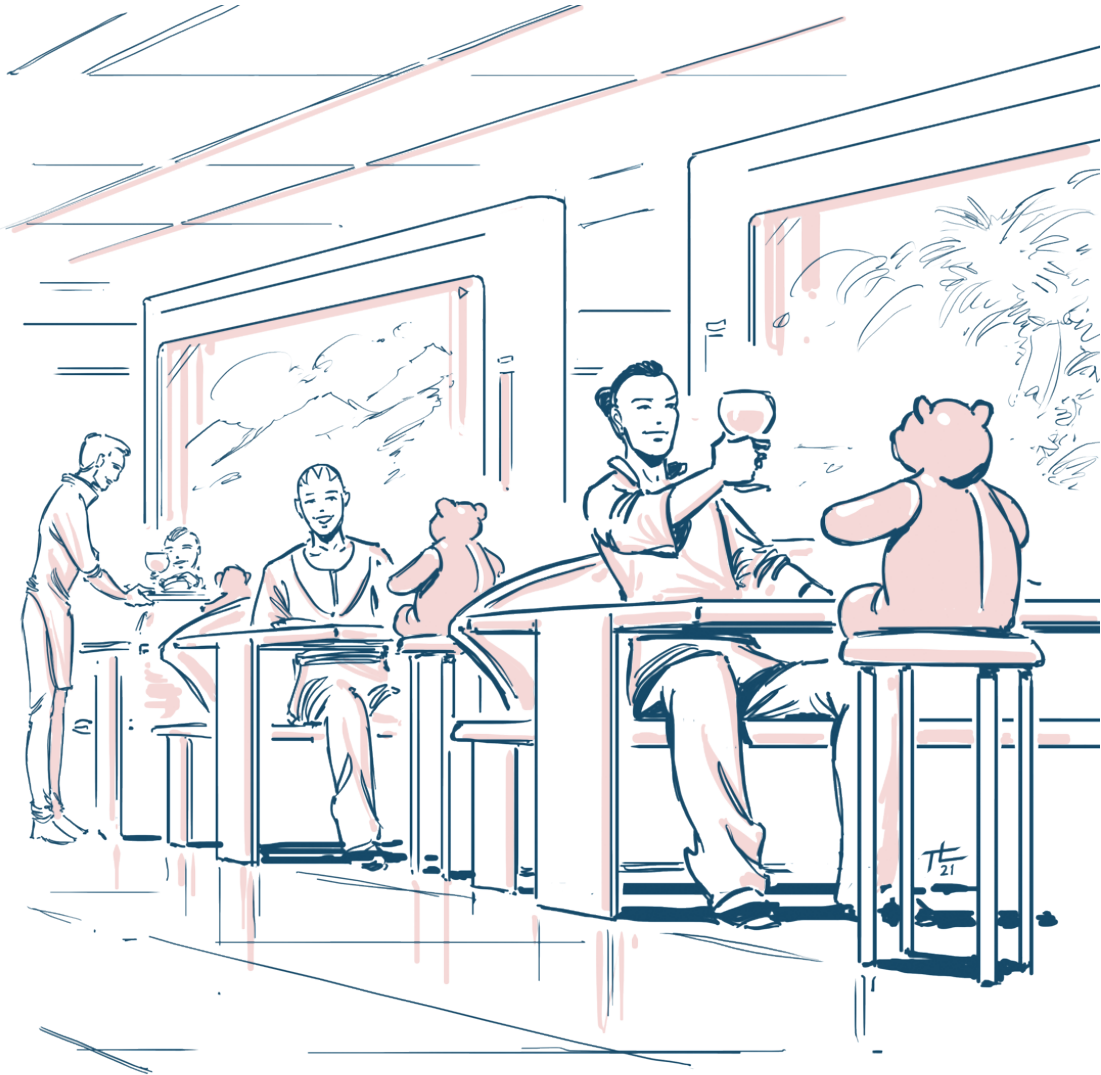


ALTERNATIVE PROTEINS



The Futures Literacy Company



According to the Good Food Institute, animal agriculture causes 15-20 percent of direct global climate emissions. According to the most conservative predictions it is foreseen to rise by 60 percent through 2050. Animal agriculture requires 80 percent of agricultural land, more than 1.25 billion metric tonnes of feed crops for farm animals, and 77 percent of the global soy crop, mostly to feed chickens, pigs, and farmed fish. All of these numbers are rising year after year, inextricably linked with the growing global population, and will continue to rise unless alternative proteins are successful. It is to remember that according to the World Resources Institute, 9 calories of feed are required to produce 1 calorie of chicken meat and 40 calories of feed are required to produce 1 calorie of beef.

