in 2019 to 16 percent in 2022, and Fortune Business Insights predicted an 11 percent compound annual growth rate. Both organizations cited taste parity and price parity gaps between plant-based meat and conventional meat products as simultaneously the key challenges and opportunities for plant-based meat market growth. A section below discusses the shared features of alternative protein forecast models in greater detail.

**Figure 17: Plant-based industry forecasts by year released**



Despite the more cautious approach taken to forecasting plant-based market growth in 2022, the long-term prospects for plant-based foods remain strong. A recently released study showed that over 40 percent of consumers globally believe that most people will be eating plant-based foods instead of conventional animal products in the next 10 years. Research elsewhere shows that 66 percent of consumers aged 16 to 40 (Gen Z and Millennials) across 10 countries expect to consume more plant-based products in the future. These two generations are estimated to

comprise 69 percent of global spending by 2040 (up from just under half today). Demography is not destiny, but generational trends favor the rise of plant-based meat. Plus, the enthusiastic global environment for plant-based proteins suggests market expansion, even if individual locales experience fluctuations in support for plant-based products.

But challenges exist as well. The industry shouldn't overly rely on demographic trends alone to carry plant-based meats to significant market share. Companies should continue to innovate and develop products that better meet consumer needs.

- In Mintel's 2022 report, consumers listed taste and flavor concerns as the top reasons why they don't eat plant-based proteins. And only 20 percent of survey respondents categorized plant-based meat products as tasty, versus 61 percent for animal-based meat. Creating tasty, delicious products that close the sensory gap with conventional meat should be a priority for any plant-based meat company.
- The still-significant price premium of plant-based products compared to their animal-based counterparts also poses a threat to the industry's ability to capture significant market share. Consumer perceptions of plant-based products as expensive could solidify, which could hamper sales. A consumer survey from Deloitte found that from 2021 to 2022, the number of consumers (limited to those who sometimes purchase plant-based meat) who said they were willing to pay a premium for plant-based meat declined by 9 percentage points. Significant price premiums, lower willingness to pay more, and perceptions of plant-based meat as expensive are phenomena happening within an inflationary macroeconomic environment, which could exacerbate consumer concerns around price and lead to low engagement.
- Meanwhile, novelty could fade. A study conducted from 2018–2020 suggested that 40 percent of plant-based meat consumers were motivated in part by seeking novelty. This is in line with the fact that a significantly lower percentage of households repeatedly purchase in the plant-based meat category in U.S. retail compared to the conventional meat category. The industry should ensure that consumers remain engaged in the category, as new formulations and products that come to market can bring distinct, novel value propositions to consumers.
- Consumers also identify health aspects and nutritional value as a benefit when buying alternative protein products. Mintel's 2022 report showed that 34 percent of respondents identify plant-based meat as healthy, on par with 33 percent for animal-based meat. The Deloitte survey also found that from 2021 to 2022, the number of consumers who said plant-based food is generally healthier for them than conventional meat fell by 8 percentage points. Limiting such erosion of health perceptions could be important to retain consumers.

In the coming years, the brands likely to thrive are those that implement clear strategies to meet consumer demand for tasty, affordable, nutritious, and accessible products. All of this underscores the urgency with which companies, governments, and NGOs must continue to invest in plant-based research and technologies to ensure a sustainable, secure, and just protein supply.

Conventional meat consumption is vast and growing, and plant-based products still comprise only a small segment of the meat market. Continuing on this path, with business-as-usual ways of producing meat, will make it impossible to meet global climate goals, restore biodiversity, improve food security, and protect public health. With just seven years until 2030, the milestone year by which governments have agreed to cut global emissions by half, there is an urgent need to shift toward alternative proteins. Plant-based meat can play an important role in this shift as it provides consumers with a healthy and efficient source of protein.

So, where is the plant-based market headed? We expect 2023 to be a year of moderate growth for the industry as consumers shake the lingering effects of inflation and global interest in the space remains robust. Large plant-based companies will further implement their asset-light, strategic growth strategies announced in 2022, streamlining some plant-based categories and creating an opening for year-over-year improvement in combined retail and foodservice sales globally. Sensory improvements will continue to be enabled by technological advancements, and increased willingness to create hybrid plant-based, fermentation-derived, and cultivated products will support such progress. If the global venture capital environment improves, so too will investments in the plant-based space, and ESG considerations will remain top-of-mind for participants in this category. Plus, the continued development of the plant-based market outside of the U.S. and Europe—the two largest players in the space—will support the global growth of the category.

