PLANT-BASED FOOD AND ALTERNATIVE PROTEINS

POISED TO TRANSFORM THE FOOD INDUSTRY

MAY 2021

BNP PARIBAS
ASSET MANAGEMENT

The sustainable investor for a changing world

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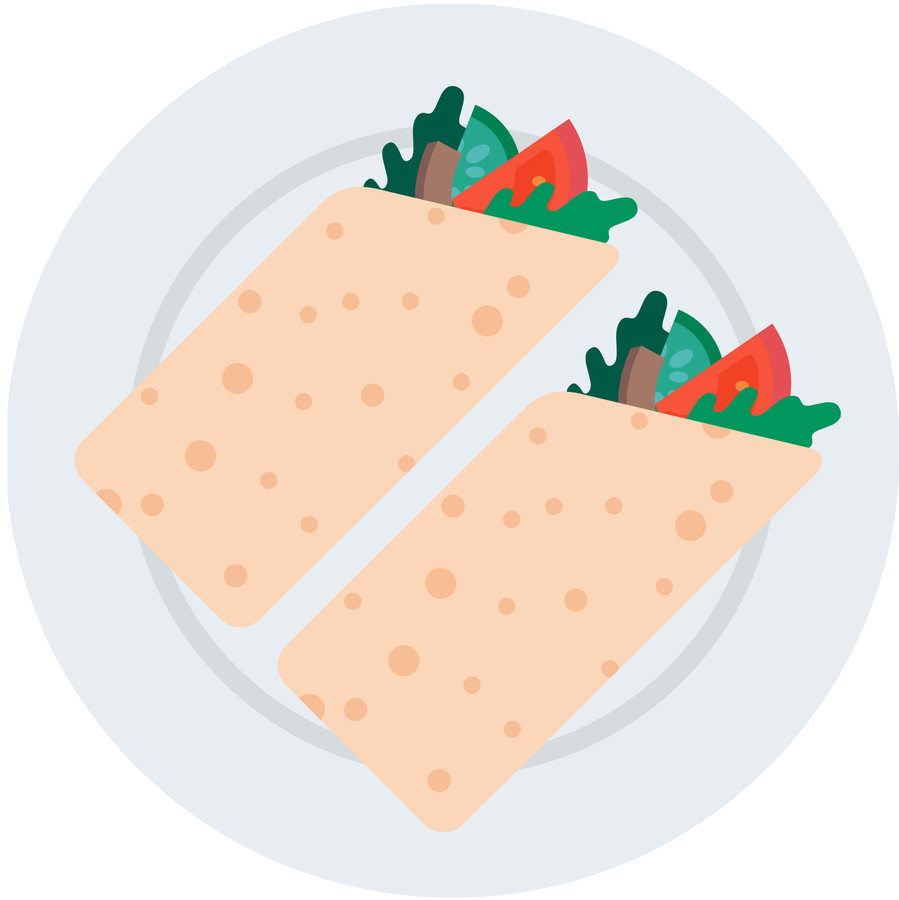
01 | SUMMARY

THE FOOD INDUSTRY, RIPE FOR DISRUPTION

The food industry is on the brink of a decade of profound change. Unparalleled growth in plant-, microorganism-, and animal-cell-based alternatives have the potential to drive this change.

COVID-19 has accelerated the digitisation of food consumption along with bespoke food and delivery.

A new world order is emerging, driven by health considerations, taste, personalisation, ESG (Environmental, Social & Governance) considerations and convenience as consumers turn to fresh and prepared food items.



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02 | INTRODUCTION

NUMEROUS FACTORS BEHIND THE SHIFT TO A PLANT-BASED DIET

Evolving consumer tastes. In the USA and Europe, a growing number of people are cutting their meat intake or giving it up altogether. As a result, in addition to vegans and vegetarians, there are an increasing numbers of flexitarians - consumers who have primarily vegetarian diets but occasionally eat meat or fish. Rising demand for alternative food types is reflected in the increasing number of vegan products available across Europe, around **10 000 new products** in 2018 up by **52%** on 2017[1].

Post-COVID 19, a new order in food consumption is likely to emerge, focused on health, taste, personalisation, ESG (Environmental, Social and Governance) criteria, and convenience. These forces will increasingly drive food developments in the food industry.

Growing awareness of the substantial health benefits associated with a mostly plant-based diet, including reduced LDL cholesterol and reduced likelihood of coronary heart disease.

