



Protein reimagined

The global protein system is reconfiguring rapidly. The primary sources of conventional protein have changed little since the domestication of animals for meat, dairy and eggs. Today, consumers are demanding fresh, sustainable, transparent, nutritious and affordable food solutions. Enabled by technology, consumers are driving innovation in food systems. Technology is reshaping how humans produce and consume proteins through processing plants, fermenting microbes and cultivating cells that “biomimic” conventional proteins. Researchers and food companies are also developing fungi, insect and blended protein products to expand the protein matrix and develop novel, sustainable and affordable products globally.

The global population is expected to reach 9.7 billion by 2050, up from 2.5 billion in 1950.¹ Gross domestic product (GDP) is growing as well, particularly in Asia, which will have an estimated 5.3 billion people and a projected US\$84 trillion GDP by 2050. North America and Europe will continue to lead the world in GDP per capita, with a combined population projection of 1.1 billion and combined estimated GDP of US\$57 trillion in 2050.² In Asia, an emergent middle class is consuming increasing levels of protein while in North America and Europe, consumers are actively shopping for sustainability and health attributes, such as increasing plant-based proteins in their diets.

More than three-quarters of global agricultural land is used for livestock production today,³ which supplies one-fifth of the world’s calories.⁴ Food production accounts for more than a quarter of global greenhouse gas emissions, and more than half of that is attributable to livestock and fish production.⁵ Additionally, the domestication of livestock has altered the makeup of our global biomass (measured in gigatons of carbon, or Gt C) and ecological systems. Currently, the biomass of humans (~0.06 Gt C) and livestock (~0.1 Gt C) outweighs the biomass of all wild mammals (~0.007 Gt C), and the biomass of domesticated poultry (~0.005 Gt C) outweighs the biomass of all wild birds (~0.002 Gt C).⁶ Conventional protein production for human consumption has altered the global ecology, leading to increased attention from consumers regarding the environmental footprints of their food choices.



Consumers, governments and investors are driving innovation in the protein system. In a recent survey conducted by Ernst & Young LLP, almost 50% of consumers indicate that the environment and climate change will be top priorities in their purchase decisions, and 63% of consumers globally indicate they will be more aware of their physical health going forward.⁷ Beyond the COVID-19 pandemic, 25% of consumers will be “Health First,” prioritizing health above all else in their consumption decisions, while 33% will be “Affordability First,” focusing on their budgets.⁸ In the face of rising protein demand in both emerging and advanced markets, environmental and health challenges will increasingly drive the need for technological innovation in protein production to drive sustainability, nutrition and affordability.

Governments, driven by food security, sustainability and combating antibiotic resistance, are exploring both the research and regulation of plant- and cell-based foods while also considering “meat taxes” and other regulations on conventional protein production. For example, German politicians proposed raising the value-added tax (VAT) on conventional meat by 12% in 2019, with the funds earmarked for animal welfare improvements.⁹

Investors like BlackRock and investment networks like **Farm Animal Investment Risk and Return (FAIRR)** are altering their investment theses and raising awareness of the environmental, social and governance (ESG) risks and opportunities of intensive, conventional animal production. As the alternative protein industry matures, firms such as Temasek and SoftBank have made substantial investments in companies such as Memphis Meats, Growthwell Group and Impossible Foods.¹⁰ Consumer, government and investor stakeholders globally are driving entrepreneurs and innovators to make the protein matrix more sustainable and healthy through advancements in technology.

