



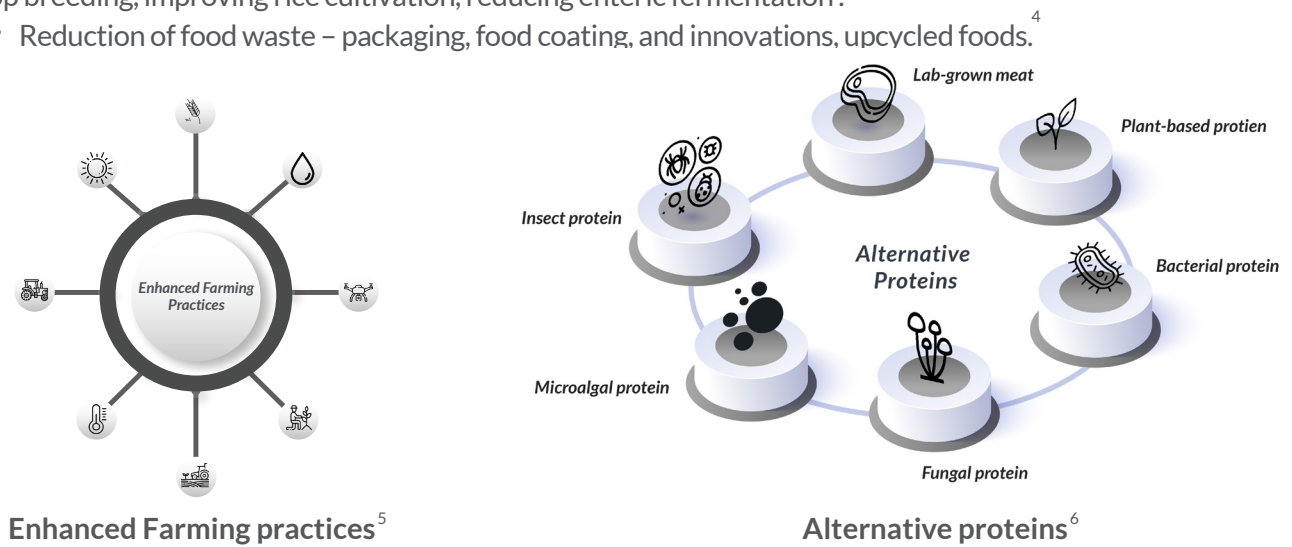
Future of Food – Alternative Proteins

This white paper was written by BALAJI VASUDEVAN with input and contribution of UM6P Ventures Team.

INTRODUCTION

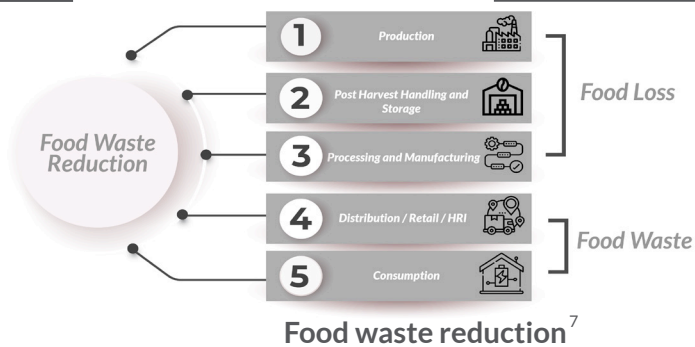
The global food system represents one of the greatest challenges to both climate change and broader environmental sustainability. It is one of the major drivers of climate change, biodiversity loss and depletion of freshwater arable land resources. To feed the growing global population while cutting global GHG emissions, there is an immediate need for Transformation in Food and Agriculture Sustainability (TFAS) adoption. As suggested by the World Resource Institute (WRI), three areas must be filled to feed 10 billion people sustainably by 2050, the projected population of the earth’s population by mid-century, they are calorie deficits, arable Land Shortages, and the emission crisis . To sustainably provide an adequate supply of food to the growing population, combined approaches such as those outlined below should be followed and adopted.

- Supplementation with alternative proteins – plant-based, cell-based, precision and biomass fermentation .²
- Enhanced Farming Practices – CEA, agbiotech, precision agriculture, boosting pasture productivity, improving crop breeding, improving rice cultivation, reducing enteric fermentation .³
- Reduction of food waste – packaging, food coating, and innovations, upcycled foods.⁴