1) Share of new vegan products launched, Statista 2020

10 000
new vegan products in 2018

A rise of
52%
on 2017

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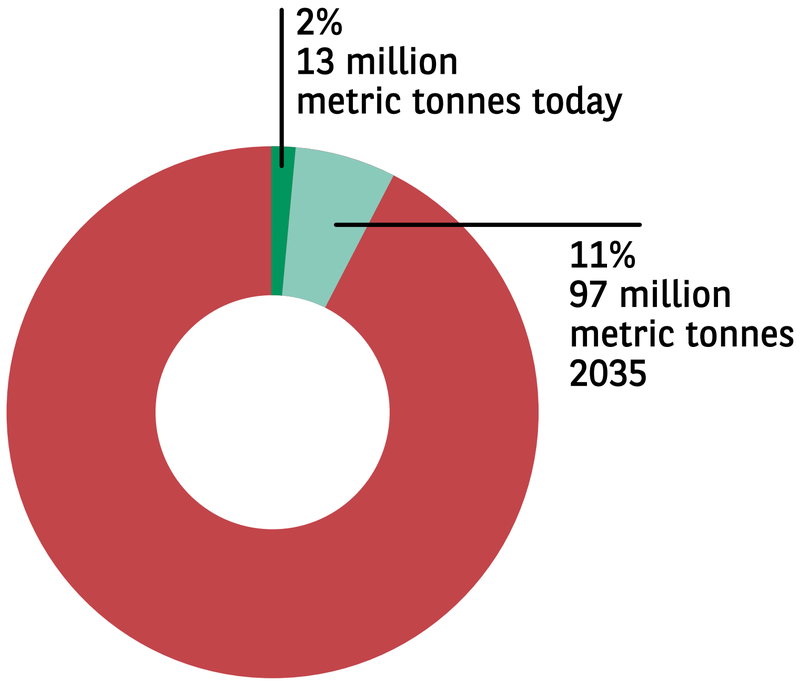
INTRODUCTION

The global food system is the primary driver of biodiversity loss contributing **20%-30% of greenhouse gas emissions**[2]. Over the past 50 years, the conversion of natural ecosystems for crop production or pasture has been the principal cause of habitat loss, in turn reducing biodiversity. Without reform of our food system, biodiversity loss will continue to accelerate. Further destruction of ecosystems and habitats will threaten our ability to sustain human populations.

The size of the alternative protein industry is growing. A recent study[3] by the Boston Consulting Group forecasts an increase in the alternative-protein industry to more than seven times its current size by 2035, from 13 million metric tonnes a year now to 97 million metric tonnes by 2035, when it will make up 11% of the overall protein market. Assuming average revenues of USD 3 per kilogram, this amounts to a market of approximately USD 290 billion (real revenues are likely closer to USD 10 per kilogram for high-quality meat alternatives but significantly less for high-volume products like milk).

ALTERNATIVE PROTEIN'S SLICE OF THE GLOBAL PROTEIN INDUSTRY



2) Food System Impacts on Biodiversity Loss, 2021
3) Food for Thought: The Protein Transformation, 2021

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Technology - there is now a range of methods to develop alternative protein sources, including engineering microbes to produce animal proteins via synthetic biology, CRISPR technology (editing genes within organisms) to improve the taste of fruits and vegetables, and producing meat by cellular agriculture. Plant-based protein sources are also being developed, and plants can be metabolically engineered to produce specific nutrients.

Small and mid-size enterprises (SMEs) and start-ups are achieving success in the field of alternative foods. Alternative protein companies are favoured by the power of intellectual property and disruptive scope food technology now offers. The traditional meat industry has gone through a difficult period during the COVID-19 global pandemic. It has been caught in an unfavourable light with regard to the practices and conditions in meat plants. Newly emerging alternative protein companies are increasingly the object of attractive valuations compared to incumbent meat companies as venture capital funding rises.

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CONSUMER DEMAND IS DRIVING PLANT-BASED FOOD MARKET GROWTH

The COVID-19 pandemic has increased the awareness around the link between food, health, food security and sustainability, leading to a surge in the demand for plant-based products.

1. Alternative proteins could soon match animal protein in taste, texture and price. This is likely to trigger a new wave of growth, propelling what is today a fairly nascent market into the mainstream, yielding significant environmental benefits and facilitating even faster growth.

2. **Principal reasons why consumers are focusing on plant-based eating**: Eating clean, more energy, lifestyle preference, environmental/sustainability reasons, and better treatment of animals.

3. Even the world's largest meat companies are embracing plant-based meat. These next-generation plant-based meat, egg, and dairy products are increasingly competitive with animal products on the key drivers of consumer choice: **taste, price, and accessibility**.

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04 | HEALTH CONCERNS

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HEALTH CONCERNS

HEALTH CONCERNS – A KEY CONTRIBUTOR TO DEMAND FOR PLANT-BASED FOOD

A growing number of people are cutting their meat intake or giving it up altogether. The proliferation of plant-based and dairy alternatives has been gaining traction for some time. Increasing plant-based offerings has become a major part of large and small brands' strategies as global consumers demand more from their meat and dairy alternatives.

These needs demand that food is more healthy, tastier, and more sustainable. This means no plastics, of course, but also sugar-free, gluten-free, ideally organic, with no genetically modified organisms (GMOs) and no glyphosate or chemicals, pesticides, herbicides etc.