Two co-benefits of a shift from conventional meat production to alternative proteins are decreased risk of antimicrobial resistance (AMR) and decreased pandemic risk. According to the Good Food Institute, currently, approximately 70-80 percent of medically important antibiotics are fed to farm animals, which increases AMR risk. Resistant bacteria kill more than 1.3 million people annually and are on track to kill 10 million people per year by 2050. Alternative proteins do not require antibiotics.

Alternative proteins are gaining increasing attention primarily due to the following factors.

Sustainable food production: Alternative proteins, such as, for example, soya, peas, beans or proteins derived from microorganisms or marine plants, can be more ecologically sustainable.

Healthy lifestyle: Some alternative protein sources are low in fat and calories, which can be beneficial for those aiming to maintain a healthy body weight.

Ethical and moral aspects: For many people, the decision to choose alternative proteins is driven by animal welfare concerns and moral issues surrounding the production of conventional meat.

Climate change: Alternative proteins may be more resilient to climate change.

Technological innovation: As research and technology advances, newer and more innovative sources of alternative proteins are emerging, such as plants, microorganisms, fungi or yeast.

Currently, the main sources of alternative proteins are: soy, peas and beans. Certain types of microorganisms, such as yeast and bacteria, can be used to produce proteins.

Also some proteins derived from marine plants, such as algae, are being investigated. Modern genetic engineering technologies allow the modification of organisms to produce desired proteins. This approach can include plants, bacteria or even animal cells.

The sole viable avenues for significantly reducing animal agriculture seem to be widespread dietary shifts, involving a global decrease in animal protein consumption, and the triumph of alternative proteins. Despite efforts to persuade consumers in developed nations to consume less animal protein, per capita consumption has not declined. However, if we can generate an authentic meat experience from plant-based or lab-grown meat at a more affordable cost, we have the potential to drastically alleviate the external costs associated with animal agriculture, such as food insecurity, climate change, and the utilisation of land and water, all without necessitating sacrifices from consumers.

Nevertheless, there are both scientific and scaling challenges involved in creating a similar or improved animal meat experience from plant-based or cultivated meat. Lack of support for private companies in addressing these challenges may involve delays or failure. Therefore, public institutions in developed countries have established a number of programmes and provided funding to support research and development in this area.

HOW IMPORTANT
WILL ALTERNATIVE PROTEINS
BE FOR OUR FUTURE DIETS?

WHAT ARE THE CHALLENGES
TO MAKING ALTERNATIVE
PROTEINS FIT FOR THE FUTURE?

WILL MEATLESS PRODUCTS
REALLY BE BETTER
FOR THE ENVIRONMENT?




Research and production of alternative proteins is growing fastest in North America, Europe and Asia. The leading countries in terms of investment in the production of alternative proteins are Israel, the United States, Canada, Singapore and China.

Governments will need to invest \$4.4 billion/year in research and development and \$5.7 billion/year in private sector incentives in order to reach 50 percent market penetration by 2050.

@McKinsey for ClimateWorks Foundation and the UK's Foreign, Commonwealth & Development Office

To date, plant-based & cultivated meat combined have received less than \$11 billion in public and private investment (all in the past 10 years), even as clean energy received \$1.4 trillion in investment in 2022 alone).

@Good Food Institute



Canada has developed a framework to guide the country toward a plant-based ecosystem and invested in the development of plant-based foods.


@EIT Food

Israel has invested more than \$20 million in alternative protein research, including \$18 million for a cultivated meat research consortium. Moreover, Israel-based start-ups were the second largest recipient (after the US) of plant-based food tech investments in the alternative protein industry as a whole in the first half of 2022.

@EIT Food


Singapore, on the other hand, has already made policy and regulatory decisions to encourage investment in the sector, including allowing cellular meat. The country aims to meet 30% of its food needs locally by 2030.