Enhanced Farming practices⁵

Alternative proteins⁶



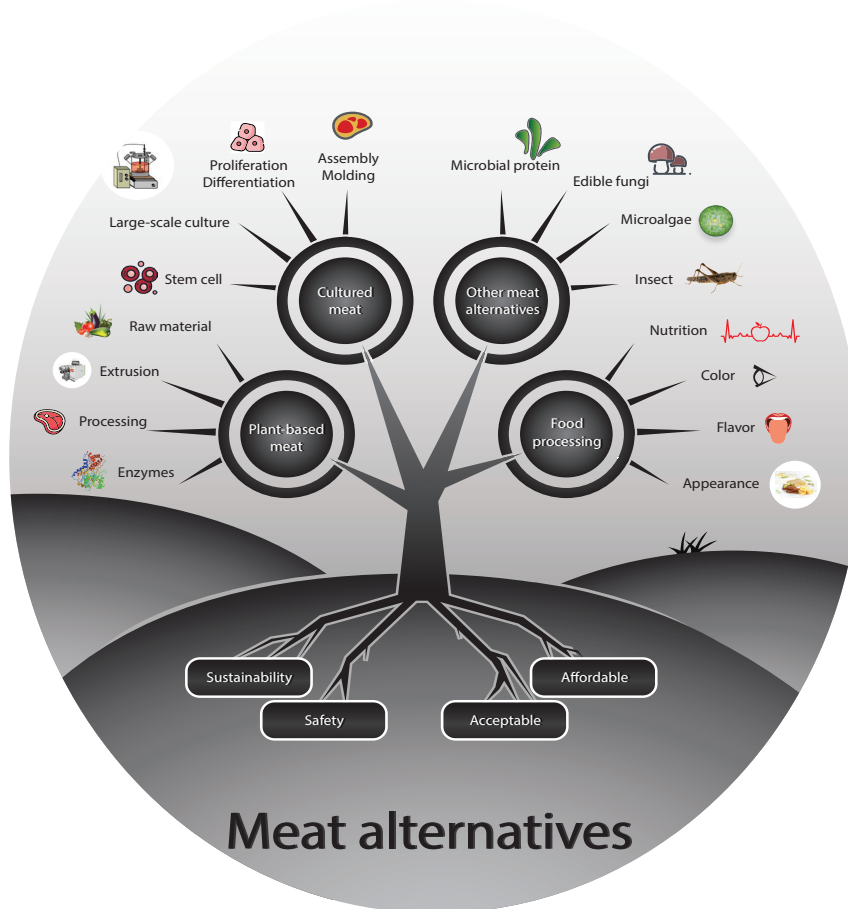
Food waste reduction⁷

Alternative proteins represent a rapidly emerging new domain within the food system. Alternative proteins provide a great opportunity to reduce dependency on animal agriculture in a more sustainable and climate-friendly way. In recent years, there has been a widespread development and roll out of product and market innovations involving new pure plant-based alternatives such as insects, fungus, algae, microbial fermentation, and the application of cutting-edge biotechnology to develop cell based cultivated meat. This white paper will highlight the relevance of alternative proteins as a sustainable alternative to animal proteins and a source for healthy food production and consumption. Other topics that will be explored are the challenges associated with our existing protein consumption, current and future trends of this sector, opportunities within the food market, the global regulatory and policy landscape, investment opportunities and trends, and the future direction of the alternative protein sector.

¹ <https://www.wri.org/insights/how-sustainably-feed-10-billion-people-2050-21-charts>
² <https://pentec-consulting.eu/alternative-protein/>
³ https://medium.com/general_knowledge/what-are-the-iot-applications-in-agriculture-d830bbb9fa50
⁴ <https://www.futurelearn.com/info/courses/explore-how-farmers-produce-food-sustainably/0/steps/60783>
⁵ <https://pentec-consulting.eu/alternative-protein/>
⁶ <https://centdegres.ca/ressources/11-millions-de-tonnes-d-aliments-comestibles-gaspillees-chaque-annee-au-canada>
⁷ Zhang et al., Current Opinion in Food Science, Feb 2022, Vol 43, Pages 43-52
 Weindl et al., Global Food Security, June 2020, Vol 25

WHAT ARE ALTERNATIVE PROTEINS ?

Alternative proteins are protein-rich foods derived from various sources that can be plant-based, microbe-based, fungus-based, algae-based, insect-based, or animal cell-based as shown in the figure below. They are designed and developed to replace animal proteins and mimic the taste and texture of meat, seafood, chicken, eggs, and dairy products. Alternative proteins are considered as novel and innovative food sources produced by combining various ingredients at the right proportion to mimic animal meat, seafood, fish, chicken, and dairy. Alternative protein companies attempt to lure consumers with plant- or meat-based diets by touting the benefits of consuming an environmentally friendly product without compromising on taste, flavor, appearance, or texture. The key promise of alternative proteins is redesigning the way meat, fish, and dairy are produced and consumed to feed the growing world population while tackling animal welfare and environmental concerns.

