



FOOD TECH

TURNING PROMISE INTO OPPORTUNITY

ZINTINUS

BAIN & COMPANY 

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1. Prologue

When The Club of Rome published *The Limits to Growth* in 1972,¹ it made it clear that we would significantly endanger our future prospects if we continued behaving as if we had unlimited access to the resources of our planet. Today, addressing this challenge has become one of the most urgent tasks of our time. Global warming, which is a result of the exploitation of natural resources, can no longer be overlooked. A determined search for ways to slow down its development and limit its effects is required: handling our planet's resources in a responsible manner will be decisive.

The huge size and impact of the global food industry means it has a crucial role to play in this task. Worldwide food revenues are expected to reach \$8.8 trillion in 2022,² with food demand projected to increase by more than 50% by 2050. Demand for protein-rich foods like meat and dairy products is projected to rise even faster, by nearly 70%.³ Pressure for change is also growing, as awareness of the negative ecological footprint of parts of the food sector has reached most parts of society and the political debate. This discourse, as well as increased health awareness, has led to a change in consumer preferences. A growing share of consumer demand has shifted towards alternative products in recent years. For example, grocery sales of plant-based meat alternatives in the US have experienced a growth of 53% over the past two years.⁴

The convergence of the need to make the industry more sustainable with rapidly changing consumer demand opens vast new opportunities. The variety of opportunities ranges from new ingredients, formulations, products and distribution strategies to completely new food service concepts. This is now being reflected above all in the rapidly growing number of food innovations across various categories. As a result, investment activity has intensified.

This innovation-led transformation does not open space only for founders and investors but ultimately for all players in the industry. Every upheaval leads to shifts and relocations. Steering this process in a targeted manner offers the opportunity for change that can benefit large parts of society and the economy. The overarching goal should be the provision of healthier and more sustainable food for the benefit of as many people as possible.

The opportunity to offer new perspectives to the numerous members of the value chain should not be missed. This starts with seeds and ingredients; continues with processing and

production, refinement and distribution; and ends with recycling. From farmers to producers, the retail sector to the hospitality industry and consumers, everyone is affected by the changes that are taking place and all can use them to their advantage.

Governments and legislators can also gain new perspectives from food tech innovation. While this innovation can help address some of the root causes of climate change, it has the potential to provide access to healthier food and thus release pressure on health systems. It also offers a magnificent opportunity to positively influence the macroeconomic development of every country. Legislation has a crucial role to play in this: setting framework conditions and incentives in a targeted manner can accelerate the transformation and give as many players as possible access to emerging opportunities.

The idea of enhancing the food system has been around for quite some time. However, now it appears as if factors are converging that lead us to a crucial tipping point, and the promise is turning into a significant opportunity. This white paper takes a holistic look at the incipient transformation and should be an invitation for stakeholders throughout the food sector. Hopefully, it will serve as a guide and inspiration to recognise and seize the opportunities. The document will highlight the factors that have led to the increased momentum and the vast opportunities that innovation can create. It will also deal with the framework conditions that appear necessary for sustainable success and the greatest possible benefit for society and the economy. Building on this, the white paper will focus on the opportunities in Europe, one of the largest and most important food markets in the world.

The success and effect of the transformation will depend largely on the cooperation of as many stakeholders as possible. Those who make a decisive commitment at an early stage are most likely to succeed, as shown by previous waves of innovation. The transformation of the food industry appears to be accelerating rapidly. It is emerging as an opportunity of historic proportions, even if some of the parameters are still not entirely clear. We hope to arouse your interest and curiosity in this topic. The transformation of the food system is one of the most urgent challenges of our time for the benefit of consumers, the planet and as many industry stakeholders as possible.



2. Context and framework

Urgent change is needed in the food sector. As that becomes increasingly evident, so do the innovations that can transform challenges into opportunities. We have compiled the key factors that we believe will play a major role in this transformation.

2.1. Change momentum

There is nothing new about the realisation that our diet must change to protect our health and the environment; numerous organisations have been addressing this topic for decades. But things seem to have gained momentum since 2015, especially amongst consumers. Their daily purchases are votes on what is a success or a failure. Consumers are voting on the orientation of the industry, and the public debates on sustainability and health are increasingly influencing their consumption. At the same time, pressure from nongovernmental organisations (NGOs), media and governments for the food system to resolve some of the urgent challenges is growing.

2.1.1. The ecological footprint of the food system

Insufficient access to food was the greatest challenge for generations of human history. To solve this problem, enormous efforts have been made to ensure there is enough high-quality food that is also affordable. The food industry has played a crucial role in achieving this significant progress. However, according to the Food and Agriculture Organization (FAO) of the United Nations, 750 million people globally are still suffering from hunger and more than 2 billion people have no access to healthy diets.⁵

At the same time, the food industry is creating significant challenges:

- According to the UN FAO, global food systems are responsible for more than 33% of worldwide greenhouse gases (GHGs).⁶ Today the food sector is regarded as one of the biggest drivers of global warming.
- Meat production is the No. 1 reason for deforestation.⁷
- Livestock production is one of the largest consumers of freshwater resources.⁸

While meat is a popular part of Western diets, the associated environmental impact is dramatic. GHG emissions and water consumption are a major concern. Beef especially (and also pork) has a low protein conversion rate,⁹ leading to a significant overutilisation of resources compared to alternatives.

Today, agriculture has claimed 50% of the world's habitable land.¹⁰ More than 75% of this is used for livestock, even though meat and dairy represent only 18% of the world's calorie supply and 37% of its protein supply. The ratio of energy input to protein output (that is, the fossil energy required to produce 1 kilocalorie of animal protein) is problematic, going up to 40-to-1 for beef¹¹ production.

Similarly, fish demand has steeply increased over recent years, leading to a situation in which 93% of global marine stocks are maximally or overly exploited.¹² As a result, many species are threatened. Though there has been a massive increase in aquafarming for the controlled cultivation of seafood, this carries with it a number of potential problems, such as oxygen depletion, overuse of antibiotics, high risk of destroying natural habitats and ecosystems,¹³ and using fishmeal for feed, thus exacerbating the overfishing issues.

While the food sector has made a huge contribution to a better supply of high-quality, safe and affordable food for a growing number of people, it is also true that the use of resources currently required to produce food is reaching its limits. A powerful symbol of this phenomenon is Earth Overshoot Day.¹⁴ This marks the date when the consumption of natural resources exceeds what earth can regenerate in that year. Many countries reach their 'overshoot day' by March or April each year, with food production making a significant contribution to the excess consumption.

In 2019, a report released by The Food and Land Use Coalition¹⁵ noted that production and consumption of food and land use accounted for \$12 trillion in hidden costs to the environment per year. While the report highlights problems and raises urgency, it also indicates there are plenty of approaches to address these challenges. In fact, they can be turned into significant opportunities.

EXHIBIT 1

Country overshoot days 2021

When would Earth Overshoot Day land if the world's population lived like ...



Source: National Footprint & Biocapacity Accounts, 2021 Edition data.footprintnetwork.org

2.1.2. The protein paradox

This already-challenging situation threatens to worsen in the coming years. One of the drivers is the growth of the world population by roughly 25% to almost 10 billion in 2050. Another factor is increasing median income, which will lead to growing calorie intake. As a result, growth in underdeveloped markets will likely result in a disproportionate increase in food production.