However, the growth of the global plant-based industry is not inevitable. It hinges upon advances in production processes, investments in distribution and manufacturing infrastructure, and the development of delicious, nutritious, affordable products that win over more and more consumers. In 2022, a number of companies, investors, researchers, universities, and governments leaned into plant-based technologies in new and notable ways. This growing activity, and the increased recognition of the global stakes, is making possible a plant-based future. The next few years are critical, with giant strides needed by all sectors—public, private, academic, and philanthropic—to create an industry capable of transforming how meat, dairy, and eggs are made around the world.

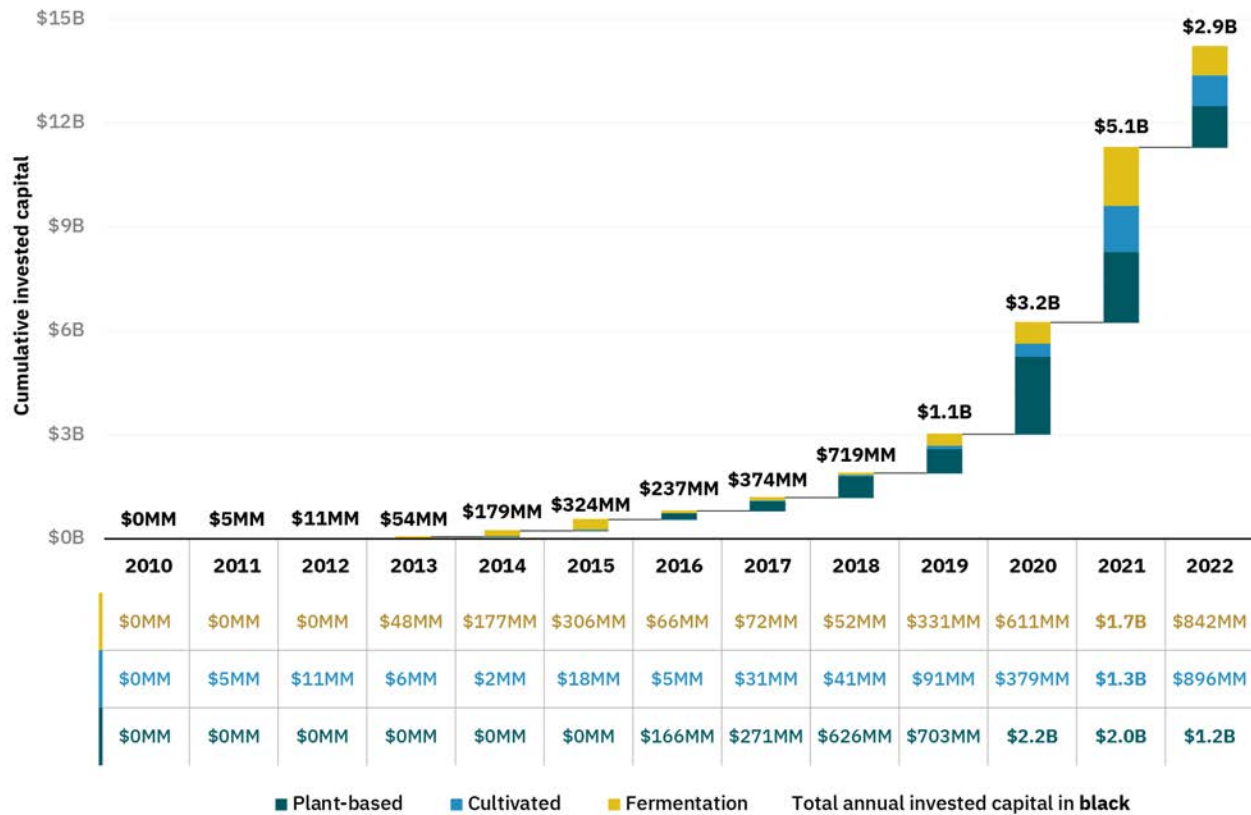


# A deeper dive into alternative protein market forecasts

The Food and Agriculture Organization of the United Nations projects that the global meat market will grow 26 percent from 360 million metric tons in 2022 to 455 million metric tons by 2050. Cultivated, plant-based, and fermentation-derived proteins represent an opportunity to significantly reduce risks and improve the efficiency of meat production while offering consumers the meat-eating experience they crave.