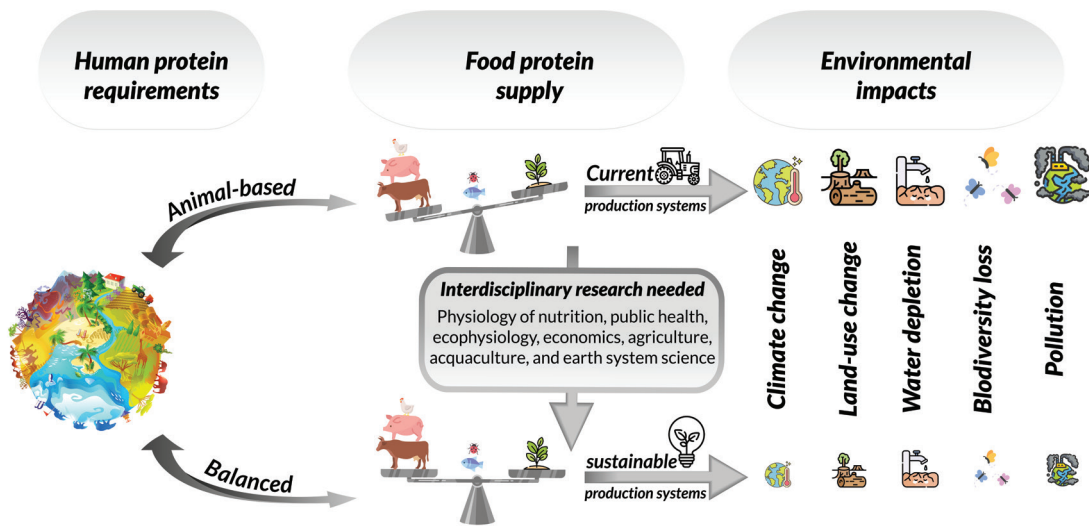


Alternative Protein Types and Sources⁸

WHY ARE ALTERNATIVE FOODS IMPORTANT ?

Alternative foods are one of the major solutions that could keep millions or billions of people alive during even the most severe food catastrophes and the shift to alternative proteins can also contribute greatly to the efforts in combatting climate change. When compared to conventional meat-derived proteins, it is widely recognized that alternative proteins offer benefits and advantages such as lower carbon emissions, no animal slaughtering, reduced spread of zoonotic diseases and pandemics, fewer concerns about the ethics and environmental consequences of intensive animal farming, more sustainable food production, and wide availability of tasty and nutritious food (see figure below).

⁸[Zhang et al., Current Opinion in Food Science, Feb 2022, Vol 43, Pages 43-52](#)



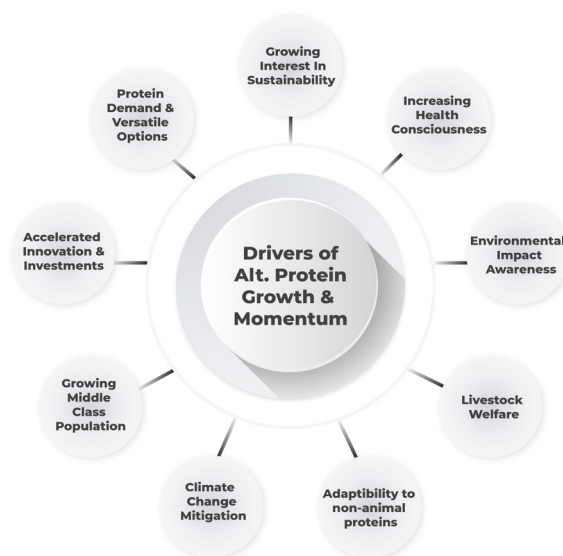
Sustainable food protein supply reconciling human and ecosystem health⁹

Alternative proteins are less resource-intensive compared to their conventional animal protein counterparts as shown below:

- 86-99% fewer greenhouse gas emissions
- 97-99% less land use
- 70-99% less air pollution
- 83-99% less toxic chemical production
- 95-99% less water use

KEY DRIVERS OF ALTERNATIVE PROTEINS

In recent years alternative proteins have evolved from a niche product to a more widespread mainstream food category as demonstrated by the plant-based alternatives available for every conventional meat product in the market. A major shift from current global dependence on animal agriculture, factors farming and animal proteins to alternative protein sources produced sustainably will be driven by the following factors:



Drivers of alternative proteins

⁹Weindl et al., Global Food Security, June 2020, Vol 25

CHALLENGES

There are multiple challenges facing the alternative protein sector. Price parity, taste and texture, consumer acceptance, access, and distribution are key constraints that the alternative protein sector should address in order to capture more market share of the global protein market. The above infographic details challenges for this sector that need to be addressed in order for it to grow.



Alternative proteins challenges

MARKET LANDSCAPE

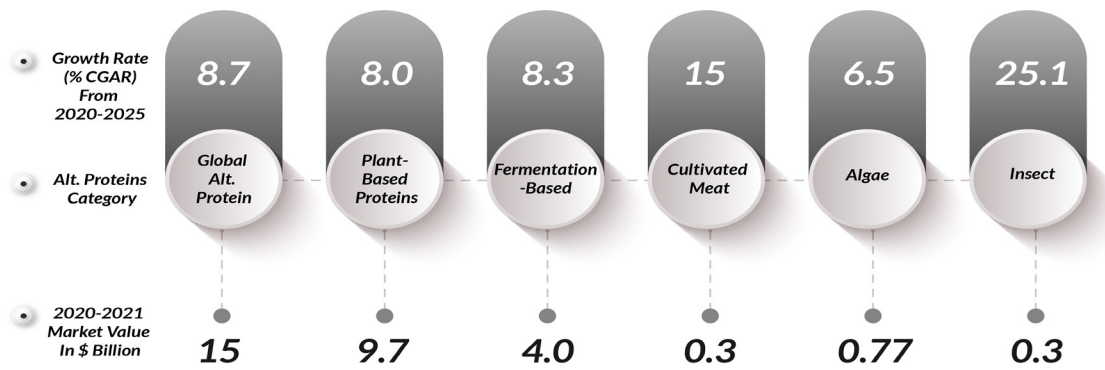
The global market opportunity in the alternative protein sector is growing at a rapid pace. There is a transformation happening in the food system that is moving alternative protein from a niche product to a mainstream product. In fact, alternative protein is becoming more of an everyday food item globally. Recent years witnessed continuous growth in the overall market value and share of protein demand. Data from public and private sectors reveals that alternative protein sales was \$4.2 billion USD in 2020 and is expected to touch \$28 billion USD by 2025¹⁰. Global sales of meat substitutes are currently at 1% now and projected to grow by 10% over the next decade¹¹. Insect derived proteins, classified by some as alternative protein, are expected to be more than \$10 billion USD by 2027¹². Of all the global markets expected to see explosive growth in alternative proteins, APAC will be the fastest projected to grow 11% by 2028¹³. The current market and estimated size for alternative proteins is presented below.