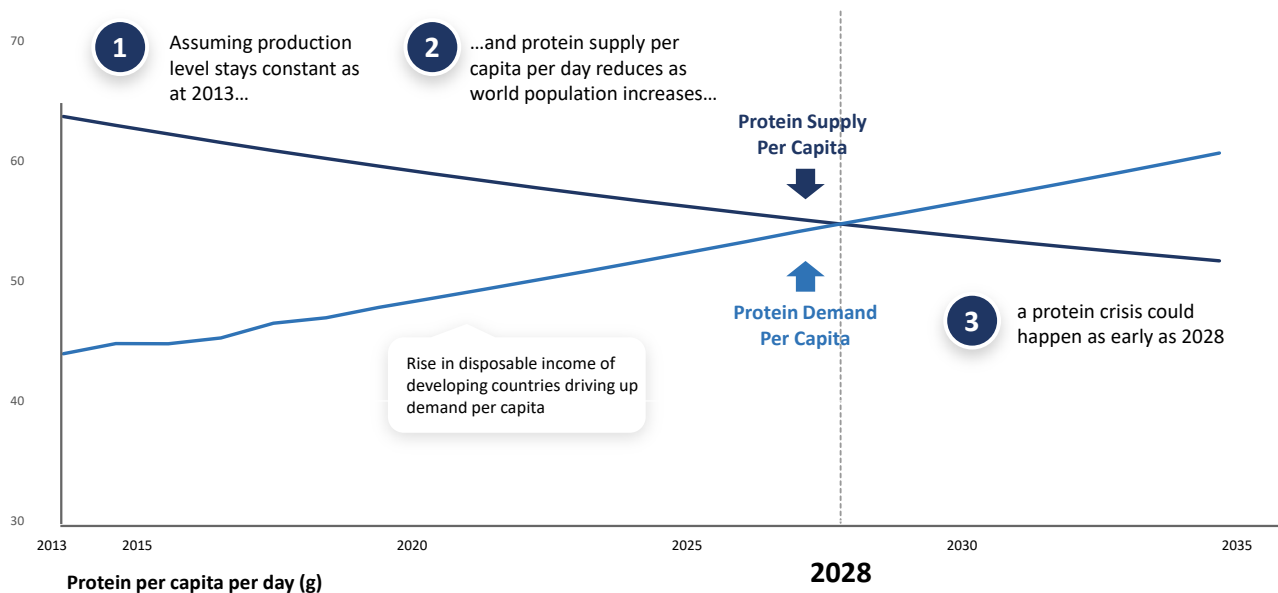
Because there is a strong correlation between income per capita and meat consumption,¹⁶ meat demand is expected to increase substantially. In total, the World Resources Institute (WRI) estimates that, compared to 2009, food production will need to increase by more than 50% to feed 10 billion people.¹⁷ Modelling the available proteins versus the demand for proteins on a per capita basis over the coming years leads us to predict a bottleneck. Bain & Company estimates a protein crisis could occur as soon as 2028.¹⁸

Today's methods to produce proteins are not suitable to satisfy this demand in a sustainable way. In fact, agriculture emissions would reach 15 gigatonnes by 2050 if current production concepts are extrapolated. This is in stark contrast to the declared aim to limit agriculture emissions to 4 gigatonnes by 2050 to stabilise climate change at the 2°C level.

New processes and solutions will be needed to cover the expected demand without further worsening the environmental impact.

EXHIBIT 2

The “protein paradox”



2.1.3. Pressure on the health sector

Awareness around health and wellness has grown steadily over the years. Access to a healthy diet is a key precondition for a good life.

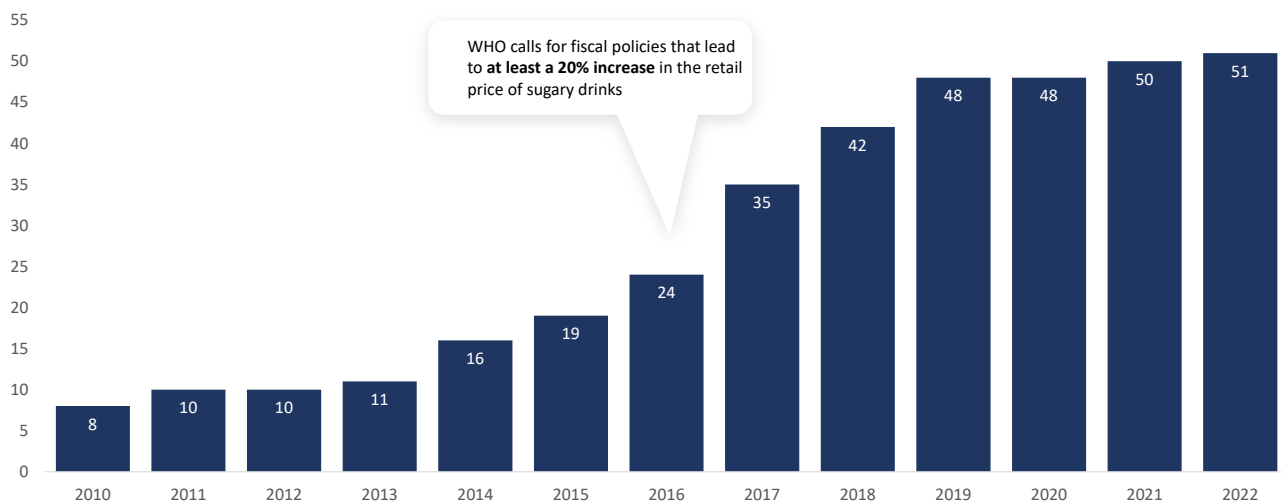
For many years, numerous studies have pointed to a connection between diet and diseases. There is growing evidence that a significant number of noncommunicable diseases (NCDs) are linked to diet-related causes,¹⁹ which are also causing a significant number of deaths.²⁰ In the European region alone, cardiovascular diseases cause more than half of all deaths, up to 30% of all cancer cases are linked to poor dietary habits, and about 60 million people aged 25 years and older suffer from type 2 diabetes.

All of this puts healthcare systems under extreme pressure. As an example, European healthcare expenditure to treat diabetes increased to almost \$190 billion in 2021.²¹ In 2015, it was estimated that the German healthcare system already spent almost €17 billion annually on the treatment of diseases caused by improper nutrition, such as those caused by high fat, salt and sugar (HFSS).²² Western diets that are high in saturated fats, refined carbohydrates (including sugar) and salts, along with insufficient consumption of omega-3 fats, vitamin D, calcium and fibre, lead to these alarming health outcomes.²³

To contain the harmful effects caused by unfavourable diets, laws have been enacted worldwide that are intended to limit the consumption of alcohol, tobacco and HFSS.²⁴ For example, the number of countries levying taxes on sugar has increased rapidly to more than 50 in 2021.²⁵

EXHIBIT 3

Number of countries with sugar tax



Obesity Evidence Hub - <https://www.obesityevidencehub.org.au/collections/prevention/countries-that-have-implemented-taxes-on-sugar-sweetened-beverages-ssbs>

2.1.4. Changing consumer preferences

Shifts in consumer preferences have progressed. Scientific insights should favour a continued shift in consumer preferences towards healthy and sustainable food. In fact, a recent study suggests that nutrition has the power to increase life expectancy by up to 10 years.²⁶ In addition, awareness has risen about the impact of our consumption and eating habits on the environment, climate and animal welfare.²⁷ Consumers are saying they are willing to pay some level of premium for healthy products and more sustainable food.²⁸

Of respondents in a European consumer survey, 32% stated that they had increased their healthy eating habits, and 20% confirmed that they had reduced or stopped consuming meat.²⁹

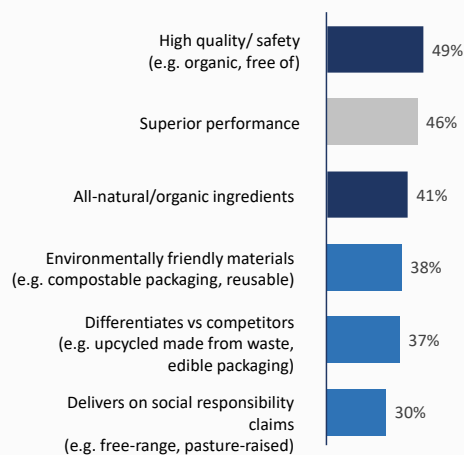
Reasons to switch away from meat could include:

- ▀ increased prevalence of NCDs;³⁰
- ▀ increased consumer focus on health;³¹ and
- ▀ increased interest in self-optimisation and biohacking: consumers are increasingly looking for functional foods that match their individual nutritional needs and ambitions. The focus of today's consumers on prevention and optimisation has opened the market for technologies that make personalised nutrition more accessible.