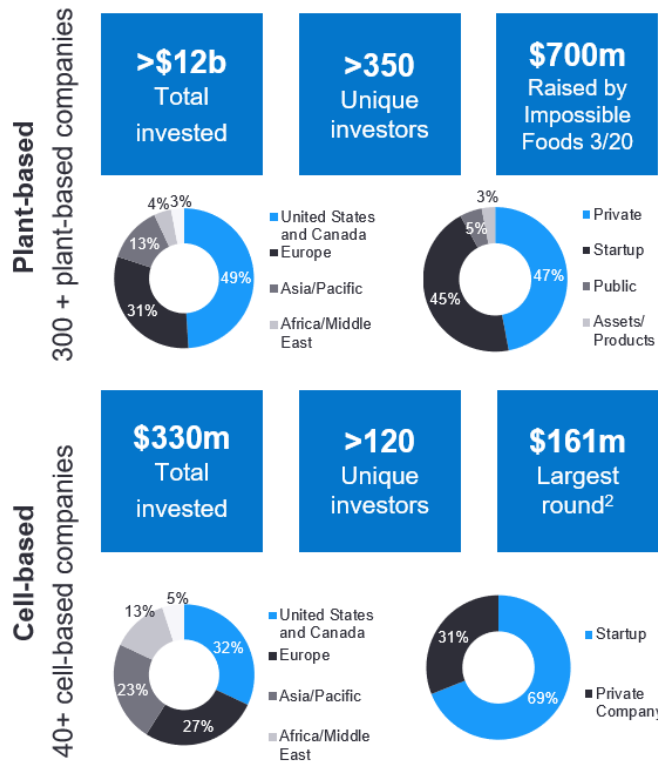
Ernst & Young LLP is working with clients, including alternative and conventional protein producers, across the food system, helping them navigate the protein market as it rapidly evolves. Changes in the growth drivers and production technologies have pushed the alternative protein market into the mainstream. Mission-driven investors and consumers, concerned about sustainability and animal welfare, are being joined by mainstream investors and consumers seeking high returns through mass-market products. While there is no crystal ball to predict market share by 2030, EY Food and Agriculture practice anticipates a reconfiguration of the protein system over the next 10 to 20 years. Following investment flows today can unlock clues about the future of alternative proteins.

Investments and market sizes

Total investments in alternative proteins have exceeded US\$16 billion over the past decade.¹¹ More than US\$1.5 billion was invested in the first three quarters of 2020,^{12,13,14} with investments continuing despite the pandemic. Impossible Foods alone raised US\$500 million in March 2020 and another US\$200 million in August 2020.¹⁵ Globally, there are an estimated 1,000+ startups operating in the alternative protein space.¹⁶



Alternative meat investment landscape¹



Sources: The Good Food Institute, Food Industry Association, Investor Place, Fast Company, Forbes, AgFunder News, New Protein Landscape v2.8, EY Embryonic, EY analysis.

Meat consumption will likely exceed 300 billion kilograms globally by 2030, with poultry and pork consumption exceeding 130 billion kilograms and 100 billion kilograms, respectively.¹⁷ EY Food and Agriculture practice estimates that alternative protein penetration of the global meat market by volume will climb from <1% in 2020 to between 5% and 10% in 2030, and potentially much higher over the following decades. The critical drivers will be cost and quality, both of which are improving rapidly. It is estimated that the cost of alternative protein production will likely fall below the cost of conventional protein production by the mid-2020s. By 2030, the cost of alternative protein production is expected to be less than US\$5 per kilogram.¹⁸ At the same time, the global average meat price is expected to increase from approximately US\$4.7 per kilogram in 2020 to more than US\$5.2 per kilogram by 2030.¹⁹ EY Food and Agriculture practice estimates the total alternative protein market size between US\$77 billion and US\$153 billion by 2030, up

from between US\$5 billion and US\$10 billion in 2021. While conventional proteins are currently growing at approximately 2.4% per year,²⁰ alternative proteins are estimated to grow at more than 36% per year. Additionally, the cost of alternative protein production is relatively species agnostic, and consumers who were once price sensitive toward beef or lamb may choose to consume more, driving change in the species mix. Increasing affordability for end consumers will be a critical driver of adoption, particularly in middle-income countries.