> **"It is an inexorable trend. We are seeing in every single country in the world a shift towards more plant-based diets, even in emerging markets."**
>
> Chief executive of a global consumer goods company on the rise of plant-based foods

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05 | ALTERNATIVE PROTEINS

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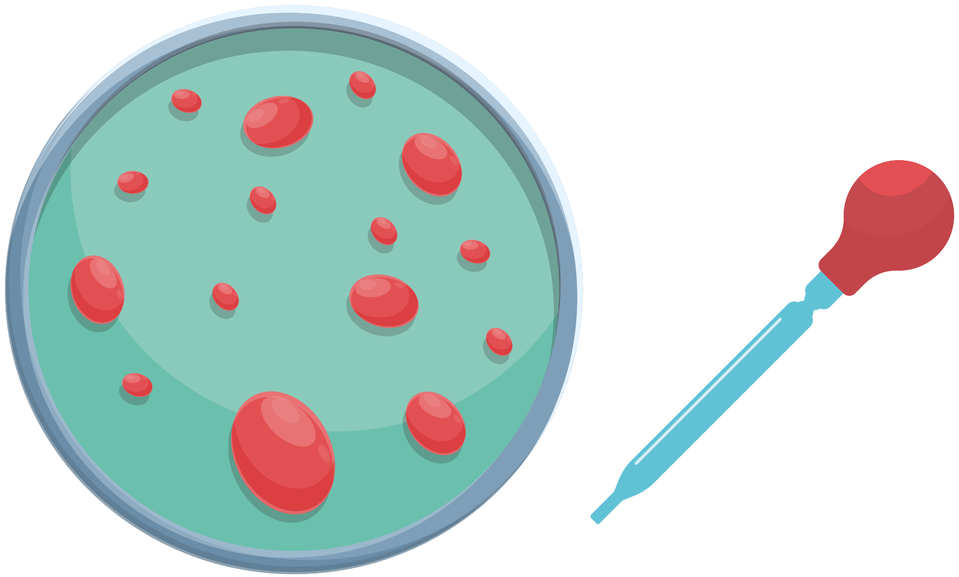
ALTERNATIVE PROTEINS

ALTERNATIVE PROTEINS HAVE THE POTENTIAL TO TRANSFORM THE FOOD INDUSTRY

By 2035, 10% of meat, eggs and dairy produce eaten around the globe is very likely to be made using alternative protein sources. That would represent a transformation of eating habits.



10% of meat, eggs and dairy will be made from alternative protein by 2035[4]

There are several reasons for believing we are at the beginning of a paradigm change in the food industry:

Consumers, led by millennials, are chomping for change…

Concern among consumers about the climate — and, more broadly, sustainability — will bring change. Many consumers want to reduce the amount of animal protein in their diets, especially if they can do it without sacrificing taste or paying more. In addition, **investors are increasingly incorporating environmental, social, and corporate governance (ESG) criteria into their investment strategies**. We predict that, taken together, these factors will generate enough consumer demand and investor interest to drive a shift to alternative proteins.

The technology is now available to refine and scale up existing technologies to unlock parity, when the taste, texture and price of alternative proteins closely match those of animal proteins.

4) Food for Thought: The Protein Transformation, 2021

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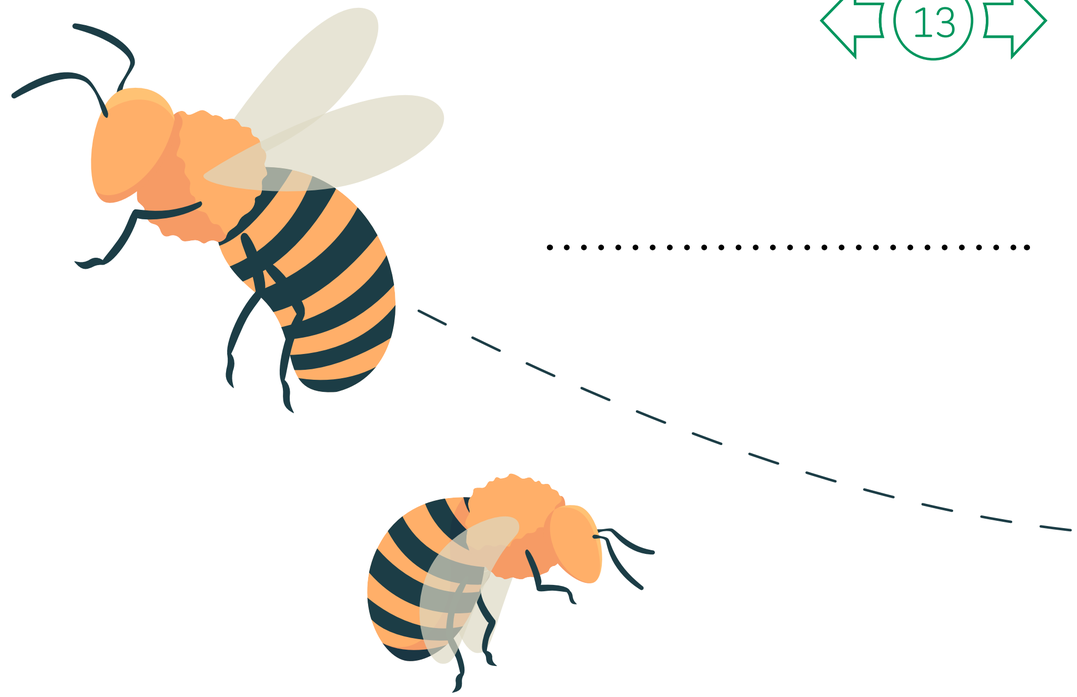
ALTERNATIVE PROTEINS



This is under a base case scenario. If the food industry can generate even more momentum with step changes in alternative-protein technology at both incumbent food companies and start-ups supported by public or private investment, the result would be rapid gains in production efficiency, better taste and texture, and lower cost. Earlier parity would be the outcome and could represent a 16% market share by 2035.