EXHIBIT 4

Quality, performance and natural/organic are features consumers are most willing to pay more for ⁴⁾

Consumers claim **willingness to pay premium (more than average price)** for products that provide:



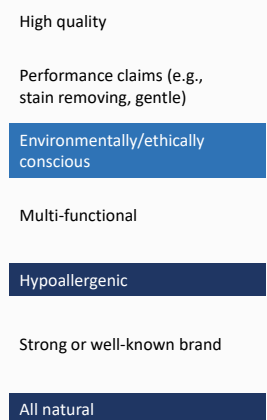
Sustainability-related features are among the top reasons why consumers pay more for products ⁴⁾

Main features for which consumers are willing to pay more

Food & Beverages



Household Supplies



Key: Sustainability related features (blue bar) Health related features (grey bar)

2.1.5. Supply chain disruptions

Our globalised economy depends on supplies from around the world—at the right time, at the right cost and in the right quantity. However, recent experience shows that supply chains are vulnerable to disruptive events, such as the pandemic and geopolitical conflicts. According to the Institute for Supply Management (ISM), 75% of all companies experienced disruptions in their supply chains related to transportation restrictions at the beginning of the Covid-19 pandemic.³² The war in Ukraine has led to a surge in the cost of energy and certain food commodities. Russia and Ukraine are highly relevant suppliers of grains, vegetable oil and fertilisers for global markets, and a supply disruption locally has an impact around the world. In fact, this has led to a 70% increase in wheat prices in the first quarter of 2022,³³ highlighting the challenges of supply concentration.

This vulnerability has increased the need for secure access to relevant resources and for a more resilient food supply chain with reduced dependency. Nearshoring, diversification of supply and the development of alternative solutions, which will often entail food tech innovations, will be needed to achieve this.

Securing access to food will be given greater priority in national politics. The '30 by 30' programme launched in 2019 by the Singaporean government serves as a good reference. It aims to enable Singapore to produce 30% of domestic nutritional needs locally by 2030. This will require a significant share of innovative food solutions, such as vertical farming or cell-based products. Not by coincidence, Singapore has turned out to be one of the most progressive locations for food tech.

2.2. Change opportunities

The pressing need for change can also be seen as offering promise. Various perspectives have emerged in recent years to reduce the ecological footprint and meet consumer requirements while enabling the provision of healthy food to more people. These nascent and emerging technologies have bold and commendable ambitions to provide health benefits and limited environmental impact. And as these technologies evolve, these benefits are still being proven. Although these approaches are still in their early phases, a successful and exciting transition in the food sector is foreseeable. In this section, we select a few areas that have potential for a significant positive impact.

2.2.1. Alternative protein

Plant-based proteins like legumes (beans and peas), nuts, seeds, whole grains and others have always been part of human diets. The refinement of plant-based proteins in products such as tofu, seitan and tempeh also comes with a long history. They convey superior taste and are very popular in some parts of the world. However, they do not match the experience of eating meat. Similarly, alternatives for animal milk, such as horchata, have existed for more than 1,000 years, especially in regions with higher rates of lactose intolerance.

Alternative proteins have gained even more popularity in recent years. The realisation that animal-based proteins are associated with a number of problems has led to the search for solutions that come as close as possible to the taste experience of eating meat, fish and dairy products, and drinking milk. The aim is to avoid the enormous use of resources required to produce animal-based proteins and thus reduce the harmful environmental impact.

Plant-based protein products

Alternative products based on plant proteins have advanced significantly in taste and consumer response and as a result have also grown in popularity. Plant-based protein products are still a small share (less than 1% of the total food market), but they are significantly outgrowing incumbent products by a factor of 5-to-1.³⁴

While a few years ago, plant-based alternatives were still playing in a niche market for a small group of vegan and vegetarian consumers or those with health issues, they have become a more mainstream phenomenon. Of consumers in the US, UK and Germany, 54% claim to have tried plant-based protein at least once, and 47% are consuming it at least once a week.³⁵

Plant-based meat alternatives carry a significant advantage in regard to environmental impact. According to a comparison generated by the Good Food Institute (GFI), plant-based meat alternatives use 47%–99% less land, emit 30%–90% less GHG, use 72%–99% less water and cause 51%–91% less aquatic nutrient pollution than conventional meat.³⁶ Furthermore, plant-based meat requires no antibiotics. Demand has increased steadily: the plant-based meat market had a market size of \$4.3

billion in 2020 and an expected compound annual growth rate (CAGR) of 14.0% until 2025,³⁷ but it has the potential to be even greater if some barriers are removed.

Another impressive change is occurring in the milk market, where rising health awareness has increased demand for plant-based milk substitutes. They have been popular with people suffering from lactose intolerance for many years. Plant-based milk substitutes, such as oat milk, offer benefits such as no cholesterol, high levels of fibre and vitamins, and the replacement of saturated fats with unsaturated fats.³⁸ However, there are also nutritional disadvantages, such as lower protein content and less thiamine, niacin, pantothenic acid, vitamin B₆ and folate.³⁹ Various crops have been used, such as oat, pea, almond, soy and others, with oat currently being the most popular. While the different types of plant-based milk substitutes vary in taste and nutritional value, they all share an ecological footprint that is significantly lower than dairy milk. The production of these substitutes results in almost less than a third of the GHG emissions of dairy milk, according to a University of Oxford study.⁴⁰ Plant-based milk also uses significantly less water and land. Consumer demand has resulted in a global oat milk market size of \$2.23 billion in 2020 and a CAGR of 14.2% expected from 2020 to 2028.⁴¹

Another attractive building block for plant-based proteins could be mycoprotein, a single-cell protein derived from fungi through fermentation. Rich in fibre and protein but very low in fat, it is applied in various products, such as patties, cream cheese or chicken alternatives. One of its great advantages is the structure of fungal fibres, which enables the creation of food products with a composition similar to the original meat product.

Due to the recent success of plant-based products, expansion is progressing into other categories. Alternatives to dairy products, such as cheese, yogurt and butter, have enjoyed a good response, and seafood alternatives have emerged. In fact, the opportunity to establish healthier and more sustainable plant-based products across almost all categories seems to be limitless.

While enormous progress has been made in the taste experience in recent years, the next evolution of the product will focus on ensuring it is a healthy or even healthier option. Another barrier to adoption is price. To be commercially successful and drive mass adoption, those products will need to reach price parity. While true price parity is unlikely in the short term, prices are still expected to drop as many of those products become more commoditised and reach sufficient scale.

EXHIBIT 5

Plant-based protein



Attribute	Current assessment
Taste parity/superiority	Close to parity
Cost parity	Moderate premium
ESG impact	Very significant
Nutritional value / healthy diet	Mostly under par
Infrastructure	Essentially available
Recent consumer response	Significant growth in demand
Market potential	Significant
Authority approval (FDA/EFSA etc.)	Feasible
Ingredients accessibility	Excessive demand expected

Precision fermentation

For thousands of years, fermentation has been used for food and drink products like yogurt, bread, beer and wine. Precision fermentation builds on the same logic but advances it by using microorganisms. This highly efficient approach to generate proteins and other nutrients like sweeteners has been used since the 1980s. Precision fermentation carries with it the promise to generate a wide variety of high-quality proteins in a very environmentally friendly manner and at attractive cost levels. It could therefore become a key driver in the shift towards alternative proteins.

The products being developed range from dairy, ice cream and fermented egg protein to gelatine. A promising opportunity also arises from ingredients that are generated by precision fermentation. This has been applied to enrich the taste of plant-based products like the Impossible™ Burger, which uses heme as a core ingredient.

Precision fermentation allows the generation of proteins that are healthier and tastier but do not require animals or fields. It is therefore significantly more environmentally friendly and cost-efficient, and could become a catalyst for the transformation of the food sector.

However, regulatory approval needs to be kept in mind. Precision fermentation ingredients and products might often fall under novel food regulations if their main output has not been used before 1997. This is particularly relevant for generated ingredients that cannot be found in nature, or if genetically modified raw materials were used in production. The US Food and Drug Administration (FDA) and European Food Safety Authority (EFSA) have given approval for various products in recent years.

EXHIBIT 6

Precision fermentation



Attribute	Current assessment
Taste parity/superiority	Close / very close to parity
Cost parity	Moderate premium / parity foreseeable
ESG impact	Very significant
Nutritional value / healthy diet	High / very high
Infrastructure	Still to be built
Recent consumer response	Only few “new food” products available
Market potential	Significant
Authority approval (FDA/EFSA etc.)	Approval required
Ingredients accessibility	Accessible

Cellular agriculture

Another very promising approach is cellular agriculture, which focuses on ‘growing animal cells’ rather than ‘growing animals’. The approach is based on in vitro cultivation of animal cells that produce proteins, fats and tissues. The aim is to shift from ‘resource-heavy’ livestock farming to ‘resource-light’ and clean cell farming. The most popular application is meat, though some companies specialise in seafood. In an approach adopted from the medical sector, animal stem cells are extracted and exposed to a culture medium that feeds them and allows them to grow. This offers the possibility of cultivating meat and seafood with the same taste experience and the same or even better nutritional value as meat from an animal, without any antibiotics and produced in a way that is significantly more resource efficient.

