Good Food Institute

Industry update: Alternatives to eggs

Plant-based and fermentation-enabled innovations for egg substitutes

Climate change, zoonotic disease, and growing demand are putting pressure on U.S. food systems

Eggs are a hidden vulnerability in supply chains.

Rising temperatures and persistent avian flu outbreaks are disrupting egg production, as an expanding population and climbing incomes create more strain than ever on egg supply.

Overreliance on conventional eggs puts the food industry at financial, brand, and operational risk.

Photo courtesy of Jacob Boomsma/Shutterstock.com

Innovations in egg substitutes offer reliable, cost-stable, and sustainable solutions

Alternatives to eggs can achieve the same functional, sensory, and nutritional properties that conventional eggs deliver—from binding, emulsifying, leavening, and foaming, to glossing, browning, and protein fortification—without requiring any animals vulnerable to diseases like avian flu.

Existing plant-based eggs harness the power of chickpea flour, soy, mung beans, canola protein, aquafaba, tapioca flour, and even duckweed.

Plus, new ingredient solutions are on the horizon. Innovations like precision fermentation enable the production of ingredients that are functionally the same as animal proteins, including egg proteins.

Photos courtesy of Onego Bio

Opportunities to replace whole eggs and eggs as ingredients

Whole alternatives to eggs

The plant-based egg category encompasses a range of products including liquid, folded, and hard-boiled egg substitutes as well as powdered egg substitutes that consumers or chefs can swap for whole eggs.

Plant-based egg sales in U.S. grocery stores make up less than 0.5 percent of overall egg sales, signaling massive room for growth.

Egg ingredient alternatives

About 30 percent of U.S.-produced eggs are used as ingredients in consumer-packaged goods like baked goods and pastas, meaning food manufacturers have a unique opportunity to explore alternatives that can deliver the functionality of eggs without impacting the consumer experience.

Photo courtesy of AcreMade

Plant-based eggs are gaining traction with consumers

+11%

Retail dollar sales growth of plant-based eggs in the U.S. 2021–2023. Retail sales increased another two percent in 2024.

GFI/SPINS

+28%

Broadline foodservice dollar sales growth of plant-based eggs in the U.S. 2023–2024

GFI/CIRCANA

Repeat rates are rising.

Consumers are coming back to the plant-based eggs category at an increasing rate, a promising signal of products better meeting consumer demand.

+12%

Household repeat rates of plant-based eggs in U.S. retail grew from 44 percent to 56 percent, 2022–2024

GFI/SPINS

Photo courtesy UPSIDE Foods

There is significant room for growth in the plant-based eggs category

1%

Percent of U.S. households that purchased plant-based eggs in 2024. Compare to: 93 percent of U.S. households purchased conventional eggs

GFI/SPINS

14%

Plant-based milk dollar share of total fluid milk sales in the U.S., 2024

GFI/SPINS

$46MM

If plant-based eggs grew to match plant-based milk's market share, the category would expand to nearly $1.6 billion, up from $46 million in 2024.

GFI/SPINS

Photo courtesy Alanna Taylor Tobin

Supply chain & risk landscape

Avian flu, conventional egg price instability, and supply disruptions

Volatility in the conventional egg market isn't just a fluke, it's a pattern.

Avian flu outbreaks and the resultant supply insecurity have happened in the U.S. in 2014–2015, 2022–2023, and 2024–2025, and at different times in regions around the globe.

Prolonged price spikes and supply chain disruptions underscore the fragility of our food system, leaving consumers and businesses vulnerable to unpredictable costs.

160+ MM

Birds in the U.S. that have died or been culled 2022-2025 due to avian flu.