Over the past decade, the promise of alternative proteins spurred billions of dollars in investment, led to rapid growth in the plant-based meat market, and increased funding and activity in cultivated meat and fermentation-derived proteins. From 2017 to 2022, the global plant-based meat and seafood market grew 118 percent from \$2.8 billion to \$6.1 billion, according to Euromonitor data. All-time investments in cultivated, fermentation-derived, and plant-based proteins approached \$3 billion, \$4 billion, and \$8 billion, respectively, by the end of 2022.

**Figure 18: Cumulative and annual alternative protein invested capital, by pillar**

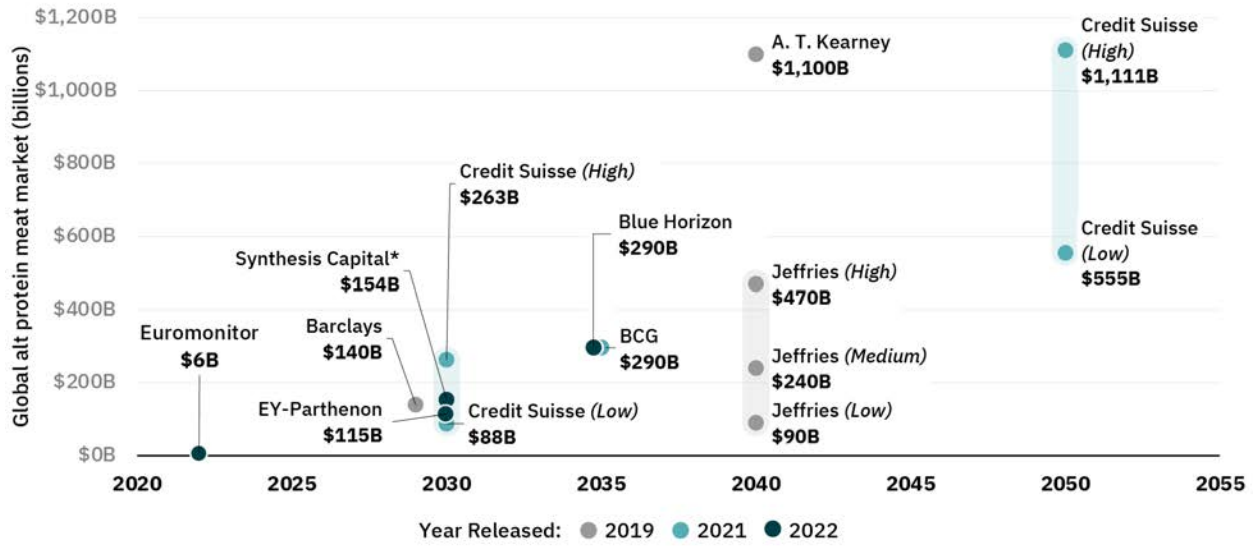


Despite the relative newness of the alternative protein sector, industry forecasts followed the trend of rapid growth, with estimates for a 2040 total market size ranging widely from \$90 billion to \$1.1 trillion. The reasons these forecasts vary are manifold, but they include large variances in key drivers such as customer adoption rates and policy environments. What these forecasts tend to share is mapping out growth paths built on relatively rapid compound annual growth rates.

But in 2022, the short-term outlook for alternative proteins shifted from the rapid growth expectations of prior years. Global overall venture funding fell in response to changing macroeconomic conditions, and alternative protein companies were not immune to this decline. Invested capital in plant-based proteins—the alternative protein sector with the largest market presence—didn't match the highs experienced in 2020 or 2021 (although 2022 was the third-highest year ever for invested capital in plant-based proteins, representing 15 percent of all-time funding). On average, alternative protein forecasts limited their upside relative to those published in years prior (see figure 19), as the market landscape tempered expectations for consistently high double-digit year-over-year growth rates. This change was most pronounced in forecasts specific to the plant-based market, but total alternative protein projections also took a more modest approach.

The fact that 2022 forecasts had lower ceilings than those published in earlier years—even though multi-decade outlooks should be relatively impervious to short-term market conditions—raises questions about the benefits of examining the specific outcomes of any single projection. With methods, scope, and publication date varying widely by forecast, in the next section we focus on the assumptions, growth factors, and roadblocks shaping projections rather than the topline numbers frequently pulled for headlines.

**Figure 19: Total alternative protein industry forecasts by year released**



\*Some forecasts projected share of the total meat market rather than the industry size in dollars. For those forecasts, we estimated the dollar size of the alternative protein sector using EY's forecast for the total 2030 meat market.