The first cultivated meat burger patty was developed by Mark Post in 2013 for an estimated cost of €250,000. Since then, commitment to this technology has increased significantly, with nearly 50 companies operating in this space today. The range of applications is wide—from chicken meat to fat, from beef muscle to foie gras. Interest in cell-based products has increased significantly because they promise full taste parity or even superiority with a much less problematic ecological footprint. Tasting participants have been generally delighted with the taste and quality. However, it is still very early days, and some studies suggest that the achievement of taste similarity will require significant effort.⁴²

Scaling this technology is one of its major challenges. Bioreactors—the containers in which the cultured cells proliferate and mature—were designed to process small quantities, and significant effort and investment will be needed to expand their capacity for industrial use. Of course, this also creates an enormous opportunity. The use of foetal bovine serum (FBS), which is extracted from cattle fetuses, has raised ethical questions, given that one of the main aims of cultured meat is to move away from animal slaughter. Furthermore, it would be prohibitively expensive to use FBS to produce cultured meat. Major players have moved away from FBS, and tremendous efforts have been made to find more cost-effective and ethical alternatives. Great progress has been made in this regard,⁴³ although the breakthrough of identifying inexpensive serum has not yet been achieved. But like the bioreactors, there seems to be an exciting opportunity here.

Cellular agriculture falls into the novel food domain in Europe⁴⁴ as in other parts of the world. As such, regulatory approval is needed to market these products, something that will take one to two years in most markets. However, Singapore issued the first regulatory approval for lab-grown meat in December 2020.⁴⁵

EXHIBIT 7

Cellular agriculture



Attribute	Current assessment
Taste parity/superiority	Close / very close to parity
Cost parity	Very high cost at this stage
ESG impact	Very significant
Nutritional value / healthy diet	High / very high
Infrastructure	Not yet developed
Recent consumer response	Almost no product available yet
Market potential	Significant
Authority approval (FDA/EFSA etc.)	Approval required
Ingredients accessibility	Cost-efficient ingredients not yet available

Alternative protein will be on the rise for all of these reasons, which creates significant opportunities for new entrants and incumbents to expand the range of categories and product variants. Scaling these applications will certainly substantially improve their economics. What's more, the demand for a supply of equipment, processing technologies and key ingredients will increase steadily too. It could also open the space for production specialists to serve brands and private labels on a business-to-business basis.

2.2.2. Functional food

Functional foods meet fundamental desires of today's consumers: to be healthy and live long lives. They differ from fortified foods, which are usually part of the daily diet and contain added nutrients, such as vitamins or minerals (e.g. milk or bread fortified with vitamin D). Fortified foods thus fulfil a 'nutritional function' and are 'good for you'. Functional foods, however, have the appearance of traditional food and contain added ingredients that lead to the maintenance or improvement of health (a 'physiological function'). Examples are energy drinks with added caffeine and vitamins, kombucha, high-protein meal replacements, probiotic-enriched food and immunity-boosting drinks. Some functional foods can be considered food as 'medicine'.⁴⁶ By contrast, food supplements are typically concentrated sources of nutrients with a nutritional or physiological effect. They are generally sold in pre-measured doses in forms such as pills, tablets, capsules or liquids.⁴⁷

Functional foods are expected to carry a large and rapidly growing share of the EU food market because they provide enhanced nutritional value in the same or equivalent eating occasions. The global functional foods market size is projected to reach \$275.8 billion by 2025, according to a report by Grand View Research released before the Covid-19 pandemic.⁴⁸

Increased health awareness, as mentioned above, is a significant driver for this. Consumers consider functional food as a self-determined way to improve well-being and lifestyle. They are looking for solutions in the areas of sports nutrition, weight management, immunity, digestive health, clinical nutrition, cardiovascular health and bone health.

The growing interest in products' ingredients further reflects this:

- 70% of global consumers find ingredients that claim to boost immunity very/somewhat appealing
- 73% consider ingredients that claim to aid digestive health very/somewhat appealing;
- 66% consider ingredients that claim to promote relaxation very/somewhat appealing; and
- 50% claim to buy food/drink with added vitamins either all the time or occasionally.

Personalisation is one of the great opportunities offered by functional food going forward. Many functional foods are currently mass products that do not match individuals' needs. Though personalised products would achieve the ideal benefit, this would require a high degree of logistical complexity and incur significant costs related to testing, targeted production (to service a 'segment of one') and delivery. That said, the significant health benefit and the increased willingness to pay a premium for superior products indicate a significant opportunity. In fact, a few companies have started to engage in this.

The marketing of functional foods falls under the Nutrition and Health Claims Regulation: only food products with a proven health effect can be marketed including a health claim. In Europe, the EFSA assesses the scientific evidence supporting the health claim to ensure a trustworthy and transparent market.⁴⁹ Interviews with industry stakeholders showed that investments in research and development (R&D) are considered risky, as the chance of getting a health claim authorised is small. Companies prefer to use the 'follower strategy' by using a claim that has already been approved.⁵⁰

There has been a step change in the range of functional food products available in the past few years, driven by technological advances. Today there is a much deeper understanding of the human gut microbiome, leading to products with improved probiotic benefits. Improved self-testing methods at an increasingly affordable price point (e.g. heart rate monitors and blood testing kits) are leading to better key data points about personal health, which are now being used by fortified food producers to build personalised products. And there are more cost-efficient ways to fortify everyday foods, resulting in the fortification of an increasing number of products with vitamins, proteins and other nutritional benefits. Lastly, there are functional foods that can meet the needs of people with chronic illnesses, such as low-protein products for consumers with chronic kidney disease and formula for consumers with diabetes or hyperglycaemia.

This notable progress, in combination with growing consumer demand, creates significant opportunities. Identifying the specific nutritional needs of defined audiences might lead to uncovering new target segments. Leveraging the latest nutritional science to build beneficial products for consumers with preconditions or with the desire to optimise their diets will increase growth opportunities. Functional food provides the chance to create truly personalised nutrition products, which could allow food producers to enter a very strong personal relationship with consumers. As the domain grows, capacities will need to be expanded. Therefore, scaling appropriate equipment, processing technologies and key ingredients will become another great opportunity.

2.2.3. Clean food

Clean foods are products in which a specific less healthy ingredient has been actively reduced, removed and/or substituted (e.g. gluten, sugar, salt, preservatives), or not added (e.g. additives, preservatives) during production. Giving consumers access to products without additives and chemical ingredients has become a major trend over recent years. Clean food has turned into a lifestyle, and the readiness to pay more is a catalyst for the development of clean nutrition and will lead eventually to economies of scale, enabling an even broader reach to consumers. This is in addition to the traditional clean food market that has served the needs of consumers with specific medically diagnosed allergies or conditions. It is worth mentioning that 2.5% of adults worldwide have a food allergy.⁵¹ The global market for 'clean' labelled products was \$38.8 billion in 2021, with a forecasted CAGR of 6.8% between 2022 and 2027.⁵²

Various factors have led to this growth momentum, reflected in a survey conducted in the second quarter of 2021:⁵³

- 77% of global consumers found products with simple/short ingredient lists on packaging very/somewhat appealing;
- 54% were inclined to agree that they pay a high amount of attention to the ingredients list of products; and
- 57% of consumers noted that they preferred seeing simple or fewer ingredients on packaging.

In addition, a 2018 study revealed that 68% of consumers are paying attention to natural attributes and are willing to pay a price premium for them.⁵⁴



Governments can even be expected to support consumption of clean food products, in part by restricting the marketing of HFSS products. The French government's 2017 introduction of a nutritional rating system called Nutri-Score, to be displayed on packaging on a voluntary basis⁵⁵ was a first step in this direction. Furthermore, reflections about taxes on unhealthy food and beverages to reduce consumption have increased. Studies suggest that such taxation does lower purchases of unhealthy products.⁵⁶ To come to a holistic assessment, however, it is necessary to consider which products are consumed as substitutes.