@EIT Food



China's five-year plan for agriculture, published in January 2022, includes references to cultivated meat and other alternative proteins for the first time, which could see an acceleration of the country's research and investment in the sector.

@EIT Food



In 2022 the US announced plans to invest more than \$2 billion in the biotechnology sector, including for the use of microbes and other biologically-derived resources to make new foods, fertilisers and seeds.

@EIT Food

Across Europe, governments are investing in research and innovation efforts to accelerate protein diversification. The European Commission's Farm to Fork Strategy and the Communication on Europe's Beating Cancer Plan recognise the role of a more plant-based diet consisting of less red and processed meat and including more fruits and vegetables in disease prevention and reducing the environmental impact of the food system.

@European Commission



In 2021, Denmark announced that €168 million in public funding would be made available to invest in plant-based foods – the largest investment in plant-based R&D by any EU country to date. France has also systemically invested millions of euros toward developing its domestic production of plant proteins for both feed and human nutrition, with the French government allocating €100 million to the sector in 2020. The Netherlands has increased investment in alternative proteins, to a record level of €60 million for cultivated meat and precision fermentation in 2022, with a prospect to deploy up to €450 million in the longer term.

@EIT Food



Also food giants from Tyson to Cargill are working to navigate a future where protein isn't dominated by traditional animal sources. Meanwhile, startups using technology to engineer meat in labs or manufacture it from plant-based products are rising in popularity. In 2019, one of the world's biggest alternative protein brands, Beyond Meat, the manufacturer of the plant-based Beyond Burger, went public. Shortly after, Burger King released the Impossible Whopper — a meatless variant of its most well-known product. The Impossible Whopper replaces beef with plant-based meat manufactured by Impossible Foods.

@CB Insights



The market for alternative protein products is projected to grow exponentially to a value of at least \$290 billion by 2035. In Europe, retail sales of meat and dairy alternatives increased by almost 10% per year between 2010 and 2020. Several supermarket chains have reported on annual growth rates of nearly 100% for protein alternatives to meat. At this rate, between 11-22% of global meat, seafood, eggs and dairy are likely to be replaced by alternative proteins by 2035.

@BCG



Technological Challenges

The production of alternative proteins often requires advanced manufacturing technologies and processes. Depending on the protein source, innovative breeding, fermentation, extraction or genetic engineering methods may be required.

Sustainable Production

Although alternative proteins may be more environmentally sustainable, some production methods may generate other issues related to water, energy or natural resource consumption. Proper management and minimisation of environmental impacts is an important challenge.

Economic challenges

Mainstream meatless consumption could create economic challenges that eliminate jobs across the meat production value chain. It would disrupt the whole farming sector, especially the livestock sector, but also the arable crop sector, whose production is mainly used as feed.

International uncertainties

Food production is the most common human activity, despite huge differences in productivity, and food products, despite barriers to foreign trade, are offered in competitive global markets. Thus, the centralization of protein production may, paradoxically, increase vulnerability to geopolitical risks and worsen competitive conditions.



Consumer Trust and Acceptance

Some consumers may be used to traditional protein sources and be resistant to dietary changes. They may also lack trust in novel products. Education and information campaigns are important in building awareness and acceptance.

Regulatory Issues

Some jurisdictions have specific regulations for the production and marketing of alternative proteins. Manufacturers must meet certain quality and safety standards, which can be complex and costly.

Production scalability

Scale-up of the production of alternative proteins is difficult and expensive.

Cultural heritage

As diets are deeply ingrained in cultural heritages, they can be difficult to change over a period shorter than one generation. A shift towards alternative protein sources depends on citizens' engagement and willingness to change their diets.

Price

At the current stage of development, alternative proteins are still more expensive to produce than traditional protein sources. However, the scale of production and advances in technology may help to reduce costs in the future.



Taste and Texture Issues

Taste and texture of traditional meat products are often important to consumers. The production of alternative proteins that give a similar taste and texture to traditional products is still a technological challenge.



Lack of knowledge

Lack of knowledge of the sustainability and health-related impacts of some sources of alternative proteins (e.g. cultured meat, insects, microbial-based proteins).

Policy inconsistencies

Policy inconsistencies, with a non-negligible share of public funds directed towards unsustainable and unhealthy foods, despite Green Deal and farm-to-fork objectives.

TRENDS



Current changes that could positively [↗] or negatively [↘] affect the future of alternative proteins.