Center for Disease Control

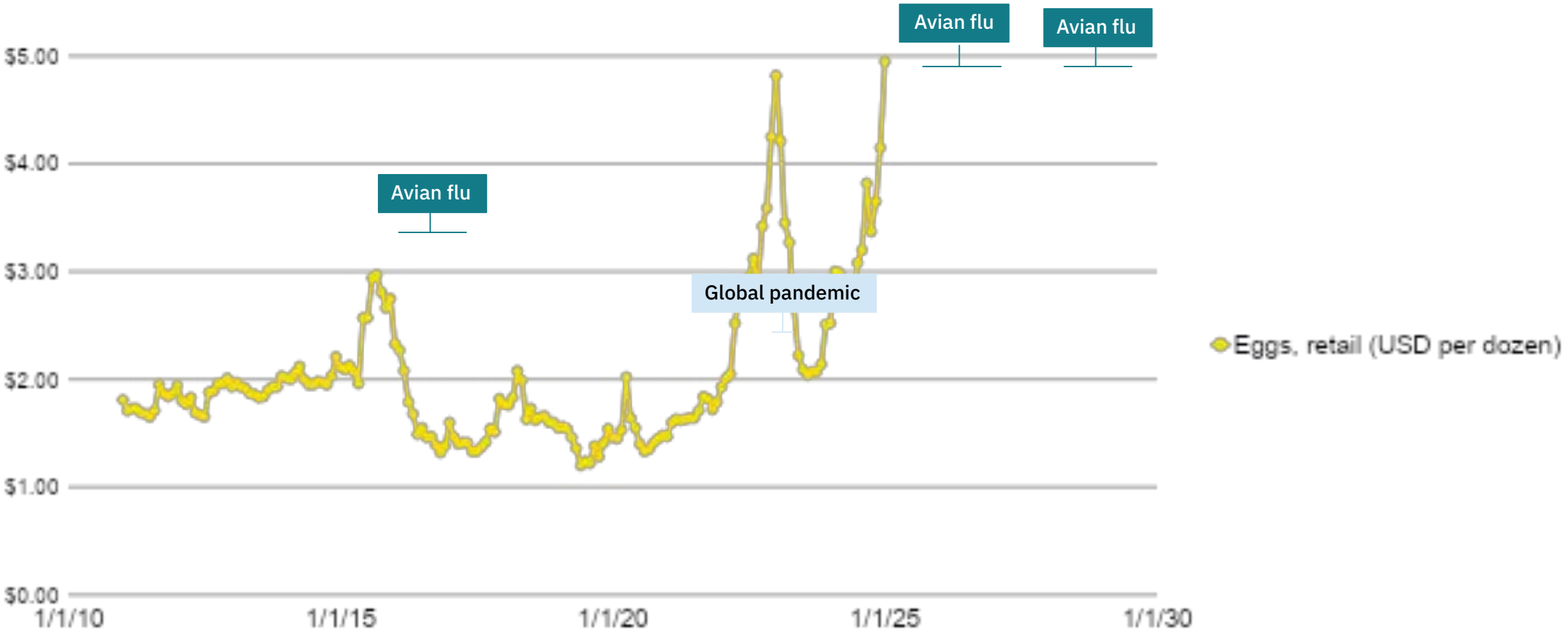
+193%

Conventional egg prices in the U.S. nearly tripled between February 2022 and February 2025.

Bureau of Labor Statistics

Photo courtesy of m.dipo/Shutterstock.com

Conventional egg supply chains are increasingly vulnerable to shocks in price, supply



Sources: Federal Reserve Economic Data, USDA Economic Research Service, USDA Agricultural Marketing Service

Experts have warned that without a coordinated global strategy involving enhanced monitoring, poultry vaccination, and improved biosecurity, the world may face increasingly frequent and severe avian flu outbreaks.

Plant-based and precision fermentation-derived alternatives to eggs offer manufacturers a smart hedge against supply chain shocks.

They can help future-proof operations, offering a reliable, cost-stable, and sustainable choice. They can ensure business continuity and increased affordability for companies and consumers alike.

Companies who rethink their egg ingredient mix today will be better equipped to weather the disruptions of tomorrow.

Sources: UN Food and Agriculture Organization, World Organisation for Animal Health
Photo courtesy of iStock/NikonShutterman

Consumer trends & perceptions

Demand for products made with eggs as functional ingredients expected to continue growing

U.S. consumers continue to seek cost-effective, ready-to-eat or quick-cook foods, including consumer-packaged goods (CPGs) like bakery items that commonly contain eggs. About 30 percent of the U.S. egg supply goes into products like these.