Regulators are likely to legislate for higher carbon prices and support for farmers transitioning from animal agriculture to alternative-protein inputs.

This could boost consumption considerably, with Europe and North America reaching "peak meat" by 2025, before consumption of animal protein in those markets would begin to decline.

60% of all meat consumed worldwide will be meat alternatives by 2040

Today's meat market – USD 1 trillion

Today, the global meat market is worth USD 1 trillion, according to the United Nations and the World Bank. The World Economic Forum says that the amount of food grown today will only feed half the population by 2050. There is a growing population that will also want to be meat-eaters. Forecasts suggest that by 2040, in only 20 years, 60% of all meat consumed in the world will be meat alternatives, rather than conventional animal protein meat.

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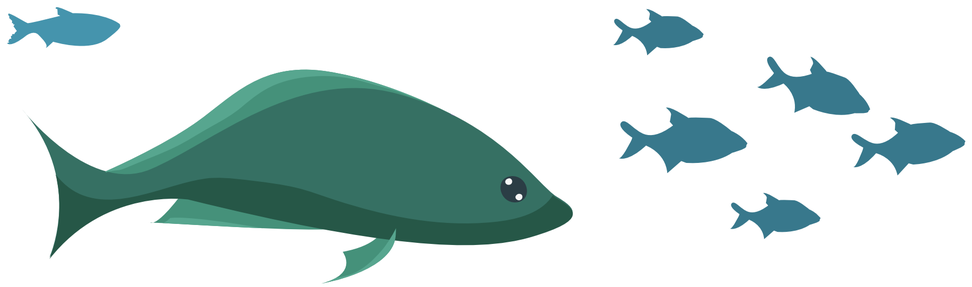
ALTERNATIVE PROTEINS

A PARADIGM SHIFT ON THE HORIZON WITH THE ADVENT OF ALTERNATIVE PROTEIN SOURCES

Plant-based protein are foodstuffs made from plant sources that imitate conventional meat, in taste, texture, smell, and appearance. Today, grains and vegetables are the primary source of plant-based proteins providing their protein, fibre, and starch.

There is an extensive range of alternative proteins. Those offering scope for application in the food industry include the following:

Cultured meat, also known as clean meat or lab meat. Meat products are grown in a laboratory from cells sourced from animal muscle and tissue. The technology is transformative in bypassing the rearing and slaughter of livestock.



Developments in biomedical engineering are applied in cultured or cellular fish in combination with modern aquaculture to culture cells in tanks. They are then transformed into a consumable product using extrusion to generate a fibrous texture.

Cultured fish offers the prospect of a shorter cycle time as cell cultures can generate foodstuffs within weeks or months. This compares to multi-year periods for sea bass or salmon to grow to an edible size. Currently an estimated 1 to 3 trillion fish are caught commercially for food each year. This technology offers the prospect of a significant reduction in over-fishing.

Insect protein, derived by milling insects for flour and then isolating the protein.

Dry matter makes up the bulk of insect protein although it varies by species. Insects are typically high in nutritious protein and richer in unsaturated fatty acids, minerals, and vitamin B than plant-based protein. **Insects require 10 - 15 times less food than beef to produce an equivalent edible amount**. Their water requirements are up to **2 000 times lower** than is the case with beef production, and they generate **100 times less** greenhouse gas emissions.

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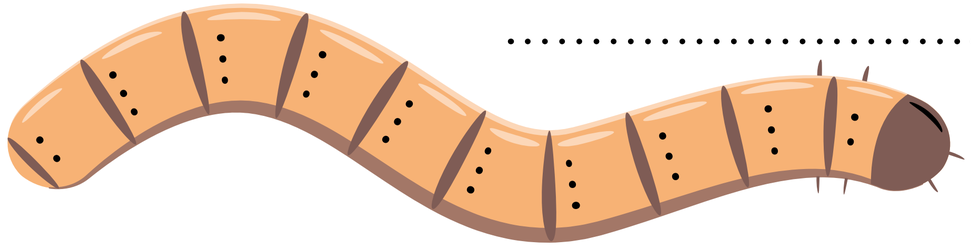
In January 2021, the European Union's food safety agency approved yellow mealworm as safe for human consumption. The European Food Safety Authority gave the green light to an application from a French insect farmer — the first European company focused on insects for human consumption — saying there were no safety concerns for dried yellow mealworm (this being the larval form of the mealworm beetle).