# Examining the structure of alternative protein market forecasts

In many cases, the assumptions and inputs of a projection can be more informative than the output itself in navigating the potential impacts of technological developments and policy changes in emerging industries. Often, the key question facing forecasters is less “How will this market develop?” and more “In what type of world will this market develop?” The decisions made on the front end of the forecasting process—about how industry participants will respond to changes in the market, what will drive growth or impede progress, and how market expansion will occur—are the focus of this section.

So, what are the most common assumptions found in alternative protein market forecasts?

## Common forecast assumption:

**Taste and price parity are essential.**

Nearly every forecast implies that improved product features such as taste and price parity with conventional meat will drive the adoption of alternative proteins. [Blue Horizon Ventures](#), for example, affirmed that health, taste, and price are key to boosting demand, while [Synthesis Capital](#) discussed a tipping point at which rational consumers switch to alternative proteins based on product cost and quality. These assumptions are backed by research: Multiple [studies](#) show that taste and price are essential drivers of alternative protein demand (and food choices generally). Achieving taste and price parity for alternative proteins is at the heart of GFI’s theory of change—give people the meat they love, made in far more sustainable ways, that costs the same (or less) and tastes the same (or better) as conventional meat. But it’s important to remember that product improvements don’t occur in a vacuum. In reality, taste and price improvements are likely necessary but perhaps not sufficient on their own for market growth. Factors like product variety, availability, and consumer acceptance are also needed to manifest the more robust visions for the future of alternative protein market share. To compete with conventional meat, alternative proteins must reach taste and price parity, but they also need to encompass the entire selection of conventional meat products, be available wherever conventional meat is sold, and be coveted by consumers.

**Common forecast assumption:  
Consumer adoption is a limiting factor to market growth.**

Most alternative protein market forecasts see growth as dependent on consumers wanting and buying alternative protein products, with market penetration naturally following. Jefferies, for example, identifies consumer tastes and adoption as key drivers of market growth, and Boston Consulting Group states that growth relies on consumers being convinced of taste, texture, and price competitiveness in relation to conventional meat. These views complement the commentary above on the importance of consumer preferences. While taste parity, price parity, and consumer adoption are all necessary, they aren't alone sufficient for achieving market growth—companies must also be able to adequately meet increased market demands for the industry to see growth. While some projections identify manufacturing capacity as a bottleneck, consumer adoption remains the key metric in most overall estimates. This may not be surprising, given how large a share the plant-based category represents in several of these models, and how, today, consumer adoption is a central bottleneck to the plant-based industry. Indeed, many plant-based companies with products on the market elected to cut costs in 2022 and lower their near-term growth expectations—as such, consumer adoption and manufacturing capacity are fitting leading considerations in this economic environment. The scope of manufacturing capacity scale-up needed is sizable—\$27 billion in capital expenditure by 2030—for plant-based meat to reach even a six percent share of the global meat market.

**Common forecast assumption:  
Innovation brings more innovation, investment brings more investment.**

Alternative protein forecasts generally assume the direction of the alternative protein market is up and to the right: Investment leads to better, more affordable products and technological breakthroughs that continue this cycle, spurring growth and leading to more investment. EY identifies an ever-increasing need for technological innovation in protein production, and Kearney states that it is all but inevitable that alternative proteins will capture substantial market share. The common practice of using compound annual growth rates as forecasts only adds to the sense of a predestined march toward 100-percent market share. While the general assumption of steady growth largely matches overall historical precedents, the growth depicted in many models doesn't tell the full story. First, rapid double-digit growth rates year-over-year can make sense for an emerging category where bringing one or two facilities online or launching a handful of new products can double revenue. Additionally—and particularly in times of macroeconomic upheaval—it's important to understand that inconsistent growth patterns can be common in emerging industries. When seeking to project realistic long-term outcomes, it's critical to acknowledge that outcomes can take hard turns in either direction with even the smallest of perturbations affecting a market. Take renewable energy and electric vehicles: Just a few short years ago, these technologies struggled to compete in the market. At the time, both were written off as unlikely ever to compete with fossil fuels and gas-powered cars. But as governments continued to expand market access, prices fell faster than most experts expected. Sales of solar energy reached one percent penetration in 2015. Sales of electric vehicles reached that same percent in 2017. Today, the biggest automobile manufacturers in the world are pledging to produce 100 percent electric vehicles by 2035, and according to the International Energy Agency, renewable energy will be the backbone of a carbon-free energy system of the future.

# Industry drivers

Next, what are the most common industry-supportive factors identified in existing forecasts?