The expected increase in demand for clean food offers several opportunities. Reviewing recipes with the aim of reducing or skipping additives and preservatives is an obvious one. That will require further research to identify 'natural' alternatives for some of the additives and preservatives, but consideration is also needed for dedicated clean manufacturing facilities, which would be free from ingredients like nuts or lactose to eliminate any risk of contamination.

2.2.4. Vertical farming

The fact that modern agriculture is resource intensive and has already covered more than 50% of habitable land has led to the search for alternative approaches. Vertical farming has emerged over recent years. It allows producers to grow crops indoors in vertically stacked layers. The idea is to create optimal, self-contained cultivation environments that can grow crops in any season. In fact, this has been the principle of greenhouse farming, where crops grow within sheltered structures, allowing cultivation of a larger variety of crops throughout all seasons.

Vertical farms take this idea to the next level. They are established within buildings and based on soil-free growing methods (hydroponic or aeroponic). Light-emitting diodes (LEDs) substitute for sunlight. Typically, growth containers are vertically stacked, allowing a usable area multiple times larger than the ground floor. To optimise growth, advanced systems are used to control growing conditions. This enables higher resource efficiency, faster yield and high quality. As a result, resource consumption (water, nutrients) is radically reduced. In fact, vertical farms can halve growing time,⁵⁷ with fewer resources than conventional methods (e.g. 90% less water, 25% of growing land required).⁵⁸

Another characteristic of vertical farms is their proximity to local consumption. Various high-quality products cannot be provided year-round due to seasonal crop availability and the limitations of conventional farming techniques. As a result, some products are imported from distant countries. This is problematic because it causes high GHG emissions along the whole supply chain and can cause significant levels of food waste because these products are typically highly perishable. Vertical farming promises to solve this problem by using a very controlled process to grow all kinds of crops locally.

There are multiple benefits. Unused urban space can be reactivated to deliver large quantities of higher-quality, better-tasting crops, thereby replacing imported produce with local products. It does not require the use of carbon-intensive fertilisers and ecologically damaging pesticides. Without question, one of the most relevant benefits of vertical indoor farming is the conservation of natural resources, such as water, land and nutrients. However, vertical farming requires a significant level of electric energy because LEDs replace sunlight and temperatures need to be stabilised.

Economics are the biggest challenge at the moment. Vertical farms require high capital expenditure investment and significantly higher operating expenditure per crop than conventional farming—Bain & Company estimates two to three times higher production cost⁵⁹—all of which translates into a significantly higher price point. As a result, vertical farming solutions are only appropriate for higher-value crops (e.g. herbs and berries).

Resolving some of these issues can turn out to be a huge opportunity. Driving down costs will be a key success factor. Process automation and enhanced data analytics to improve yields in combination with newly developed or cross-bred seeds could lead to a breakthrough on economics.

EXHIBIT 8

Vertical farming



Attribute	Current assessment
Water usage	~ 90%
Land usage	Significantly less
Fertilizer usage	None
Pesticides usage	None
Energy usage	High
Crop growth	Fast
Proximity / self-supply	High
Cost parity	Significantly higher cost
Applicable crops	Still limited, mainly due to economics

2.2.5. Food waste reduction

Food waste is without question one of the most serious issues for the food and beverage industry. According to the UN FAO, one-third of the world's food is lost or wasted every year.⁶⁰ This is one of the most painful truths of our time, as 720 to 811 million people were estimated to have been suffering from hunger in 2020.⁶¹ A study in 2013 estimated that half of edible food wastage⁶² could essentially feed the world's undernourished population.⁶³ Project Drawdown, one of the leading non-profits addressing climate solutions, ranked food waste reduction as the most important potential solution to limit the temperature rise to 2°C by 2100.⁶⁴ Food waste reduction has become a priority for large corporations⁶⁵ and for policymakers. The UN's Sustainable Development Goal (SDG) target 12.3 is to halve food wastage by 2030. Origins of food loss are found throughout the whole chain, from production, processing and distribution to consumption. The root causes are often linked to a lack of transparency (data), ineffective cool chains, inappropriate handling, packaging issues, demand forecasting and overstocks. However, food waste does not happen everywhere equally. In emerging markets the majority of food waste is on the farms and getting it to manufacturers, while in developed markets most of it happens in consumers' homes. Therefore, different solutions need to arise.

Innovative solutions are generated along the entire value chain. For example, storage solutions like solar-powered cold storage rooms have emerged specifically for temperature control in countries with limited cool chain infrastructure. Packaging solutions can also play a key role in creating products that will have longer shelf lives through an extra peel layer.

Data supply and analytics could turn out to be among the most important drivers. From supply transparency of harvested goods in developing countries to visibility of where food wastage is happening, there are various opportunities. Demand planning has been optimised at large retail companies and for fast-moving consumer goods (FMCGs). If that level of sophistication, combined with traceability, could be rolled out across the industry, significant inefficiencies could be solved.

Another example is found in the hospitality/retail industry, where artificial intelligence technology helps to identify the root causes of wastage. Making overstocks or leftovers visible has proved to offer great value for customers and a means to reduce food waste. A new market mechanism provides a platform that shows food stock in places such as bakeries or hotels that will be lost at closing time (e.g. bread or cookies that cannot be sold next day or used on the breakfast buffet). These goods are offered at a discount to consumers, giving them access to a great deal, reducing food loss and earning more revenue for the operator.

However, while there are strong incentives for retailers to limit food waste, as this can be a significant form of savings, one of the issues today is that there is no incentive for companies to reduce the food waste at customers' homes. The largest part of food waste at people's homes is still a white space, with only a few start-ups offering solutions around that (e.g. donation of overflow of food, sharing with neighbours).

Finally, the circular economy has gained significant attention because it offers opportunities to reintegrate food waste or by-product into the food chain. Press cake is one of various examples that prove that items traditionally considered to be wastage can be turned into a valuable component.⁶⁶

EXHIBIT 9

Food waste



Attribute	Current assessment
Total annual food loss	~33%
Change Levers	
Attribute	Impact assessment
Supply/market transparency	High
Traceability	High
Demand planning	High
New packaging	Significant
Temperature control / cool chain	High
Waste analytics	High
Overstock / Leftover handling	Significant



3. Food X.0 - A historic opportunity

The increasing pressure for change in the food sector also creates great opportunities for the diverse participants in the food value chain. In this chapter we want to point out these possibilities and show why there are legitimate reasons for confidence in many parts of the food system.

3.1. Benefits and opportunities for consumers

In general, consumers should benefit from greater access to healthier products that improve their quality of life. They have been leading the way for new food alternatives over recent years. Demand for alternative food products has steadily increased, leading to an ever-larger range of products to choose from. Main drivers have been a higher health consciousness and awareness of the ecological footprint of food products. This trend is likely to accelerate as millennials, who are more health conscious than previous generations,⁶⁷ have a growing impact on consumption and the economy.⁶⁸

For consumers, the good news is that the market is responding. More new alternatives are being offered. However, consumers should carefully consider the alternatives when making their purchase decision. Because taste remains a high priority for consumers,⁶⁹ some compromises might have been made to come close to taste parity. Some products still rely on flavour enhancers and a high fat content, as well as salt and sugar, to achieve the desired outcome. As a result, a product with a strong positive sustainability profile might turn out to be less healthy. The good news, however, is that such compromises could very soon be a thing of the past. Technological progress gives reason to hope that the combination of sustainability and health is feasible.

Furthermore, the ability to tailor personal needs for nutrition has further progressed. It is much more feasible to adjust personal diets to gender, age and life conditions through functional food.⁷⁰ This could become another important contributor to health and well-being.

Consumers can influence this trend by continuing to support it with their purchases. The economic success of new alternatives has the chance to turn into a virtuous circle. As financial returns improve, more investment will be attracted, there will be an acceleration and intensification of production and supply, and as a result, the variety of products in the market should grow further. This will give consumers access to increasingly diverse culinary experiences, which will further enhance quality of life. Finally, as economies of scale come into effect, there is a chance to make healthy and sustainable diets significantly more affordable.