About 2 billion people in more than 130 countries already eat insects, according to the UN Food and Agriculture Organisation, although they are not widely consumed in the west. Insect larvae are already used in Europe and elsewhere for chicken and fish feed as well as pet food and fertiliser.

Animal proteins such as casein and whey can be produced from fermented protein using a brewing process. This takes advantage of the ability of yeast organisms to produce the proteins more efficiently.

A fermented protein is in effect a pre-digested protein. Consequently, it is both easier for the stomach to digest and provides a greater bioavailability of nutrients. The fermenting process is also beneficial in removing anti-nutrients and harmful bacteria. Such proteins are better absorbed by the



human body and can help to reduce or eliminate carbohydrates.

Mycoproteins are proteins made from Fusarium venenatum, a naturally occurring fungus. Fungi spores are fermented along with glucose and other nutrients. A doughy mixture, high in protein and fibre is produced with a meat-like texture.

The protein content in mycoprotein can range from 40% - 60%. It is high in fibre with limited carbohydrates and contains no cholesterol. **The production process uses 90% less land and produces 90% fewer carbon emissions than beef.**

Algae have potential as an abundant source of good quality protein for use in a broad variety of food and pharmaceutical applications.

Algae require no fertilisers or pesticides for productivity. They can grow quickly all year round in wastewaters. Nutrient rich - just like insect and fungi protein - they require neither cultivated land nor freshwater.

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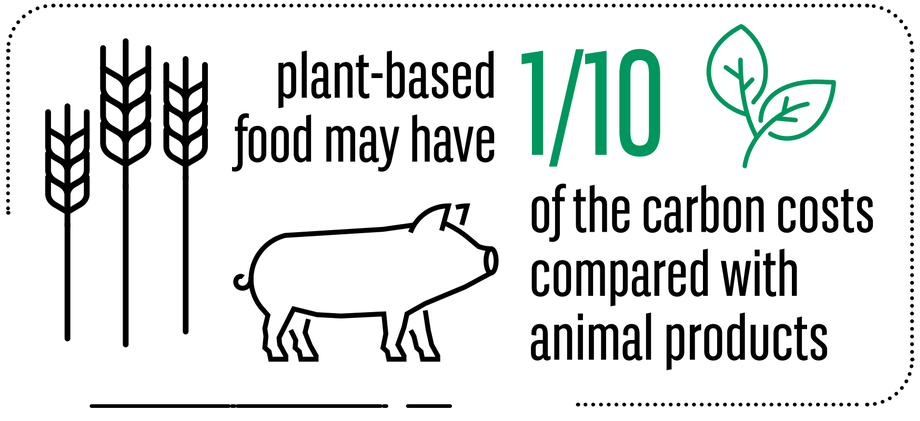
ALTERNATIVE PROTEINS

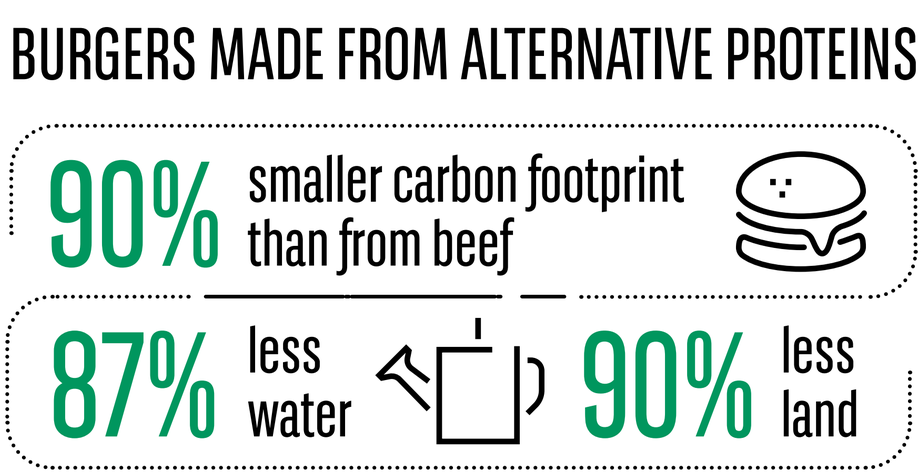
ALTERNATIVE PROTEINS OFFER MAJOR ENVIRONMENTAL BENEFITS

- Producers of burgers made from alternative proteins claim that the carbon footprint of their burgers is 90% smaller than that of a burger made from beef, uses 87% less water and 96% less land. Indeed, plant-based foods may have about one-tenth the carbon costs of animal-based foods.
- Animal proteins that relate to plant-based protein and cultured meat and cultured fish are also not only cruelty-free but have 80% to 90% less ecological impact and thus can help optimise the intersection of human and environmental health.

Today, alternative protein companies are growing strongly with the number of new companies entering the market rising strongly. New entrants are applying disruptive technologies such as synthetic biology, big data, AI, machine learning, robotics, and Internet of Things. They could potentially transform the food industry.