¹⁰ <https://foodtank.com/news/2022/04/is-fake-meat-a-false-promise-new-report-exposes-the-politics-of-alternative-proteins/>

¹¹ https://www.ipes-food.org/_img/upload/files/FakeMeatSpotlight.pdf

¹² https://www.ipes-food.org/_img/upload/files/FakeMeatSpotlight.pdf

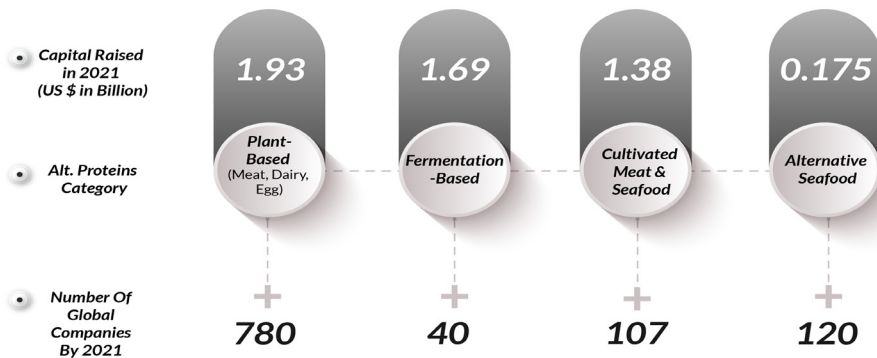
¹³ https://www.ipes-food.org/_img/upload/files/FakeMeatSpotlight.pdf



Alternative proteins market landscape¹⁴

ALTERNATIVE PROTEINS SECTOR GROWTH

The number of alternative protein companies and brands around the globe are growing rapidly. Globally, alternative protein investments grew 60 percent from 2020 to 2021 to a new record-breaking total of \$5 billion USD¹⁵. All categories in the alternative protein sector saw explosive growth in 2021 as summarized below.



Alternative proteins sector growth¹⁶

INVESTMENTS IN ALTERNATIVE PROTEINS

Changing consumer behavior and interest in alternative-protein sources, due in part to health and environmental concerns as well as animal welfare, have made way for growth in the alternative-proteins market supported by investments from private and public sectors. The investment community is instrumental to the success of the alternative protein industry. Investor interest in the field is already strong and investors are allocating their funding across the industry. In the days ahead, the investor landscape in the alternative protein sector will fall under two main areas:




- Companies involved in developing breakthrough innovations in technology within the alternative protein sector and ultimately developing a Minimally Viable Product (MVP) or solution.
- Companies that build industrial scale bioreactors and other related infrastructure for production ramp up and scaling towards commercialization.

The capital to alternative protein sector comes from three sources: investors (VC and angel), global corporations (existing food & beverage companies) and governments. The alternative protein investment summary for 2020-2021 is given below.

¹⁴ <https://gfi.org>
<https://pitchbook.com>
¹⁵ <https://vegnews.com/2022/3/global-sustainable-protein-sector-5-billion>
¹⁶ <https://gfi.org>
<https://pitchbook.com>

Alternative protein investment summary, 2010 - 2021¹⁷

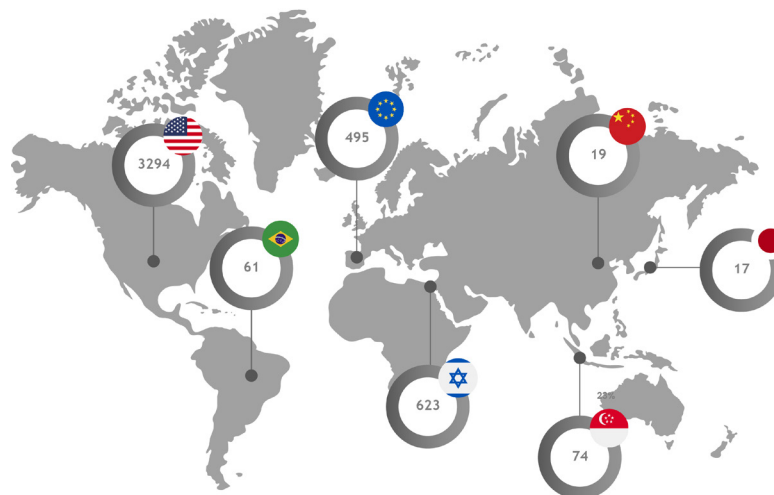
Invested capital

Category	2020	2021	All-time (2010-2021)	1-year growth (2020-2021)	Largest rounds (2021)
 Plant-based	\$2.1 B	\$1.9 B	\$6.3 B	+60 %	500 million Impossible foods
 Fermentation	\$600 M	\$1.7 B	\$2.8 B	-	350 million Nature's Fynd
 Cultivated	\$400 M	\$1.4 B	\$1.9 B	3x	347 million Impossible foods & Perfect Day
Total alternative Protein	\$3.1 B	\$5.0 B	\$11.1 B	3x	500 million Impossible foods