3.2. Benefits and opportunities for agriculture

Plant-based products have seen strong growth over recent years. Consumers have shifted their buying preferences and choose plant-based alternatives more often. As a result, the demand for crops applied in these products is increasing steadily as well. This can lead to a shortage, which could also drive an inflationary price increase.⁷¹ What does this mean for the agricultural sector? Anticipating a steady and sustainable growth in demand opens opportunities to invest in new capacities. However, this must be carefully planned and managed. Soy is an example of what can happen if there is a very large expansion in capacity without considering the impact on the environment.⁷²

Nevertheless, the surge in demand for new crops can give farmers the opportunity to generate better yields with more valuable seeds. To a certain extent, this also applies to processing. The harvested seeds need to be transformed into processable ingredients. There is currently not enough capacity for this either. As a result, this can open the door to entirely new opportunities, such as the collective processing of crops into valuable ingredients for the food industry.

To a certain extent, this applies to the livestock industry as well. Companies that focus on processing animals today could be involved in the production of alternative proteins tomorrow. This could improve the profitability of these companies while significantly reducing the burden on the environment by decreasing GHGs and water and land use. For those farms that continue to focus on animal breeding, there could also be advantages from a higher price level due to the price-quantity function and from an improvement in animal welfare. The transition in the food system can be a turning point for the agricultural sector in switching from a commodity provider with low margins to a supplier of 'value add' products with much better economics.



Biodiversity is also an opportunity. According to the FAO, our current food system relies on a very small fraction of nature, with 75% of food generated from 12 plant and 5 animal species.⁷³ Only a very small fraction of edible plants are used for food and feed. There could be a broad range of untapped nutrition sources from plants that are not yet utilised. The *Future 50 Foods* report notes several promising species, such as Bambara groundnut or mung beans.⁷⁴

Another aspect is localisation of supply and the already-mentioned need for a higher share of self-sufficiency. Technological advances in agritech can potentially play a major role in this. Low-tech urban farming can already contribute significantly towards self-sufficiency.⁷⁵ Vertical farming could eventually amplify this even further.

3.3. Benefits and opportunities for producers

The food production industry plays a huge role in the overall food system. Now we want to focus on the ingredient industry and FMCGs.

Ingredients will play a decisive role in the transition of the food system. They obviously play a key role in the functional food sector, with an ingredients market size estimated at \$98.9 billion in 2021, with projected growth to \$137.1 billion by 2026 with a CAGR of 6.8%.⁷⁶ The growth in demand is underpinned by the expected growth in functional foods that include vitamins, minerals, antioxidants, hydrocolloids, prebiotics, amino acids, plant extracts and carotenoids. Furthermore, the fact that the nutritional profile of some alternative food products still needs to improve is likely to accelerate the demand. The ingredient industry will play a decisive role in the upcoming transition of the food system. Various promising opportunities are opening through recent progress in the fields of encapsulation⁷⁷ and liposome technology, which allow for a wider range of applications. The industry might also find new ways to collaborate with the agricultural sector, with a view to sourcing healthy ingredients and more sustainable approaches.

FMCGs have shaped the food system for decades. They have consolidated the market, making quality-assured products at affordable prices available to more people. However, in recent years, a disproportionate share of growth has been accounted for by smaller manufacturers and private labels.

One of the reasons for this appears to be an underrepresentation of FMCGs within some of the fast-growing new alternatives. While plant-based foods are outpacing overall growth by 5-to-1,⁷⁸ it appears that insurgent brands account for much of that growth. Most large FMCGs have responded to this by shifting R&D budgets towards those new fields. Though there's no question they have the financial strength and excellence to expand their presence in food tech, collaboration with insurgent companies seems to be mutually beneficial. There has been a sizeable number of merger and acquisition transactions in this field in recent years.⁷⁹



Certainly the product mix will change, which is also necessary to meet ambitious environmental, social and governance (ESG) targets. More companies have joined the Science-Based Targets initiative (SBTi), which aims to intensify climate action in the private sector. Over 200 companies from the food and beverage processing sector have joined the SBTi over recent years⁸⁰ as part of their overall commitment to improve their ESG profile (including lowering water and energy consumption and reducing GHGs). Innovative consumer products or ingredients will play an important role in meeting these ambitions. However, to really play a fundamental role within larger corporations, new products will need to meet consumers' No. 1 preferences: taste and indulgence.

Cost efficiency might also arise through food tech. Some of the newly developed approaches have the promise to consume much fewer resources and therefore also provide an opportunity to reduce cost.⁸¹ Precision fermentation could be one of the first areas to combine healthy(ier) nutritional value and a more sustainable profile with attractive economics. It is still early to make a call in this direction, but it is certainly something to watch closely.

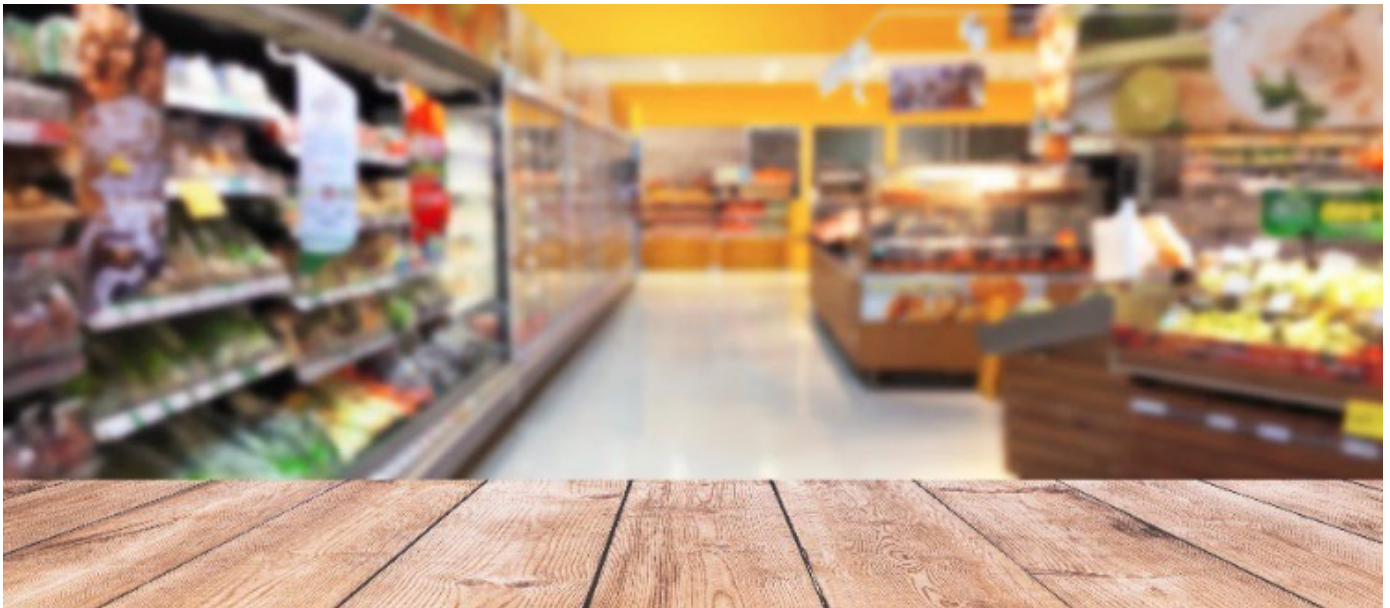
Another opportunity is a stronger proximity to consumers. Covid-19 has accelerated direct-to-consumer (D2C) distribution of food products.⁸² Within this development, an interesting trend was initiated by food tech pioneers. During the pandemic, for example, more customers ordered their snacking products online.⁸³ Shipping directly to consumers offers attractive economics for certain categories, builds a direct contact to the consumer and provides an opportunity to eventually establish a subscription business.

Companies have a chance to engage in this transition at what is still a very early stage. The opportunities for value creation are widespread and can be captured through intensification of R&D activities in the respective fields, collaboration with insurgent companies, acquisition of complementary skill sets and increased market reach.

3.4. Benefits and opportunities for distributors

Food retailers and wholesalers have played an extremely important role in making food accessible to more people. They have not only had a huge impact in expanding the reach of the food system, but they have also always been the direct interface to the consumer. As such, they were the first to notice changes in wishes and preferences.