While plant-based alternative protein companies have been around for decades, new technologies are today enabling new companies to form and flourish as consumers become more ESG aware and as the consumer experience improves.





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THE INVESTMENT CASE FOR PLANT-BASED FOOD

The expected base-case penetration of 11% by 2035 implies a market that is at least the size of a top-50 economy with a GDP of around USD 290 billion. It is however quite possible that this market's growth will outstrip that forecast, given sufficient capital and technological change as regulators encourage the transition.

Plant-based food market – a GDP of USD 290 billion

Alternative proteins are penetrating a market— food—that has very low exposure to recession and cyclicality. The sector is strongly resilient relative to others against any "unknown unknowns" that might influence the overall economy.

Demand for alternative proteins is fuelled by powerful forces ranging from health concerns to climate action and the increasing awareness of ethical issues in factory farming.

Alternative protein start-ups aim to offer consumers a similar experience to the meat, eggs and dairy from animals but produced from plants, animal cells, enzymes and other organisms. They aim to offer food produced in clean, anti-biotic-free ways, using far less land and water than live-stock, amid rising concerns about climate change, biodiversity and the food supply chain.

EUROPE – A MOVEMENT TOWARD FLEXITARIANS (OCCASIONAL CON-SUMERS OF MEAT)

A 2018 study "How many vegetarians in Europe?", sponsored by FranceAgriMer, a French government agency, showed that, based on representative groups of four European countries, 12% of 18-23 year-olds considered themselves vegetarians versus 2% of those aged over 55 and an average of 5.2% of the total population – in 1998 the figure was 0.7% according to the study.

5.2% of the European population are vegetarians

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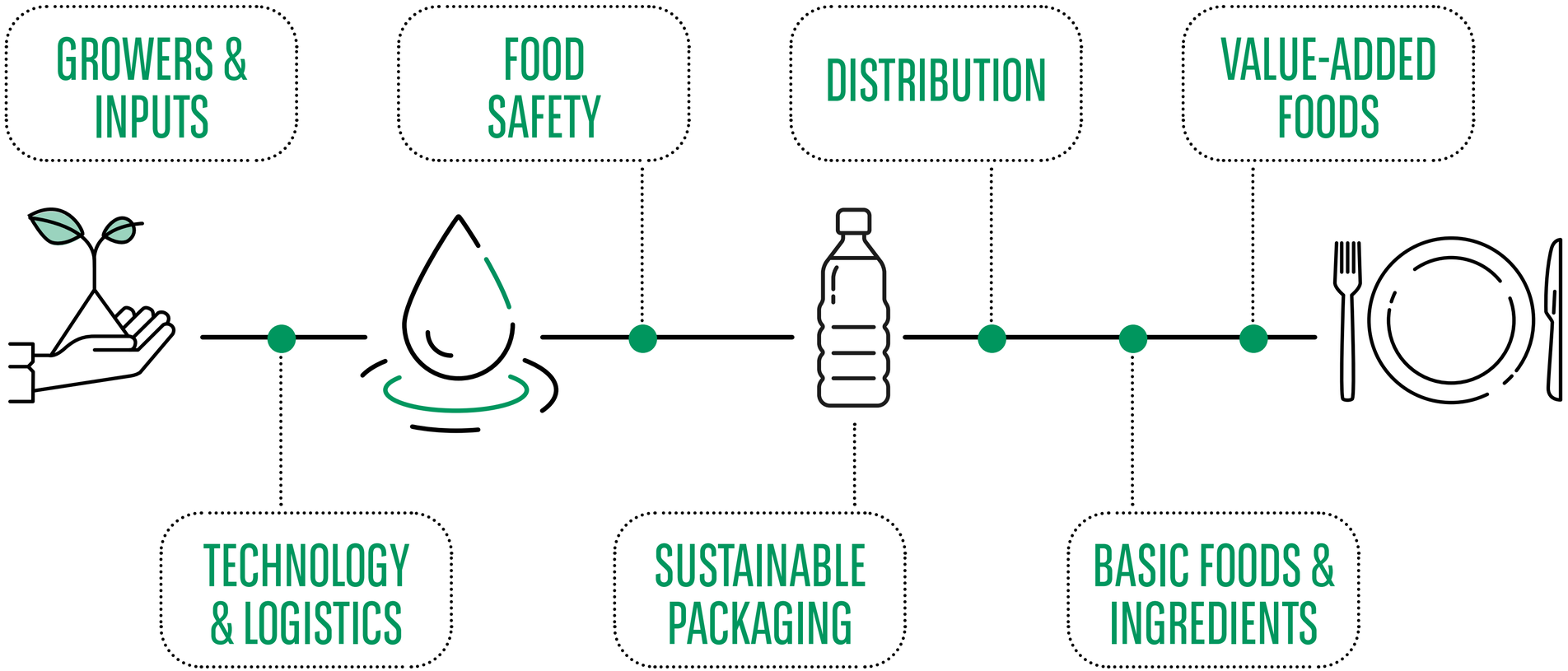
THE INVESTMENT CASE FOR PLANT-BASED FOOD



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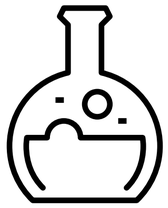
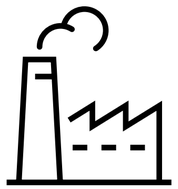
THE INVESTMENT CASE FOR PLANT-BASED FOOD

At present, most investment capital is focused on the companies offering the plant-based products that currently dominate the alternative-protein industry. These companies need to be integrated along the value chain to ensure quality control while they explore new technologies.