INVESTORS

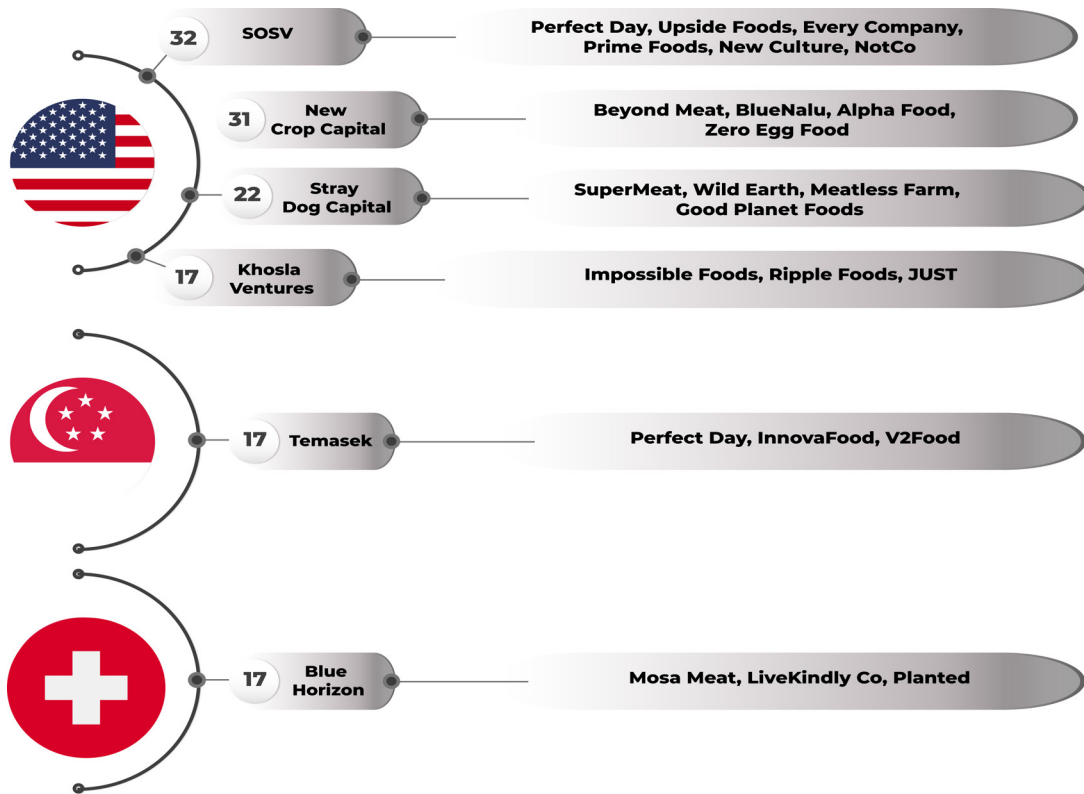
Investments in alternative proteins have trended in an upward direction for the past few years. Since 2015, about \$8 billion USD has been invested in this sector¹⁸. In 2020, \$2.9 billion USD was invested in global venture-backed alternative protein startups¹⁹, dominated by Impossible Foods' total amount of \$500 million USD in Series F.²⁰ The trend continued in 2021 with an increase in alternative protein sector investments. Alternative protein investments grew 60% from 2020 to 2021²¹. In fact, 2021 was the most active year to date for alternative protein companies with over \$5 billion USD in private investments²², brand launches, and retail sales, signaling a climate-forward shift from business-as-usual.

USA, Israel, and the EU topped the global investment landscape. Investment in fermentation and cultivated meat companies in 2021 grew by 300% in 2020²³. A snapshot of the investments into alternative protein companies for 2021 is showcased below. In 2021, over \$2 billion USD went to plant-based meat, egg and dairy companies, \$1.4 billion USD to fermentation and \$1.2 billion USD was invested in the cultivated meat sector.²⁴