## Supportive factor identified across forecasts:

**Consumer acceptance will increase as products improve.**

Many consumers already recognize the climate, health, and animal welfare benefits of alternative proteins, but for those products currently available in the marketplace, taste and price metrics often still fall short compared to conventional products. Industry stakeholders recognize additional opportunities for progress, and alternative protein market outlooks point to product innovation as a driver of future growth.

## Supportive factor identified across forecasts:

**Public and private investment will help lower costs, improve products, and raise awareness of alternative proteins' role at the center of the plate.**

While investment dollars in 2022 slowed from record spending in 2020 and 2021, the multiyear trajectory still points upward. Key partners remain committed to alternative proteins' potential—and plant-based products specifically, as evidenced by **Redefine Meat's** \$136 million Series A1 raise, **Starfield Food Science and Technology's** \$100 million Series B round, and the Danish government's 675 million kroner (\$100 million) commitment to advancing plant-based foods through 2030. In addition, public support grew, with governments around the world increasing support for alternative proteins overall in notable ways, from an uptick in public policymaking and R&D funding to China's President Xi Jinping explicitly calling for protein diversification—including from plant-based and microorganism sources—at the “Two Sessions” annual political conference in March 2022. Investment and progress to date are no guarantee of future growth, but sustained support for new technologies and ventures bodes well for the future of the industry.

# Industry roadblocks

Finally, what do alternative protein market projections frequently identify as limiting factors to market growth?

## Roadblock identified across forecasts:

**Current price premiums and a general lack of taste parity with animal products hamper alternative protein brands' abilities to attract new consumers to the space.**

Most products on the market today are plant-based, sold at a premium, and don't fully recapitulate the experience of eating conventional meat. Inflationary pressures only add to the barriers of high prices, as many consumers look for opportunities to cut costs in their grocery and restaurant budgets. Plus, complex manufacturing processes, limited availability of key ingredients, and cost to scale certain products exacerbate the current price premium and act as speed bumps to the development of the alternative protein market. That said, a clear path remains for reducing prices and improving product quality, and cultivated and fermentation-derived products paired with continued technological and ingredient innovation may ultimately play a key role in closing these gaps.

## Roadblock identified across forecasts:

**Regulation for some alternative protein product categories is new, and it's possible that regulatory hurdles could slow industry growth.**

Immense progress has been made on the path toward a fair and open regulatory environment for alternative proteins. In 2022, the U.S. FDA gave the "green light" to UPSIDE's cultivated chicken, paving the way for the first cultivated meat product to be sold in the United States. A U.S. court ruled that Louisiana's label censorship law targeting plant-based proteins was unconstitutional. But with nearly any new product or technology, the risk of challenging the status quo almost always skews toward more reactive rules and regulations, not fewer.



Since this section largely synthesizes the findings of external forecasts, the three distinct alternative protein pillars are occasionally grouped under the larger alternative protein umbrella. But in reality, each pillar exists in a different stage of development and faces its own unique set of opportunities and challenges for growth.

Plant-based meat, dairy, and egg products provide a variety of personal, environmental, and public health benefits to consumers. And while benefits like these have spurred record activity in the space in recent years, in 2022, inflationary pressures, price premiums, and, on average, a lack of taste parity to conventional products contributed to a slowdown in U.S. retail sales—though the global plant-based market still grew, according to Euromonitor estimates. In the coming years, continued investments in R&D, product quality and affordability, and strategic marketing and category positioning to further engage omnivore consumers will be key to the growth of the category.

# Expert predictions

We asked a group of industry experts for their predictions for the plant-based food industry.



*“Three key areas that are driving consumer adoption of plant-based products are price, taste and nutrition. A lot of progress has been made on those by startups, but there is more to be done. The main challenge will be managing all of them at the same time, e.g. to improve taste, new tech and extra ingredients are needed, but how to achieve it without making products more expensive, while keeping the label “clean”? What makes me hopeful is how many dedicated founders, investors, nonprofits and industry folks are working every day to address these. I am confident it will lead to better products and increased adoption.”*

– Michal Klar, Founding Partner of Better Bite Ventures and Editor of Future Food Now newsletter



*“Replacing traditional meat and dairy products with alternative proteins is one of the best tools available to combat the climate crisis. Increasing the global market share of alternative proteins from 2% today to 8% by 2030 could yield an emissions reduction equivalent to decarbonizing 95% of the aviation industry. To build market share quickly, alternative protein companies must find ways to attract mainstream consumers.”*