As alternative proteins grow from a niche product to a tenth or even a fifth of global protein consumption, however, the landscape will change, and two types of plays will emerge for investors.



Companies that solve a key technological challenge will likely become the go-to firms for that specific step along the value chain, such as flavouring, and other companies will eagerly license their intellectual property to augment their own processes.



Well-funded companies or investors will likely build industrial scale platforms for capital-intensive technologies such as extrusion (the process used to generate fibrous texture in meat alternatives).

Areas of food technology likely to expand include:

- Developing advanced formulations and ingredients, including the manufacture of premixed binders, flavours, colours, or fats with a "clean label"—natural, healthy, and widely known—for plant- and microorganism-based products. This approach has triggered interest from large, expert incumbents who recognise consumers are ready for this in their diet.
- Creating specialty ingredients via precision fermentation, such as the heme[5] used to flavour meat substitutes. This includes generalist contract manufacturers for made-to-order superstar ingredients as well as specialists that make one substance that becomes an industry standard.
- Forming mutually beneficial links through the development of useful byproducts, such as integrating microorganism-based protein production with bioethanol fermentation. This play can connect technologies within the alternative-protein industry and with outside industries, providing a cost advantage to both partners.

5) Heme is the iron-rich protein that gives blood its red colour. Heme in the haemoglobin protein enables blood to carry oxygen from the lungs through the bloodstream. Heme gives meat its taste, is abundant in muscle tissue and occurs naturally in all living organisms. Heme proteins also occur in plants.

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THE INVESTMENT CASE FOR PLANT-BASED FOOD

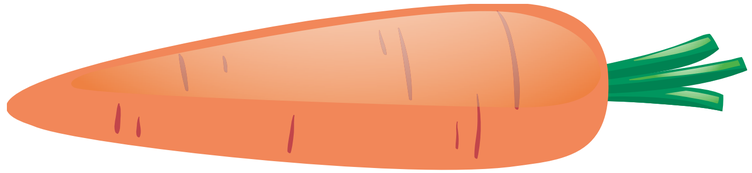
Industrialisation and platform plays

Here, companies are aiming to differentiate through economies of scale, harnessing the high barriers to entry of capital-intensive technologies. Examples include:

- Developing and supplying food-grade fermentation and cell culture equipment such as bioreactors, measuring devices, and efficient media. The technology for growing cells in culture is not new; the pharmaceutical industry has been employing it for years. To reduce the cost of the growth process, however, the industry must shift from expensive, ultrapure pharmaceutical-grade ingredients and equipment to food-grade versions.
- Developing processes and supplying machinery for largescale, reliable, low-cost formulation and texturizing, which the plant- and microorganism-based alternative-protein sectors will need to realise their growth potential.
- Refurbishing conventional-protein production plants and equipment to reduce capex and drive the transition from conventional- to alternative-protein production.

SOARING PLANT-BASED FOOD MARKET

A research report from Barclays forecasts that the value of the global plant-based food and drink market could soar by more than 1 000% to exceed GBP 100 billion by the end of the decade. Currently, the plant-based food market is fragmented, comprised of many small businesses. These offer acquisition targets for old-economy incumbents seeking to reposition in, for example, meat substitute brands.



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THE INVESTMENT CASE FOR PLANT-BASED FOOD

Potential growth

opportunity with a tilt towards faster growing midcap stocks

Sustainable investments

in the food and agriculture industry

Unique equity strategy

investing in companies applying disruptive and innovative technologies and business models

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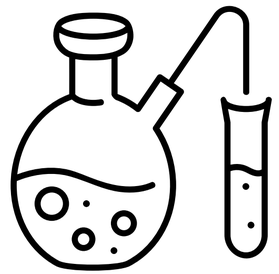
THE INVESTMENT CASE FOR PLANT-BASED FOOD

SUSTAINABLE INVESTING, IN COMBINATION WITH THE INDUSTRY'S ALREADY PROMISING GROWTH RATES, WILL LIKELY ENSURE THAT CAPITAL FLOWS TO ALTERNATIVE PROTEINS.

Substantial capital will be needed to support the growth of the alternative-protein market. Almost 30 million tonnes of bioreactor capacity for microorganisms and animal cells will be needed to reach the baseline case of 11% adoption by 2035. Building all these bioreactors will require up to USD 30 billion in investment capital – and USD 100 billion if all the dominoes fall, leading to a 22% share for alternatives. That's because far more bioreactor capacity will be needed if microorganism- and animal-cell-based proteins reach parity more quickly and demand for these alternatives rises rapidly.