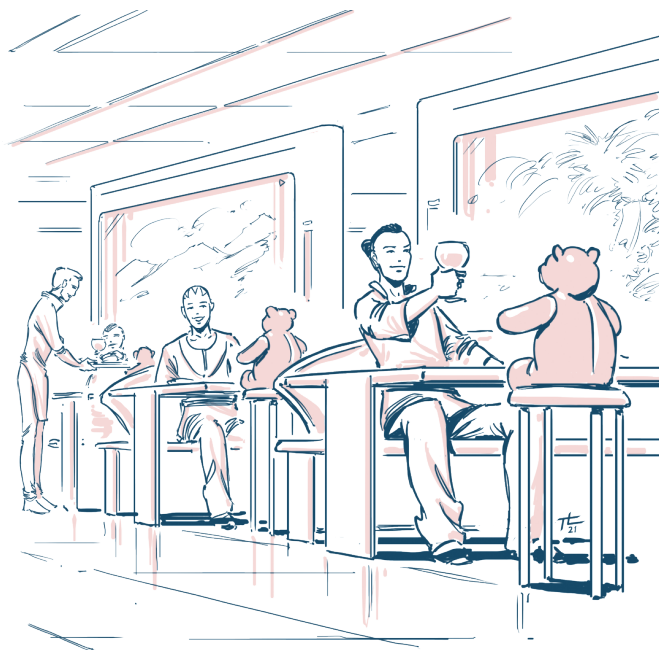
- **Rise of challenges for feeding future generations.** Forces like urbanisation, population growth, and a rising global middle class lead to greater meat consumption. Meanwhile, the world's population is expected to surge to 9.6B by 2050, leading to a 61% increase in food production. This growing demand could create challenges for feeding future generations, and meatless companies are looking to help fill the gap.
- **Rise of ethical questions around meat consumption.** The meat industry has long been subject to ethical concerns behind meat production practices.
- **Rise in demand for meat-free proteins as consumers seek healthier food alternatives.** Rising obesity rates across the globe, coupled with consumer interest in healthier food alternatives, are also driving demand for meatless proteins.
- **Increased efficiency and transparency for companies through innovation and supply chain tracking.** As climate change continues, consumers are demanding more efficient food systems. This includes the use of the latest technology to improve crops and livestock farming and reduce costs, time and environmental impact. In addition to farmers, many food and beverage companies are also taking appropriate action in this regard. Companies are paying close attention to their supply chains, tracking everything from ingredient sources to processing, packaging and distribution methods.
- **Increasing expectation that alternative protein sources help reduce the negative environmental impact and antibiotics use** associated with meat production. Livestock is one of the major contributors to greenhouse gas emissions, environmental contamination and growth of global health hazards resulting from use of antibiotics. Additionally, reducing livestock could free up global cropland, decrease soil erosion, relieve pressure on the world's water supply and limit health hazards.
- **Advances in agricultural technology and synthetic biology** are enabling high-tech meatless products. Cellular agriculture and molecular engineering are fueling tech-enabled meat substitutes that better emulate the flavour and texture of traditional animal meat.
- **Intensifying research into new protein sources, from fungus to air..** Today, researchers are exploring a number of innovative protein sources to complement their continued reliance on pea and soy. Other novel sources coming from air particles to volcanic ash or algae have shown promise as it relates nutrition, functionality, flavour, sourcing and price.
- **Expansion of fermentation-as-a-service (FaaS).** There's been heightened interest in microbial fermentation as a novel method for developing alternative protein products. Expansive capabilities in food-grade fermentation are required to support the processing, lab services and consulting needs of food and beverage companies.
- **Increasing offer of plant-based meat-free products.** It includes new products featuring kid-friendly flavours, colours and formats like chicken nuggets, plant-based versions of traditional, authentic cuisines, fish-free seafood substitutes or plant-based burgers or sausages that 'bleed' and taste like real meat.
- **Steady growth of meal replacement and dairy substitute products.** Plant-based protein alternatives, be it powder-based, shakes or products for specific diets like vegan or ketogenic, are making their way into the markets, mostly coming from the start-up scene financed by venture capital.