U.S. baked goods market sizing

- In-store bakery: Estimated at $23.5B in 2025; projected growth to $26.5B by 2029[1]
- Prepared cakes and pies: Estimated at $15.2B in 2025; projected growth to $15.8B by 2029[2]
- Packaged bread: Estimated at $30.34B in 2024; projected growth to $31.25B by 2029[3]

[1]Mintel, In-store Bakery – US – 2025, [2]Mintel, Cake and Pies – US – 2025 Report, April 23, 2025, [3]Mintel, Packaged Bread - US - 2025, June 10, 2025
Photo courtesy of Perfect Day

Plant-based baked goods category growth

Alongside growing demand for baked goods in the U.S., there's also growth in plant-based bakery and dessert options.

In U.S. retail, dollar sales of plant-based baked goods and other desserts grew 23 percent between 2022 and 2024, and unit sales grew by 15 percent in the same period, according to SPINS[1].

23%

Dollar sales growth of plant-based baked goods in U.S. retail, 2022–2024

GFI/SPINS

1 gfi.org/marketresearch/

Photos (clockwise from top left) courtesy of Perfect Day, Innovopro Ltd. (Reut Megra, Moran Lidor, Ruth Benziman, Sarit Goffen), and Microhoma

Rising interest in animal-free, allergen-free foods

Eggs are one of the most common food allergies

Alongside milk and peanuts, eggs are one of the most prevalent food allergy triggers in children in the U.S. Approximately 90 percent of all food allergies are caused by one of nine allergens, including eggs.

Allergen-free foods gain market share

The U.S. allergen-free food market is estimated to be $14.1 billion, fueled by the rising prevalence of food allergies, increased demand for clean-label products, and the popularity of plant-based diets.

Most egg substitutes offer allergen-free solutions

While most egg substitutes on the market today are plant-based and allergen-free, fermentation-enabled ingredients that are substantially equivalent to their conventionally-produced counterparts can require allergen warnings.

Photos (from left) courtesy of Leszek Glasner/Shutterstock.com, iStock.com/Ridofranz, Sweet Life Diabetes/Unsplash

Most consumers are open to trying fermentation-enabled egg products

A consumer research project run by GFI, GFI Europe, and Accenture found that more participants across markets in the United States, France, Germany, Spain, and the United Kingdom rated precision-fermented egg products as appealing than unappealing after receiving an explanation of the products.

On average, over half of participants in these markets said they would try a fermentation-enabled egg product if given a free sample.

44%

Participants who rated precision-fermented eggs as "very" or "somewhat appealing," compared to 27% who rated them as "very" or "somewhat unappealing."

50%

Participants who said they would try a fermentation-enabled egg product if given a free sample.

GFI

41%

Participants cited health as a reason to try precision-fermented egg products, the most prevalent reason followed by curiosity/novelty, animal welfare, environmental reasons, and taste.

GFI

Consumer acceptance of alternatives to eggs may be higher when used as drop-in ingredients

A 2024 study published in *Foods* found that while consumers are interested in plant-based alternatives to eggs, many expressed concerns about the taste and texture of liquid, mung bean-based egg substitutes when compared to conventional eggs or tofu scramble.

However, when plant-based egg substitutes are used *in* end products for their functional properties, hurdles to meet consumer expectations may shift.

Plus, acceptance of fermentation-derived ingredients may be easier with convenience products rather than whole foods.

Qualitative insights from GFI's consumer research found that when participants were shown different precision-fermented dairy and egg product labels and images, participants were more reluctant to consider buying or consuming a bottle of precision-fermented milk compared to a ready-made cake mix or pasta with precision-fermented egg as an ingredient.