Investment in fermentation and cultivated meat companies²⁵

¹⁷ <https://gfi.org/press/record-5-billion-invested-in-alt-proteins-in-2021/>
¹⁸ <https://www.foodingredientsfirst.com/news/record-us5-billion-invested-in-alt-proteins-in-2021-but-gfi-warns-its-not-enough.html>
¹⁹ <https://www.prnewswire.com/news-releases/global-protein-alternatives-market-report-2022-market-to-reach-4-4-billion-by-2026-start-ups-set-to-deep-dive-into-alternative-proteins-market-301524899.html>
²⁰ <https://impossiblefoods.com/media/news-releases/impossible-foods-closes-usd500m-in-new-funding-amid-record-growth>
²¹ <https://vegconomist.com/market-and-trends/alt-proteins-gained-5bn-globally-in-2021-with-half-of-total-invested-in-europe/>
²² <https://vegconomist.com/market-and-trends/alt-proteins-gained-5bn-globally-in-2021-with-half-of-total-invested-in-europe/>
²³ <https://gfi.europa.eu/wp-content/uploads/2022/04/2021-Cultivated-Meat-State-of-the-Industry-Report.pdf>
²⁴ <https://gfi.org/wp-content/uploads/2022/04/2021-Plant-Based-State-of-the-Industry-Report-1.pdf>
²⁵ <https://gfi.europa.eu/wp-content/uploads/2022/04/2021-Cultivated-Meat-State-of-the-Industry-Report.pdf>



Investments alternative protein companies²⁶

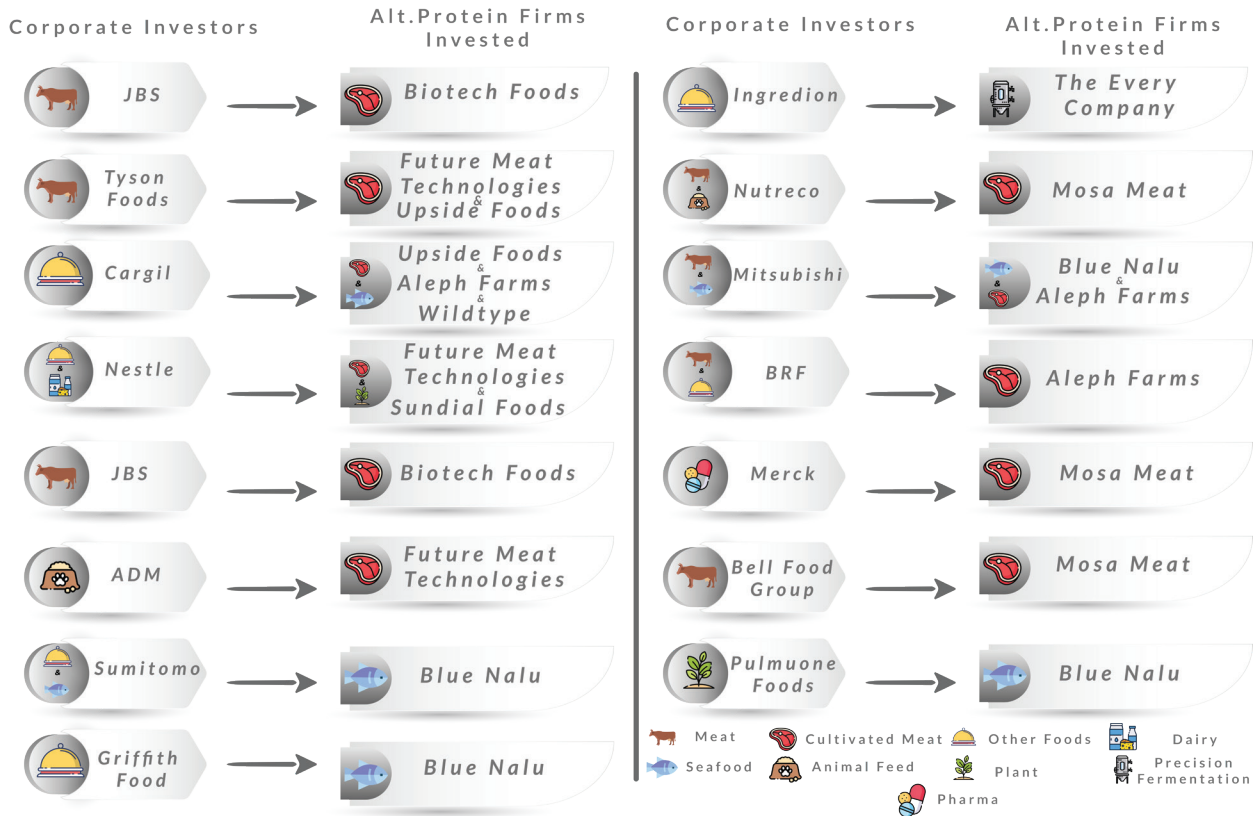
GLOBAL CORPORATIONS – FOOD & BEVERAGE TYCOONS

Investments continue to rise as global corporations recognize the market potential and environmental benefits of alternative proteins. There is a clear trend that large meat producers are moving towards alternative proteins. Cargill and JBS, the world’s two largest meat and agricultural companies are representative of corporations and their investments in the alternative protein sector. Cargill invested in cultivated meat company Aleph Farms from Israel, as part of a joint venture with pea protein firm Puris, to source insects for animal feed and develop its own plant-based meat substitute portfolio. JBS, the world’s largest meat processing company acquired Biotech Foods, a Spanish lab grown meat firm, and invested \$100 million USD in the development of cultivated meat . A snapshot of the global alternative protein companies including cell-based cultivated meat²⁷, alternative seafood, precision fermentation, plant-based proteins and corporate company investments into the alternative protein firms is presented below.