Global alternative protein market size (US\$b) and market penetration 2021 to 2030

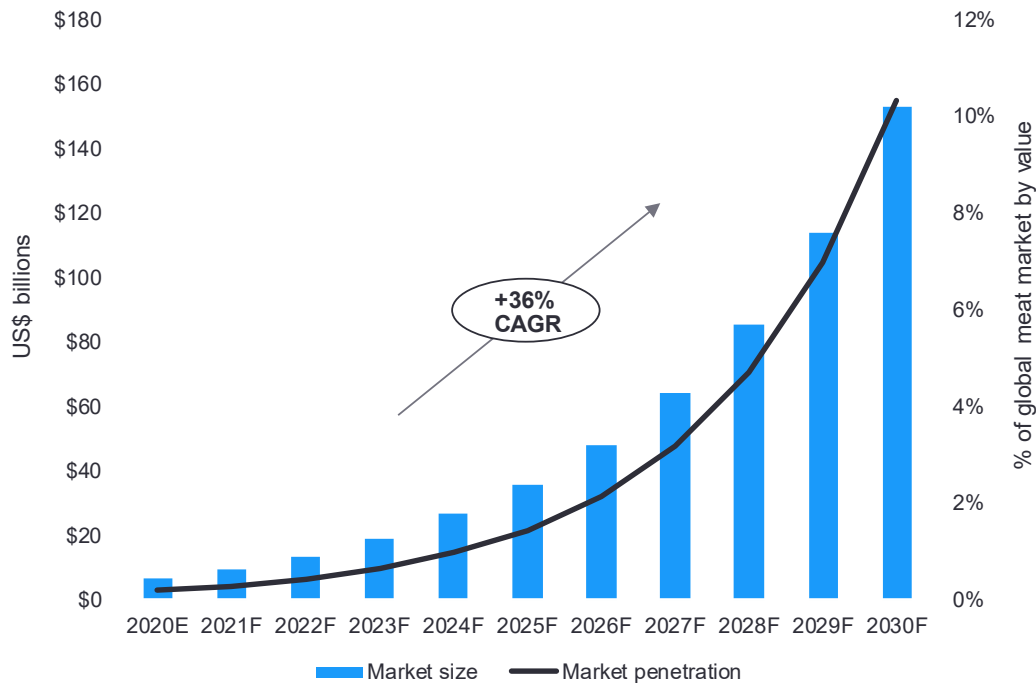


Figure 1: Global alternative protein market size (\$b) and market penetration 2021 to 2030
Source: EY Parthenon Analysis

Adoption will also be driven by product quality. Consumers increasingly demand clean labels and short ingredient decks. Many of today’s most popular first-generation beef patty replacements have more than a dozen ingredients. Next-generation alternative protein products, which are starting to become commercially available, have as few as three ingredients. Producers of alternative proteins are also increasingly able to imitate the sensory profile of conventional products, particularly in composed dishes, such as burgers or curry dishes.

Plant-based production is not the only advancing technology; cellular cultivation is advancing rapidly. A lab-grown meat restaurant, “The Chicken,” opened in Israel in November 2020, allowing the firm SuperMeat to serve diners free meals from their next-door production facility in return for feedback on their products.²¹ Also in November 2020, Singapore approved cultivated chicken by Eat Just, a San Francisco-based startup, for commercial sale.²² Singapore’s science-forward regulatory approval process is frequently regarded as a leading indicator for broader approvals by other countries. This milestone may have large ripple effects across countries in APAC, as well as others that are currently constructing regulatory frameworks for cultivated products. Cultivated products promise substantial disruption to the conventional protein industry, particularly as production costs decline.



Another rapidly advancing technology is fermentation. The costs of biomass fermentation and precision fermentation are dropping as their use-cases are growing. As the technologies scale, cultivated proteins and protein via fermentation could be substantially less expensive than conventional proteins between 2030 and 2035.²³ Fermentation-based alternative protein companies raised US\$274m in 2019 and US\$435m in just the first seven months of 2020.²⁴ We expect that the velocity of investment, technology advancement and cost reduction will continue for fermentation-based ingredient and finished goods manufacturing technologies.