Photo courtesy of Perfect Day

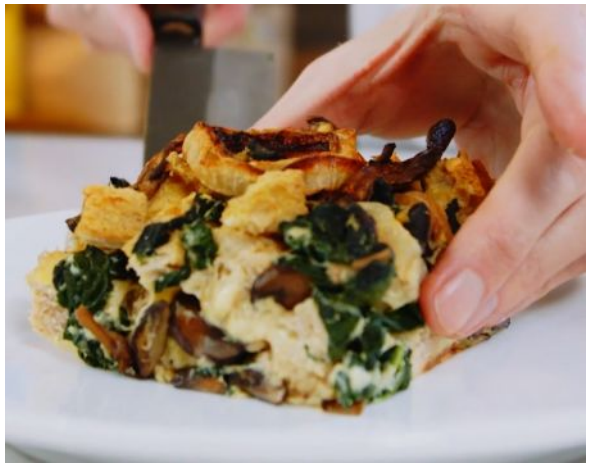
Innovations & business opportunities in alternatives to eggs

Applications for alternatives to eggs in food manufacturing

Plant-based and fermentation-enabled eggs can be applied in a range of products that typically contain conventional eggs as a primary ingredient, including:

- mayonnaises, creamy dressings, and sauces
- baked goods like cakes, cookies, breads, and meringues
- snack and protein bars
- quiches, egg bites, breakfast sandwiches, and freezer waffles
- fresh and dried pastas

As U.S. consumers increasingly seek convenient, ready-to-eat or quick-cook, affordable, familiar foods, these product types will continue to be highly relevant.



Photos (clockwise from top left) courtesy of iStock.com/ake1150sb, Onego Bio, AcreMade

Many food manufacturers are integrating plant-based or fermentation-enabled eggs alongside conventional eggs.

While some alternatives to eggs today offer cost savings compared to conventional eggs, others come at a premium. In this case, including a mix of conventional and alternative eggs can help companies reach sustainability goals more affordably.

Plus, eggs feature prominently in some brands' identities; this strategy can allow brands to continue to boast the inclusion of "real" eggs on the ingredient deck.

Importantly, few alternatives to eggs function exactly like conventional eggs. Maintaining some amount of conventional egg in product formulas can help with product consistency while plant-based and fermentation-enabled eggs are still improving.

Photo courtesy of OLALA!

What is precision fermentation, and how is it used to make alternatives to eggs?

Precision fermentation uses microorganisms to produce specific, functional ingredients—like egg or dairy proteins.

The microorganisms, like yeast, are programmed to be little production factories. This is how insulin for diabetic patients is produced, as well as rennet for cheese.

This approach has a long history of safe use in food; in fact, over 80 percent of rennet used in cheese production is made using precision fermentation. It's also common in the production of citric acid and vitamins—but its use in the alternative protein sector is relatively new.

Food giants like Unilever, Nestlé, and Bel Brands have added ingredients made via precision fermentation to products in their branded lines.

For example, Grupo Palacios partnered with The EVERY Company, a precision-fermentation company, to use their OvoPro™ protein in their Spanish omelets.

Photo courtesy of The EVERY Company

Company landscape

See GFI's Company Database for a comprehensive view of companies in the alternatives to eggs space.

Major components of plant-based eggs

Plant-based eggs use a variety of components to produce desired functional properties, which may be combined to create whole egg substitutes or be used as drop-in ingredients.

	Protein	Fats	Polysaccharides	Phospholipids	Pigments	Flavors
Examples	Legume (e.g., soy, pea, mung), cereal (e.g., wheat, oat, rice), aquatic (e.g., duckweed, microalgae)	Soy, canola, corn, sunflower, algal, coconut	Starches/modified starches (e.g., corn, tapioca), gums (e.g., guar, gellan, agar), methylcellulose	Soy and sunflower lecithin	Carotenoids (carrot), curcuminoids (turmeric)	Salts, spices, sugars, sulfur-containing compounds
Functional properties	Gelation, emulsification, foaming, thickening, binding, water holding	Mouthfeel, richness, emulsification	Gelation, water holding, thickening, binding	Emulsification, stabilization, foaming	Visual appeal	Sensory appeal
Opportunities	Lower gelation temperature, reduce off-flavors, improve processing yield	Fat structuring	Clean-label/familiar terms on ingredient decks, enhanced thermoreversibility	Clean-label/familiar terms on ingredient decks, improved heat stability	Improved heat stability	Natural egg-like flavor development, improved heat stability, improved flavor masking
Suppliers	ADM, Cargill, Roquette	AAK, ADM	Ingredion, Tate & Lyle	LECICO, ADM	Sensient, DDW (Givaudan)	Givaudan, IFF