²⁶ <https://gfi.org>

²⁷ <https://pitchbook.com>

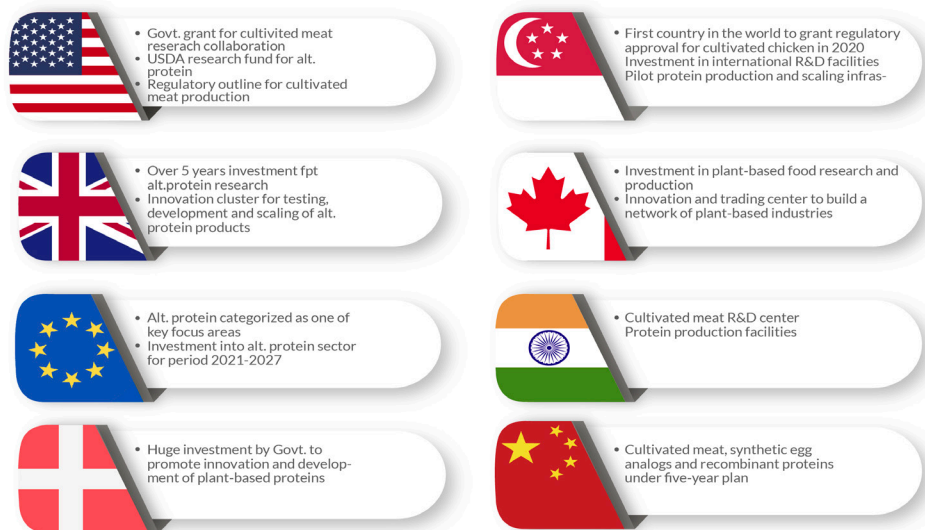
<https://agfundernews.com/jbs-to-acquire-cultivated-meat-company-in-100m-investment>



Global alternative protein companies ²⁸

GOVERNMENT INVESTMENTS

Global government investments in alternative proteins are on the rise with each passing year. The potential of alternative proteins has been recognized by many countries. Hence, the alternative protein sector is being advanced by investments, R&D expansion, regulatory policy adoption and practice. Still, no country has implemented a national plan to promote and advance alternative proteins across all departments in their respective governments. The infographic below outlines the current government progress and investments in this sector and, respectively.



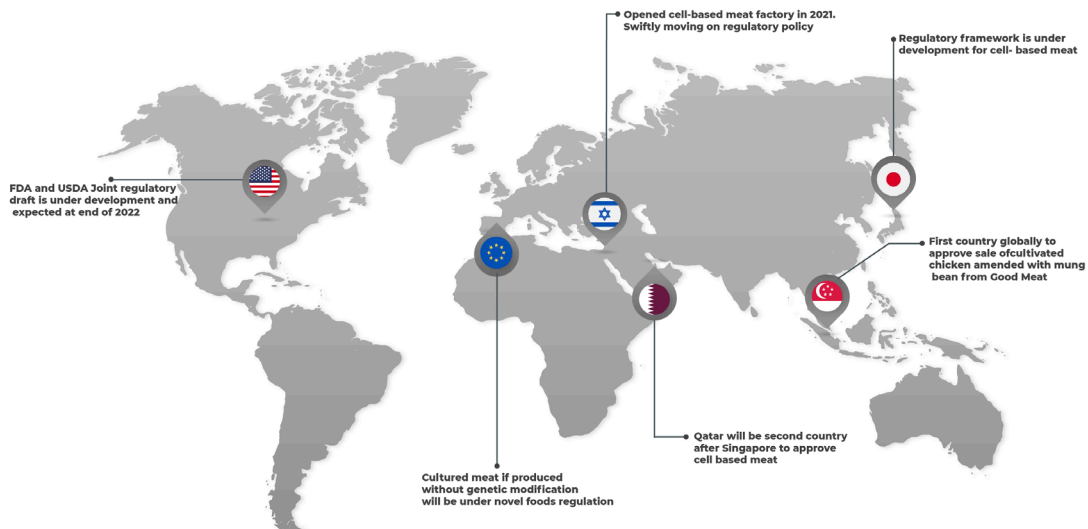
Alternative proteins government progress and investments ²⁹

²⁸ <https://gfi.org>
<https://pitchbook.com>

²⁹ <https://gfi.org>
<https://pitchbook.com>

REGULATORY POLICY LANDSCAPE

At present, the global regulatory landscape is still vague and fragmented, but is developing rapidly. There must be fair and efficient regulatory paths in every country for new categories like cultivated meat to succeed in the marketplace. While we are merely in the early chapters of the cultured meat story, many countries are already spearheading the movement. As of the end of 2021, Singapore remains the only nation to approve the sale of a cultivated meat product from Good Meat company. However, other countries are making strides in the race to approve and invest in these products as shown in the graphic below. In fact, Good Meat is almost very close to receiving approval from Qatar for the sale of cultivated chicken. The table below shows the countries that were the first to approve the regulation for alternative protein sector. If alternative proteins are to reach their full potential, consumers must trust them and know that these foods are safe to eat and that their ingredients are clearly and accurately labeled. To that end, the proper regulation of the manufacturing of alternative proteins, marketing, and labelling is essential.