There's no difference with food tech. The shift in consumer demand creates substantial opportunities to transform the assortment and service on offer, of course. The fact that customers are willing to pay a higher price for healthy and more sustainable products is great news, which, in a way, could turn out to be the financing bridge for the transition. As retailers start to market alternative products, they can mitigate some of the obvious risks of new introduction through a healthier margin. If certain items turn out to be successful, the overall income profile will improve. Of course, this process must be fine-tuned because there will also be failures. However, the market is becoming increasingly open to listing new products, including those from insurgent brands. If this trend continues, experience and economies of scale will help drive prices down and reach an increasing number of customers. This then creates the basis and incentive to expand the redesign of the range.



This offers food retailers and wholesalers the opportunity to attract customers seeking healthy, sustainable food, then build a strong relationship with them by meeting their lifestyle choices and values. This could be achieved by offering in-store engagement, such as tastings; new choices that are easy to find; and convenience in filling baskets with healthier and more sustainable food. There should also be a firm position towards suppliers when it comes to product composition and quality.

Lastly, food tech will certainly create opportunities to improve efficiency. Data will play a vital role in this. Though supply chains have been optimised over the past decades, it is fair to say there is still room to optimise inventory management and therefore further reduce food loss.

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3.5. Benefits and opportunities for hospitality

Hospitality creates a place of gathering and enjoyment, where we eat good food and share time with family, friends, partners and colleagues. It represents an essential part of our quality of life. It is no surprise that we like to rave about the great restaurants, coffee shops and bistros we love so much or that we discovered on a trip.

The diversity of hospitality is also fascinating; it is a wonderful breeding ground for innovation. As a result, hospitality plays a very relevant role in food tech. Like those who work in retail, restaurateurs are also in direct contact with consumers and therefore have a finger on their pulse. Progressive restaurateurs are often the first to notice the growth of new trends. In addition, they have the manual skills and competence to masterfully process new products and ingredients, and serve their guests from a wonderful menu.

The introduction of plant-based meat alternatives can serve as an encouraging example. It has shown how quickly the market can adopt a trend. As new products arise but face supply constraints due to limited capacities, restaurants might be a great initial partner for distribution. For them, food innovation can help attract customers and build loyalty. Health- and sustainability-conscious consumers will appreciate the addition of new items on the menu, especially if they are served in a delicious way. This is where the food innovator benefits from the abilities of the restaurateur to prepare and serve their product. Since there is no better argument for a new product than enjoying its taste, succeeding in restaurants might lay the groundwork for an expansion into food retail.

Lastly, one of the big challenges within the hospitality industry is food waste, which is economically and environmentally damaging. Food tech solutions can help optimise the supply chain of small operations and reduce loss of food.



3.6. Benefits and opportunities for environment & society

The local impact of climate change is felt around the world, and citizens urge their governments to address it. The transition of the food system can be a significant contributor in the fight to limit global warming. Food tech could help reduce GHGs and water and energy consumption but also help to protect biodiversity. Potentially reducing the land use for agriculture might allow territories to be returned to their natural habitat. This can be used for reforestation and certainly for the protection of the environment and species, further improving quality of life.

A transition of the food sector towards healthier or more sustainable food carries huge promise for society. If it is possible to provide more people with healthy food and to limit the consumption of products that have been proven to be harmful, it can be assumed with a high degree of probability that health systems will face significantly lower costs for treating NCDs like obesity, diabetes and cardiovascular diseases. In the context of continuing population growth and increasing life expectancies, there is an urgent need for society to continue to have access to good and affordable healthcare in the future and to further improve general physical and mental health.



In a world of supply chains disrupted by pandemics or geopolitical crises, self-containment will be given a much higher priority. Food tech opens new opportunities to develop a wider range of crops locally, further improve yields, switch to advanced production methods and reduce food loss. Therefore, dependence on imports could be significantly reduced.

Governments could actively influence and shape the transition of the food system by providing a framework for innovation and calibrating its support.

3.7. Benefits and opportunities for economy

Every transition opens new opportunities as demand preferences change and sources of supply need to be transformed or built from scratch. The enormous range of change outlined so far suggests a significant recalibration of the value chain. This applies to consumer products and their ingredients as well as fresh products. According to a projection model developed by SYSTEMIQ, there could be an annual business opportunity of \$4.5 trillion in 2030 linked to food system transition.⁸⁴

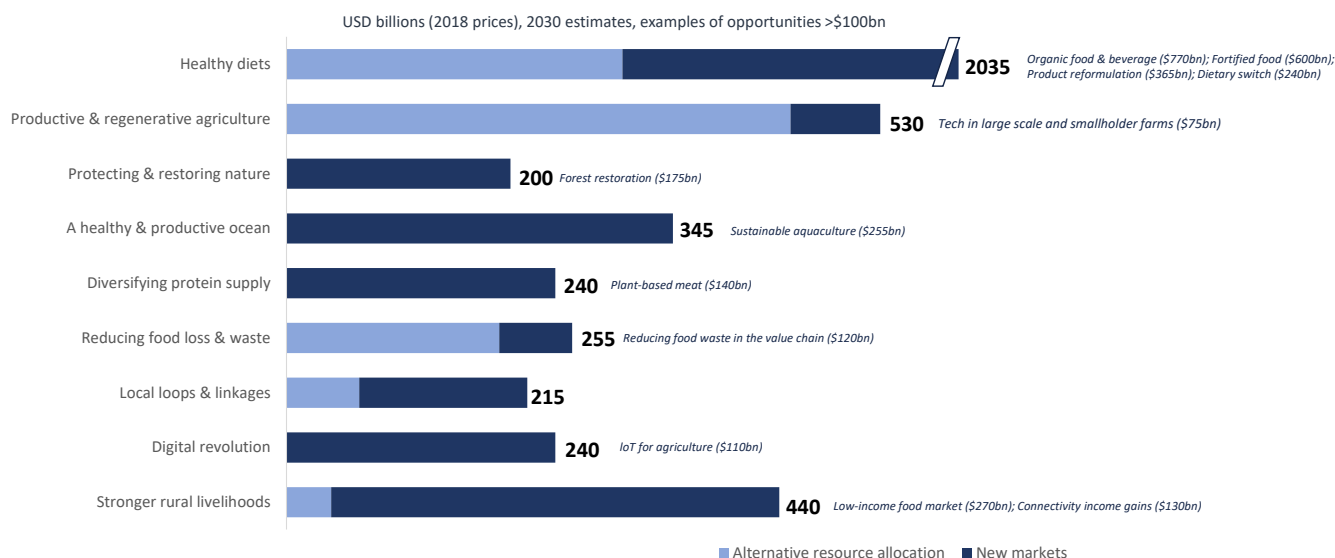
Participation in this transition provides a very attractive opportunity to capture sustainable macroeconomic growth and create new high-skilled jobs across the whole value chain. As demand for more sustainable food products grows across the world, it also presents an attractive opportunity to strengthen the economy through export of ingredients, finished food products, processing technologies, supply chain solutions and expertise.

A leading international market position will be helpful but not decisive for success: the determination and intensity of the development of the new food system will be the crucial success factor. Inevitably this could lead to significant shifts in value creation. Therefore, the economic development of the food tech sector will be a competitive process that will probably benefit those who participate early and decisively in the transition.

This is also of huge relevance for the labour market because the food industry is one of the largest employers in many countries. In the EU, 4.82 million people work in the food and beverage sector, making it the largest manufacturing industry.⁸⁵ Of course, this also means that any structural change must be approached with great care since so many people are directly or indirectly affected by it.

EXHIBIT 10

There is an annual business opportunity of \$4.5 trillion associated with 10 critical transitions in 2030



Source: FOLU - Growing Better: Ten Critical Transitions to Transform Food and Land Use P. 18 - SYSTEMIQ, Blended Finance Taskforce, 2019

3.8. Benefits and opportunities for investors

The transition of the food system will be an enormous undertaking. While last year's investments totalled about \$19 billion in upstream food innovations, it is fair to say that the food tech investment sector is still in a nascent state. In fact, net-zero financing roadmaps suggest that an annual investment of \$150 billion⁸⁶ will be needed to transform the food system. The Food and Land Use Coalition report *Growing Better* expects an even higher annual investment amount—up to \$350 billion—needed for the transition of the food system.⁸⁷ This highlights a huge gap and at the same time a substantial opportunity.