A seismic shift in agriculture: challenges and opportunities

The alternative protein industry is dynamic. Advancing technologies, decreasing cost curves, changing regulations and increasing consumer adoption will lead to substantial gains in market share for alternative protein over the coming decade. The implications to conventional protein production could be significant.

Conventional protein production is fundamental to today's food system. A reduction in animal protein demand would reduce demand for feed crops like corn and soybeans, altering the economics of production. In 2019, 5.5 billion bushels of corn were used as feed and 1.2 billion bushels of corn were used as dried distiller's grains, which was approximately 48% of total corn production in the US.²⁵ Over a long horizon, demand for animal feed will likely stagnate and corn prices may continue to fall in real terms, putting producers under increasing pressure to diversify production.

Additionally, as particular "cuts" of alternative protein grow at different rates, the economics of conventional protein production become more difficult to manage. For example, as alternative "ground beef" increases its market share, other conventional beef products, such as steaks or roasts, may need to generate increasing margins, making carcass balancing increasingly difficult for producers and processors.

The increasing market share of alternative proteins also pressures numerous other products derived from conventional animal production, such as leathers, cosmetics, pet foods and fertilizers.²⁶ Non-meat animal products comprise between 25% and 37% of an animal by weight depending on the species.²⁷ Additionally, upstream input providers, such as machinery, animal nutrition and feed manufacturers, will feel the effects of changing animal economics.

Alternative proteins can also create opportunities for the food and agriculture system to meet environmental and social needs in new ways. A transition to alternative proteins would decrease agriculture's environmental footprint, particularly its greenhouse gas (GHG) footprint. Total livestock emissions are estimated at 7.1 gigatonnes of CO₂-equivalent per year, approximately 14.5% of all anthropogenic GHG emissions, of which beef cattle comprise 65%. Shifts toward plant-based and cultivated proteins will shift crop patterns, require less land due to higher conversion ratios than conventional proteins and reduce the environmental impact of conventional protein production. Plant-based, fermentation and cell-based products will also improve food traceability and transparency, making food chains more robust to disruption. Food manufacturers can change production more rapidly than conventional protein producers to meet



rapid shifts in consumer demand or changes in channel preferences, such as the disruptions caused by the COVID-19 pandemic.

Conventional producers can begin considering a more diversified portfolio. Conventional animal production is not disappearing, but new and potentially more profitable opportunities are emerging. A consumer-led shift to alternative proteins may create opportunities for growers to diversify their production. The food and agriculture ecosystems are deeply interconnected, and many producers, processors and manufacturers are assessing their roles in a reimagined food system and their opportunities to innovate and add value to their customers and to end consumers.

Ernst & Young LLP is closely monitoring several key market signals and technologies that illustrate that the alternative protein market is advancing rapidly and its disruption potential is growing. Recent disruptive market signals include:

- ▶ Major supply chains releasing and scaling alternative protein products
- ▶ Cultivated protein startups acquiring other cultivated protein startups for key technologies
- ▶ Regulatory approvals on novel ingredients, production processes and products, such as the approved sale of cultivated products in Singapore in November 2020
- ▶ Cost reductions in cultivated production inputs such as scaffolding and growth media
- ▶ Plant genetics startups focusing on ultra-high protein crops for use in plant-based consumer foods
- ▶ Governments becoming increasingly invested in alternative protein research and funding, most recently in biomass and precision fermentation technologies

Startups, crop growers, conventional protein producers, grain processors and retailers all can profitably capitalize on emerging, consumer-driven alternative protein trends.

All food value chain players can consider their product strategy and participation in alternative proteins markets. The velocity of cost reduction and quality improvements are increasing rapidly along with consumer awareness and adoption. Industry stakeholders may need to understand the future consumer and invest now to reap future rewards as the protein system reconfigures. Firms that participate boldly will likely cement themselves as leaders in this high-growth market and may generate enormous returns as consumer adoption and technologies advance.