Global regulatory landscape ³⁰

	<p>18 approvals under the Generally Recognized as Safe (GRAS) pathway Average time from submission to a no questions letter of 10 months The majority (50%) of approvals are for plant-derived proteins In total, 25 alternative products have been notified to the FDA. Of these, 18 have been "approved", 2 were withdrawn and 5 are pending. The majority (50%, n=9) are plant based proteins followed by fermentation (22%, n=4) and precision fermentation (17%, n=3) The average time from submission to receiving a "no questions letter" from the FDA based on these GRAS notices is 10 months.</p>	FDA
	<p>Average time from dossier submission to approval is 1-5 to 3 years In total there are 23 products submitted for novel food approval Majority of applications are for plant proteins (41%, n=9) and insects (36%, n=8) Only four applications have been approved and the average time to approval was 28 months</p>	EFSA
	<p>Currently UK follows EU food laws Average time from dossier submission to approval is 1 year In total there are 3 products submitted for novel food approval All 3 are plant-based proteins None of the 3 have been approved yet</p>	FSA
	<p>First regulatory authority to approve cell cultured chicken. Average time from dossier submission to approval is 9-10 months The SFA encourages applicants to discuss the product in pre-submission meetings. They are very helpful and approachable. The updated guidance is really clear and has specific requirements for precision fermentation, biomasses from fermentation and cell cultured products.</p>	SFA

Status of alternative proteins approvals ³¹

³⁰ <https://gfi.org>
<https://pitchbook.com>

³¹ <https://gfi.org>
<https://pitchbook.com>

ALTERNATIVE PROTEINS IN AFRICA

Along with other parts of the world, Africa is rising in the alternative protein sector. The increase in investments across the continent, the number of alternative protein startups in plant-based, cell-based, fermentation-based products and the alternative seafood sector are rising quickly as the local population realizes the importance and benefits of alternative proteins on health, environment, planet, livestock, and sustainable production. A 2021 survey showed that 66% of South Africans are highly interested in plant-based and cell-based food products and willing to pay a higher price over traditional³² meat. Interest is high from investors with \$17 million USD invested in 2021.³³ In addition to high equipment costs and the difficulty in recruiting R&D talents, scaling from pilot stage to large-scale production is a huge challenge for African alternative protein startups. More than technology, startups realize that regulation and lack of clear cut policy is a much bigger challenge. Despite the challenges, startups are popping up across Africa with no shortage of novel alternative protein innovations. In the plant based space, VeggieVictory was launched in 2020 in Nigeria and is the country's first ever plant-based meat company. In the cell-based meat space, two prominent startups from Africa, Mzansi Meat and Mogale Meat have developed a cell-based chicken prototype. Two new entrants have also emerged in the alternative seafood category - Sea-Ste-matic, Africa's first cell-based seafood firm, and De Novo Dairy, a precision fermentation-based dairy protein startup based in South Africa. The alternative protein startup ecosystem in Africa is developing and supported by VCs, businesses and non-profits.

FUTURE TRENDS

Based on recent market data and numerous technological innovations, it is clear that the alternative protein market is advancing rapidly and its disruption potential is growing. This exponential growth in the alternative protein sector has included numerous startups in precision fermentation, cultivated meat, fungal protein, plant-based, insect and the seafood space. Regulatory approvals, scaling bioreactor service companies, lab space industries, and a large influx of investment capital have also contributed greatly to the growth of the sector. In 2022 and beyond the alternative protein sector outlook looks bright and promising with the following trends expected to emerge.

- More regulatory approvals expected
- More hybrid products
- Availability of more precision fermentation products
- A high influx of capital from VCs/investors
- Increased role of governments
- Increased consumer education and awareness of sustainability
- Access to new proteins from fungus, air and algae
- Scaling of 3D-printing
- Scaling of fermentation as a service
- Price reduction and achieving parity
- Technological innovations and transparency from farm to fork
- Aquatic plants as a source of protein
- Cost reduction in scaffolds and growth media
- Acquisition of startups for technologies
- Global corporations increasing investments, establishing partnerships and buying out companies

³² <https://www.greenqueen.com.hk/south-africa-alternative-protein-study/>

³³ <https://gfi.org/wp-content/uploads/2022/04/2021-Plant-Based-State-of-the-Industry-Report-1.pdf>

CONCLUSION

It is evident that alternative proteins have blossomed into a mainstream category from niche products just a few years ago. Now, for every meat product, there is an alternative on grocery store shelves that are primarily plant-based with prices on par, and some less expensive, than regular meat products. Alternative protein is becoming a food revolution as the benefits are very clear to the industry and consumers alike. However, the sector is facing challenges with price parity, taste & texture, access and distribution. Market reports forecast alternative proteins to reach price parity in the next decade or even sooner with innovations in technology, quick regulatory approvals, consumer education and further acceptance. With increased support and capital from investors, governments, non-profits and academia, the alternative protein sector is poised to achieve steady growth and contribute to the transformation of food and agriculture sustainability. UM6P Ventures is committed to supporting the development of sustainable agriculture and is pleased to be a part of this food transformation by helping startups in their earliest stages with capital, infrastructure, R&D facilities, IP analysis, service platforms, mentors, SMEs and a global network of investors.