– Neeru Ravi, Principal, Boston Consulting Group



*“Technology has redefined the world of gastronomy in every sense and the plant-based sector has grown enormously over the past few years. New products such as those offered by Redefine Meat are a prime example of how this food is able to attract a wider group of consumers. What’s interesting is the world of food itself and how food is developing decade after decade. Plant-based meat is a game changer—simple as that. It’s about removing the blinkers and dissolving the boundaries. That’s the future of gastronomy.”*

– Marco Pierre White, Celebrity Chef



*“As we’ve seen with many transformative technologies, whether it’s the move from horses to automobiles or from landlines to mobile devices, it takes time to push consumer adoption and kickstart a shift. Once it kicks into gear though, I anticipate we’ll see swift change. I expect that over the next 10 years or so, we’ll see a wider distribution of plant-based products, just as we’ve seen with plant-based milk. However, the next 1-3 years may look more bumpy, as the industry is still in the early stages of consumer adoption.”*

**– Andre Menezes, CEO and Co-Founder, TiNDLE**



*“We see a big opportunity to lead the net-positive food tech movement by accelerating the plant-based protein transition across Europe. Our approach to this isn’t just to mimic animal products but to go beyond animal meat as a benchmark. We are focused on creating meat successors – foods that deliver on taste but are also superior from a nutritional and sustainability standpoint.”*

**– Marc Coloma, Co-founder & CEO, Huera Foods**



*“The attention the plant-based industry has received in the past few years is inspiring many to take a fresh look at our food production system, and to take into consideration the full landscape, from the farm to the consumer. The industry needs to think more holistically at critical barriers and opportunities of growth, and then connect to the players who are motivated to drive novel solutions.”*

**– Anthony Kingsley, Sr. Director, ESG and Stakeholder Engagement, Benson Hill**

# Conclusion

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Exciting developments propelled the alternative protein field, including plant-based meat, seafood, eggs, and dairy, forward in 2022. The sector still has miles to go, however, to reach its full potential. We offer three summary reflections to take into the year ahead:

## 1

**Keep the long view in sight.**

The alternative protein industry is still very early in its development. At this moment in time, it's promising to see increasing recognition among both the public and private sectors of the potential of alternative proteins to meet long-term global goals in the areas of climate, public health, biodiversity, and food security. Advances in plant-based, fermentation-derived, and cultivated meat technologies are happening fast, as more researchers and funding flow into the field. The policy and regulatory landscape is just starting to take shape. Consumers want sustainable options, but they don't want to compromise on taste, price, or convenience. Navigating and building the path to scale and adoption will take years.

## 2

**A global protein transformation will require strong, system-wide participation.**

Companies can lead by delivering tasty, affordable alternative protein products to mainstream consumers, representing a significant market opportunity given growing consumer interest in sustainable foods. The research community can lead by encouraging more scientists, from diverse disciplines and at different points in their careers, to jump into the alt protein field. The world's governments can lead by funding critical R&D to advance alt protein science, manufacturing incentives to help scale-up, and policies that level the playing field to allow alternatives to compete on taste, price, and convenience. Doing so can address the industry's biggest technical challenges, inspire additional research, create new opportunities for growth, and ensure these sustainable foods can benefit everyone.

# 3

## Believe change is possible.

At GFI, we bring determination and informed optimism to our work because we know a better food future is achievable. We see these same traits in those who pushed the field forward this year, many of them highlighted in this report. Across sectors and regions, there is a growing understanding of the importance of finding viable alternatives to industrial animal agriculture, and huge opportunities for companies who get involved in this space. Just as the world is changing how energy is produced, we need to change how meat is made. Alternative proteins can satisfy growing demand, reduce pressure on the planet, and enable a more sustainable, secure, and just food future. Alongside other advances and innovations, alternative proteins—including cultivated meat and seafood—can help write the next chapter for food and agriculture around the world.

*To those who are in this work already, we hope GFI's 2022 State of the Industry Report: Plant-based meat, seafood, eggs, and dairy gives you a more detailed look at this rapidly evolving sector. For those new to the field, welcome. Stay a while, grow with us, and change the world.*

# Acknowledgments

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## About GFI

The Good Food Institute is a nonprofit think tank working to make the global food system better for the planet, people, and animals. Alongside scientists, businesses, and policymakers, GFI's teams focus on making plant-based and cultivated meat delicious, affordable, and accessible. Powered by philanthropy, GFI is an international network of organizations advancing alternative proteins as an essential solution needed to meet the world's climate, global health, food security, and biodiversity goals. To learn more, please visit [www.gfi.org](http://www.gfi.org).



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