Sources: The science of plant-based foods: Constructing next-generation meat, fish, milk, and egg analogs, Next Generation Plant-based Foods, Recent innovations for improving the techno-functional properties of plant-based egg analogs and egg-mimicking products to promote their industrialization and commercialization

Plant-based egg categories

Plant-based eggs can be applied in a range of applications, from foodservice settings for scrambles, omelets, and pancakes to commercial-scale baked goods and other CPGs.

	Technological & commercial maturity	Typical ingredients	Advantages	Limitations	Suitable applications	Company examples
Liquid whole egg	Tech maturity: High Commercial scale: Large	Mung, soy, chickpea, pea, and lupin protein; oils; gums; turmeric/ beta-carotene	Consumer familiarity, drop-in solution	Cooking performance, texture and flavor profile still evolving	Scrambles, omelets, baking (muffins, pancakes), batters	JUST, Zero Egg
Liquid egg white	Tech maturity: High Commercial scale: Large	Aquafaba	Clean-label/familiar term on ingredient decks	Limited functionality, high variability	Meringues, mousses, baking (macarons, cakes)	Oggs
Ready-to-eat eggs (e.g., hard-boiled, sunny side up)	Tech maturity: High Commercial scale: Medium	Sunflower/soy lecithin; chickpea flour; oil; turmeric/beta-carotene; modified starches	Consumer familiarity, drop-in solution	Texture and flavor profile still evolving	Ready-to-eat meals, quick-service restaurants/foodservice	Yo Egg
Powdered egg	Tech maturity: High Commercial scale: Large	Pea/chickpea protein; algal protein; methylcellulose; turmeric/beta carotene; lupin flour; gellan gum	Some single-ingredient products	Limited functionality	Baking	AcreMade

Fermentation-enabled alternatives to eggs

Some fermentation-based solutions have long been established in foods. Others, like single-cell protein and precision-fermented ovomucoid and ovalbumin, are recent developments.

	Technological & commercial maturity	Advantages	Limitations	Suitable applications	Examples of companies using	Suppliers
Precision-fermented proteins (ovalbumin, albumin)	Small scale	Single ingredient, highly soluble, defined functionality; emulsifying, binding, foaming	Cost, further formulation studies required	Baking, plant-based meat, sauces, confection ingredients	Pulp Culture LA, Palacios	Onego Bio, The EVERY Company
Upcycled yeast protein	Small scale	Sustainability benefits, binding	Product consistency needs to be proven out from brewing sidestream materials	Plant-based meat binder	Unknown	Revyve
Single-cell biomass bacteria/fungi protein	Lab scale	Sustainability benefits, minimally-processed, functionality unknown	Further formulation and potential bioprocess studies required	Baking, plant-based meat, sauces	Pre-commercial	N/A
Single-cell biomass oleaginous microbes (some yeasts, microalgae)	Lab scale	Sustainability benefits, minimally-processed, high lipid content	Further formulation and potential bioprocess studies required	Baking, plant-based meat, sauces, confection ingredients	Pre-commercial	N/A
Xanthan gum	Large scale	Cost, extended shelf life	Clean label concerns	Sauces, liquid dressings, beverages	Extensive use in foods	Bob's Red Mill, Jungbunzlauer, CP Kelco

Commercial developments in plant-based eggs: Aquafaba

Aquafaba can replicate key egg functionalities while leveraging food industry byproducts for added cost savings and waste reduction.

Aquafaba is the viscous liquid from cooked chickpeas (or other legumes). It can provide foaming, emulsifying, binding, and thickening properties for use in a range of product categories, including baked goods, dressings, sauces, and plant-based dairy products.