On the plant-based side, the extrusion capacity needed in the base case will require up to USD 11 billion, and as much as USD 28 billion if the greatest upside scenario comes to pass. These high-level initial estimates do not include the necessary R&D spending or materials and operating costs of all these bioreactors and extruders. The total capital needed to unlock alternative proteins' growth will likely be much higher.

30m tonnes
of bioreactor capacity needed to reach 11% by 2035



USD 30 bn investment required

USD 100 bn investment needed to reach **22%**

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THE INVESTMENT CASE FOR PLANT-BASED FOOD

Investment needed for extrusion capacity

Investment in alternative proteins will fuel technological progress, raising demand and the need for more production facilities.

Venture capital funding alone totalled more than USD 4 billion from 2015 to 2020, according to PitchBook. Most of that went into companies pursuing plant-based alternatives, followed by USD 733 million in microorganisms and USD 416 million in animal-cell-based proteins.

In 2021, 170 alternative meat and dairy start-ups in North America pulled in record funding of USD 3.1 billion, up from USD 1 billion in 2020 (data from US alternative protein research and lobby group, the Good Food Institute).

In Europe, the sector raised a record USD 527 million, a four-fold increase on 2019. Plant-based meat, egg and dairy companies attracted the bulk of the capital, but investment targets widened to cultivated meat companies, which grow meat from animal cells, and fermentation companies, which use microorganisms in the production of meat, eggs and dairy goods.

WORLD IS SHIFTING TO A MORE PLANT-BASED DIET

Food industry companies are targeting significant growth in the plant-based foods business. After success with vegan products, a leading Anglo-Dutch global food corporation (and owner of 400 brands) has targeted worldwide sales of EUR 1 billion (USD 1.2 billion) from plant-based meat and dairy alternatives within the next five to seven years.

This compares with EUR 200 million today. Expanding the range of plant-based foods is a strategic priority. Growth is set to come from the development of a vegetarian butcher brand and ramping up vegan alternatives among existing brands.

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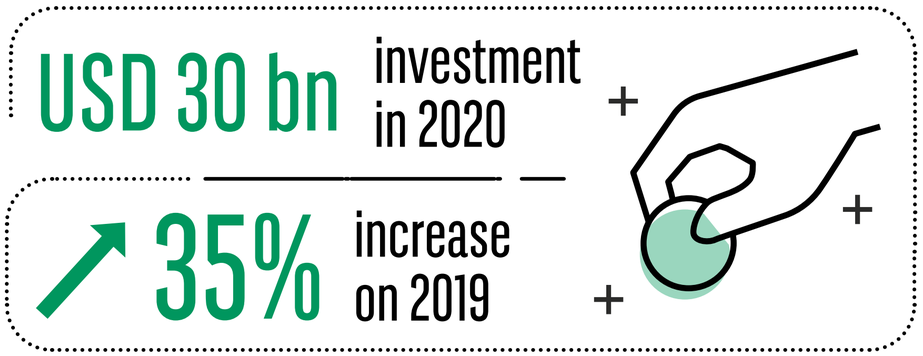
THE INVESTMENT CASE FOR PLANT-BASED FOOD

Alex Money, director of the Innovative Infrastructure Investment programme at the University of Oxford, said replacing meat and dairy protein in our diets was the most efficient way to cut the carbon impact of food consumption. Other methods of trimming agricultural emissions "are like rearranging the deck chairs", he said.

INVESTMENT IN ALTERNATIVE PROTEINS



Growth in alternative proteins outperformed the rise in investment in the broader agri and food tech sector, which is estimated to have reached USD 30 billion in 2020, up by 35% on 2019, according to AgFunder, a VC based in California that specialises in the sector.

Plant-based meat, cultivated meat and fermentation companies have raised almost **USD 6 billion** in the past decade. Plant-based meat, egg and dairy start-ups received **USD 2.1 billion** in funding in 2020, compared to **USD 667 million** in 2019.

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THE INVESTMENT CASE FOR PLANT-BASED FOOD

Cultivated meat companies raised more than **USD 360 million**, six times the amount raised in 2019 and **72%** of the total raised in the industry's history.

Fermentation start-ups attracted **USD 590 million** in investments, more than double the amount raised in 2019[6].

In summary, plant-based foods and alternative proteins offer scope for a transformation of the food industry. The sector is set to grow, has the potential to attract higher valuations and greater funding as the technology becomes approved worldwide and consumers shift to more alternative protein products and plant-based foodstuffs.

The rise of alternative proteins is already underway as incumbent meat producers define themselves as "protein" companies, making and marketing their own alternatives. This makes sense, given the size of the prize. **It is estimated that alternative-protein revenues will reach USD 290 billion in 2035**, with the profits distributed throughout the value chain: to the startups and incumbent food companies producing alternatives, the upstream players providing the industry with the inputs and tools needed to unlock these revenues, and the investors willing to support their efforts.

6) Source: Good Food Institute

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