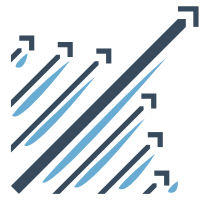
ANTI TRENDS



Factors of change that may disrupt currently observed trends in a way that can be either beneficial [↗] or detrimental [↘] to the development of alternative proteins.

- ↘ **Pandemics**
- ↗ **Population growth**
- ↗ **Climate change** limiting current farming and livestock production techniques
- ↘ **Lobbying of meat industry** slowing the development and uptake of alternative proteins
- ↘ **Difficulty to scale-up the production and lower the costs** of alternative proteins, thus its limited accessibility
- ↘ **Farmers' resistance to disruption** in the livestock and arable crop sectors
- ↘ **Reluctance to change diet**, preferences and behaviour among consumers due to lack of trust in new products or because of old habits
- ↘ **Policy inconsistencies and regulatory issues** limiting market uptake of alternative proteins
- ↘ **International uncertainties** related to economic conditions, conflicts or trade barriers





CONCLUSIONS

The imperative to diversify dietary habits by including alternative protein sources in the diet is an important yet promising element in addressing global challenges, including climate change, resource scarcity, food security and malnutrition. Advances in genetic engineering and other innovations in the area of plant-based foods, as well as trends related to healthy eating, increase the chances of integrating alternative proteins into the mainstream diet. However, it seems necessary to take into account the cultural habits and requirements of societies related to the taste and flavour of food, as well as trends in healthy lifestyles, including nutrition, for the introduction of alternative proteins into the diet to be successful. There is still quite a long way to go. We first have to deal with the technological hurdles, ensure sustainable and cost-effective production of new alternatives at the right scale, overcome potential consumer resistance and ensure appropriate regulation on a global scale. If we succeed in this, the benefits will be obvious: a healthier diet, reduced environmental impact, increased resource efficiency and innovation in cultivation methods, which will contribute to a transformation in various social dimensions.

Collaborative efforts involving producers, researchers, and policymakers are essential. The adoption of alternative proteins is gaining traction globally, with significant investments in research and development from countries like Israel, the United States, Canada, Singapore, and China. Major food corporations are already adapting to this upcoming shift.

Consumers seeking healthier alternatives are propelling the demand for meatless proteins. Such initiatives as “From seed-to-fork”, tech-enabled meat substitutes and fermentation-as-a-service are to shape the changes in the industry. However, these trends might face challenges, caused by pandemics, climate change, lobbying by the meat industry, economic hurdles or cultural resistance, to name a few. Overcoming these obstacles requires collaborative efforts and a comprehensive approach. Despite uncertainties, the potential benefits of alternative proteins in addressing nutrition, health, climate, circularity, and innovation underscore the importance of navigating these trends towards a more sustainable and resilient future.

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4CF is a strategic foresight and long-term strategy building consultancy. For almost two decades, 4CF has been helping its clients prepare for an uncertain tomorrow. The company has completed hundreds of projects for private companies, public and international institutions, including UNESCO, UNDP and WHO.

Using foresight, 4CF supports clients in uncovering future opportunities so that they can make important strategic decisions today and implement solutions to ensure a better future for their stakeholders. We care that our clients are always one step ahead of the competition. The company is the only Polish member of the Association of Professional Futurists, Foresight Educational and Research Network and founder of the Polish node of The Millennium Project.

4CF is at the forefront of global innovation and actively contributes to the development of cutting-edge foresight tools. The company's foresight experts have extensive interdisciplinary knowledge and experience. They are constantly refining the 4CF methodology and actively collaborate with leading international foresight centres.



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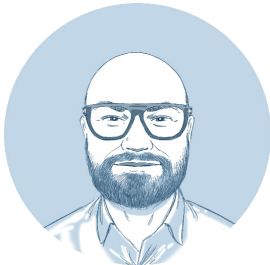
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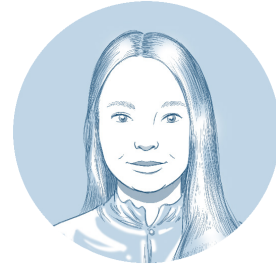
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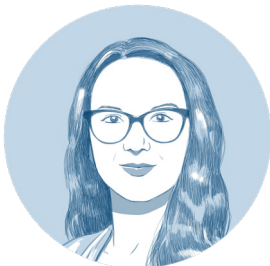
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