Its abundance in industrial food processing enables it to be a cost-effective, scalable egg replacement for manufacturers.

Some companies produce aquafaba in dehydrated or powdered forms for more efficient, shelf-stable handling and storage.

Photo courtesy of Fattyplace/Shutterstock.com

Commercial developments in plant-based eggs: RuBisCO

RuBisCO is a plant enzyme key to photosynthesis and one of the most abundant proteins on earth. It also can be an effective egg substitute.

Nutritionally, RuBisCo is regarded as an "exceptionally ideal composition of essential amino acids among plant proteins."[1] Some companies are extracting the protein from lemna (also known as duckweed), upcycled banana leaves, and other leafy greens to produce plant-based egg ingredients, including **Plantible Foods**, **Day 8**, and **Lemnago**. Plantible launched Rubi Whisk™, the first commercially-available RuBisCO-based egg replacement, in 2023. Rubi Whisk mimics the emulsifying, gelation, and binding properties of eggs.

According Plantible, their lemna can be grown efficiently and rapidly in ponds, requiring no arable land and using 95 percent recycled water.

[1]Handbook of Biologically Active Peptides, 2006.
Photo courtesy of Plantible Foods

Supply chain resiliency and cost competitiveness: Today and in the future

Plant-based and fermentation-enabled egg substitutes offer affordability, convenience, and stability.

Some estimates show that switching from using conventional eggs as ingredients to alternatives can save costs for manufacturers by as much as 30 percent.

$150B

A report from McKinsey highlights the supply chain benefits of fermentation-derived proteins and estimates the market for these products could be $150 billion by 2050.

McKinsey & Company

"Because fermentation takes place in a synthetic environment, manufacturing is both controlled and modular, increasing geographic flexibility and reducing exposure to weather, supply chain, and disease-related disruptions in the traditional food and agriculture value chain."

McKinsey & Company

Environmental, social, and governance (ESG) benefits

Animal sourcing may create ESG and compliance issues

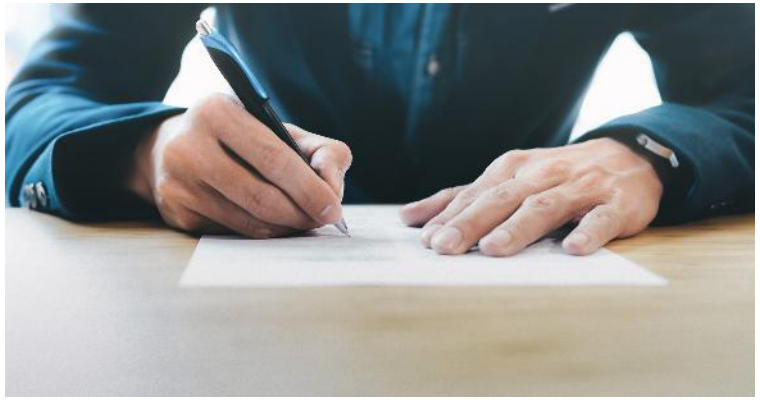
Companies that fail to transition alongside ESG frameworks and disclosure requirements may face brand erosion, investor divestment, or penalties.

Investor pressure is rising

Over $30 trillion in assets are under management with ESG frameworks, which call for Scope 3 emissions disclosures—including from animal protein supply chains. (Animal agriculture is responsible for 14.5 percent of GHG emissions.)

Increasing scrutiny on production methods

Labor conditions, animal welfare, and antibiotic use in egg production raise scrutiny from watchdogs and consumer advocacy groups.



Regulatory momentum is building

The EU, UK, and some U.S. states are moving toward stronger animal welfare and environmental disclosure requirements—posing compliance risks for global brands with animal-heavy supply chains.

Photos (from left) courtesy of iStock.com/piyaset, Jordan Opel/Unsplash, iStock.com/ijeab

Comparative life cycle assessments: Conventional eggs versus alternatives

Plant-based and fermentation-enabled alternatives to eggs offer significant reductions to greenhouse gas (GHG) emissions, land, and water use compared to conventional chicken egg production.