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- ¹ United Nations, Department of Economic and Social Affairs, World Population Prospects.
- ² EY-Parthenon analysis; population data: United Nations WPP; GDP data: European Commission, 2015 estimates, inflated to 2020 real dollars.
- ³ Source: World Economic Forum.
- ⁴ Source: World Economic Forum.
- ⁵ Source: *OECD-FAO Agricultural Outlook 2019-2028*.
- ⁶ Source: "The biomass distribution on Earth." Proceedings of the National Academy of Sciences of the United States of America, May 21, 2018.
- ⁷ Source: EY Future Consumer Index, October 2020.
- ⁸ Ibid.
- ⁹ "Germany: 'Meat Tax' on the Table to Protect the Climate." Deutsche Welle, August 7, 2019. Accessed at <https://www.dw.com/en/germany-meat-tax-on-the-table-to-protect-the-climate/a-49924795>.
- ¹⁰ Sources: AgFunderNews.com (<https://agfundernews.com/singapores-growthwell-gets-8m-in-temasek-led-round-invests-in-israeli-alternative-protein-startup.html>); *Businesswire* (<https://www.businesswire.com/news/home/20200316005301/en/Impossible-Foods-Confirms-Approximately-500-Million-in-New-Funding>); *TechCrunch* (<https://techcrunch.com/2020/01/22/memphis-meats-raised-161-million-from-softbank-group-norwest-and-temasek/>).
- ¹¹ AgFunderNews.com (<https://agfundernews.com/2019-was-a-breakout-year-for-alternative-protein-startups-whats-in-store-for-2020.html>)
- ¹² Source: Good Food Institute (<https://www.gfi.org/record-investment-in-alternative-protein-in-2019-and-q1-2020-media-release>)
- ¹³ Source: Good Food Institute State of the Industry Report – Fermentation: An Introduction (2020)
- ¹⁴ Crunchbase.com, November 16, 2020
- ¹⁵ Source: FoodDive.com (<https://www.fooddive.com/news/930m-invested-in-alternative-proteins-in-q1-2020-tops-record-setting-2019/577891/>)
- ¹⁶ Source: EY-Parthenon conducted interview
- ¹⁷ OECD Data, retrieved from <https://data.oecd.org/>, November 2020
- ¹⁸ EY-Parthenon analysis; data from RethinkX and EY-Parthenon conducted interviews
- ¹⁹ EY-Parthenon analysis; data from OECD and MarketLine
- ²⁰ "MarketLine Industry Profile: Global Meat." (October 2020). MarketLine.
- ²¹ Source: "World's first cultured chicken restaurant opens in Israel". (November 2020). SuperMeat. Retrieved from <https://www.wattagnet.com/articles/41546-worlds-first-cultured-chicken-restaurant-opens-in-israel?v=preview> in November 2020.
- ²² Source: "Cultured meat has been approved for consumers for the first time." (December 2020). *MIT Technology Review*.
- ²³ Source: "Rethinking Food and Agriculture 2020-2030." (September 2019). *RethinkX*.
- ²⁴ Source: Good Food Institute State of the Industry Report – Fermentation: An Introduction (2020)
- ²⁵ "Corn Usage by Segment 2019." (2019). National Corn Growers Association. Retrieved from <http://www.worldofcorn.com/#corn-usage-by-segment> in November 2020.
- ²⁶ "Where's the (Not) Meat? Byproducts from Beef and Pork Production." (2011). US Department of Agriculture, Economic Research Service. Retrieved from https://www.ers.usda.gov/webdocs/outlooks/37427/8801_idpm20901.pdf?v=1447.9 in November 2020
- ²⁷ EY-Parthenon analysis; data from USDA retail reports, National Pork Board, National Chicken Council, and Utah State University



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SCORE no. 12011-211US

2101-3655802
ED None

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