Conventional egg production contributes a significant portion of annual agricultural GHG emissions, especially when scaled to hundreds of millions of animals.

Some suppliers of egg substitutes have conducted life cycle assessments (LCAs) to evidence the sustainability benefits of their products.

98%

Eat Just—known for their liquid plant-based egg, JUST Egg—says their LCA tool estimates JUST Egg uses 98% less water and 83% less land than chicken eggs.

93%

Eat Just reports JUST Egg generates 93% lower GHG emissions compared to a conventional chicken egg.

Green Queen

87–89%

Onego Bio's LCA found their albumin (an egg white protein) made using precision fermentation uses 87-89% less land compared to traditional egg white powder production.

35–55%

Onego Bio's peer-reviewed LCA reported their albumin causes 33-55% lower GHG emissions than egg white protein from chickens.

Nature Food

Alignments with SDGs, net zero targets, and ESG frameworks

Whether your company has committed to taking actions towards the United Nation's Sustainable Development Goals (SDGs), net zero carbon emissions, ESG targets, or a combination thereof, engaging with alternatives to eggs can represent a meaningful step towards these goals.

Investing in the growth of the alternatives to eggs market can help fulfill the following SDGs:

- 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- 6: Ensure availability and sustainable management of water and sanitation for all
- 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
- 12: Ensure sustainable consumption and production patterns
- 13: Take urgent action to combat climate change and its impacts
- 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Navigating consumer acceptance and labeling

Leveraging consumer perceptions

Fermentation-enabled eggs: Naming and messaging

Explore the most effective nomenclature and messaging for driving consumer interest in and appeal for products made with precision fermentation-derived egg proteins.

GFI

Consumer snapshot: Fermentation-enabled proteins

Explore an overview of U.S. consumers' awareness of, openness to, and expectations of fermentation-enabled dairy and egg proteins.

GFI

Consumer perceptions: Plant-based eggs

Explore consumer sensory perceptions of plant-based eggs as well as their product expectations, emotional responses, and proposed uses.

Food

Market examples: Labeling products made with fermentation-derived ingredients

Most brands that have launched products in the U.S. market featuring precision-fermented whey use “animal-free milk,” “animal-free whey,” or “animal-free dairy” to describe the product on packaging—in line with GFI’s consumer research on the most effective nomenclature for fermentation-derived dairy and egg proteins.

Product messaging that emphasizes functional benefits, like lactose-free, cholesterol-free, and antibiotic- and hormone-free, is also shown to increase consumer appeal in GFI’s research.

Photo courtesy of Strive Milk

Market examples: Labeling plant-based eggs and egg ingredient substitutes

JUST Egg, the first widely commercially-available plant-based liquid egg scramble, refers to their product as “eggs from plants” on the front of their packaging. Following best practices referenced on page 33, their product messaging also highlights functional benefits like “5g protein per serving” and “no cholesterol.”

AcreMade, one of the top powdered, plant-based alternatives to eggs in the U.S. made for cooking and baking applications, similarly highlights their advantages when compared to conventional eggs, like “top nine allergen-free,” “no cholesterol or saturated fat,” and “shelf-stable.”

Photos (from left) courtesy of AcreMade and Eat Just

Meet with our team of experts to learn more about sustainable, scalable, and resilient future food solutions

We conduct research, share insights, and engage with the private sector to catalyze innovation and investment in alternative proteins.

Interested in learning more about how alternative proteins like plant-based or fermentation-derived eggs can provide cost-effective, stable solutions?

Reach out to our team of industry experts at corporate@gfi.org to schedule a meeting for more best practices and resources about the alternative protein transition.

We engage with stakeholders across the entire innovation-to-impact pipeline:

- CPG companies and food manufacturers
- Entrepreneurs and startups
- Equipment manufacturers
- Food scientists and R&D teams
- Foodservice companies
- Ingredient companies
- Investors
- NGOs
- Public institutions & governments
- Retailers
- Suppliers

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