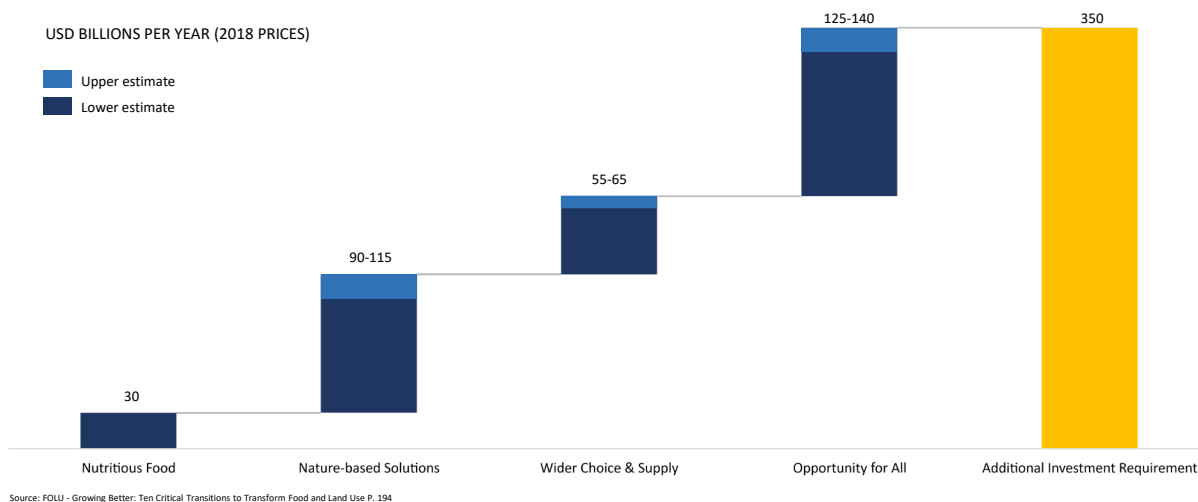
The markets making up the food system are large and global (e.g. the meat market was about \$840 billion⁸⁸ globally in 2020), and therefore attractive from an investor perspective. There is a quite diverse set of insertion points for investors along the value chain, from ingredients, processing and consumer products to data analytics and infrastructure. For investors with a strong emphasis on ESG, the food tech sector can be a very relevant area.

The transition of the food system is regarded as one of the most impactful means to fight global warming and therefore has strong potential to combine attractive financial returns with tangible social and environmental benefits—for example, reducing GHGs, improving health options for consumers and tackling supply bottlenecks.

The potential to make a substantial contribution to society and the economy should also create the conditions for cooperation with public facilities and institutions over time. In fact, public-private partnerships might play an essential role in growing and accelerating the positive impact of food tech.

EXHIBIT 11

The annual investment requirements associated with the ten critical transitions are between \$300 and \$350 billion (2018 - 2030)





4. The time is now

The public debate about the food system started almost 40 years ago. At that time, it was primarily NGOs that pointed out the challenges. The intensive discussion about global warming, coupled with comprehensive scientific knowledge regarding the health and sustainability of food, has caused consumers to rethink. This phenomenon is increasingly affecting their consumption patterns, and it has evidently been further accelerated by the pandemic. All of this reinforces the notion that we may be at a tipping point that could cascade into action by a wide range of stakeholders, leading to a systemic transformation of the food system.

4.1. Market dynamics

Consumer preferences have shifted towards healthier and more sustainable food over recent years. This trend accelerated during the pandemic. In a recent Bain & Company survey, consumers set health as priority No. 2 and sustainability as priority No. 4 in their purchasing decisions.⁸⁹ The fact that quality (i.e. taste and performance) remained priority No. 1 suggests that consumers will probably not tend to make compromises in the long term when it comes to taste. Food must be tasty, and it must be easy to process and prepare to be successful in the long term.

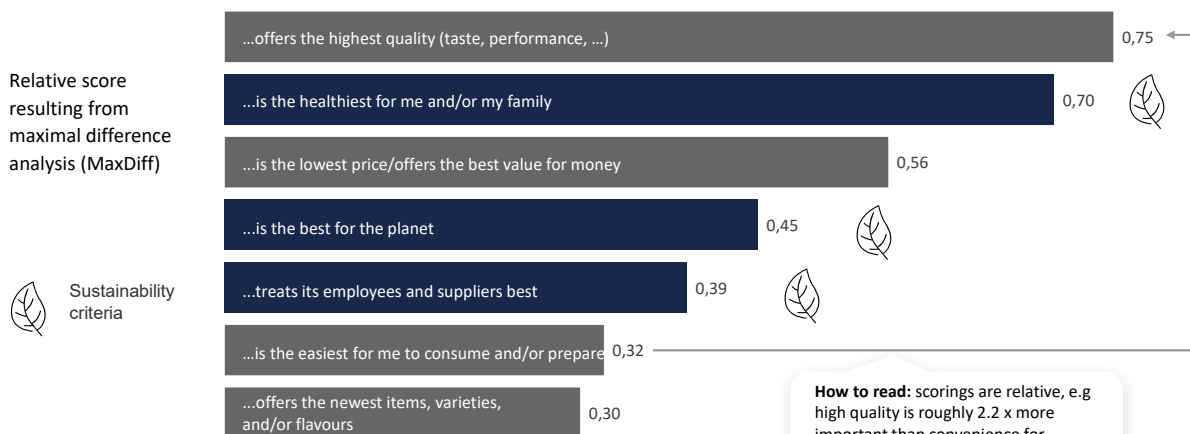
Chances for insurgents are improving, while the pandemic has further accelerated consumer demand, particularly among millennials and Gen Z, who are now the largest segment of the adult population. In a European consumer survey conducted in June 2021, roughly 40% of millennials and Gen Z stated that they are eating healthier food since the start of the pandemic, and roughly 75% stated that they spend more on food products to buy sustainable.⁹⁰

Relative Importance Of Key Purchasing Criteria

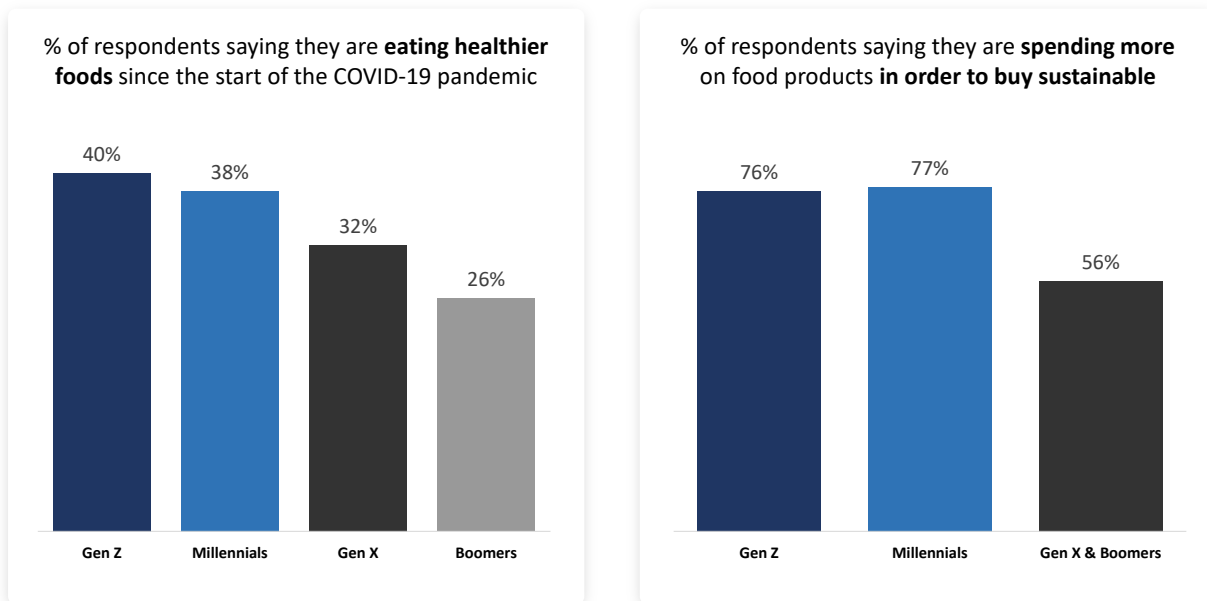


Q: You will each time see a set of statements that may or may not be important to you while grocery shopping.

In each question, please indicate which item is most important to you and which item is least important to you when deciding which product and/or brand to purchase.



European Consumer Pulse Survey

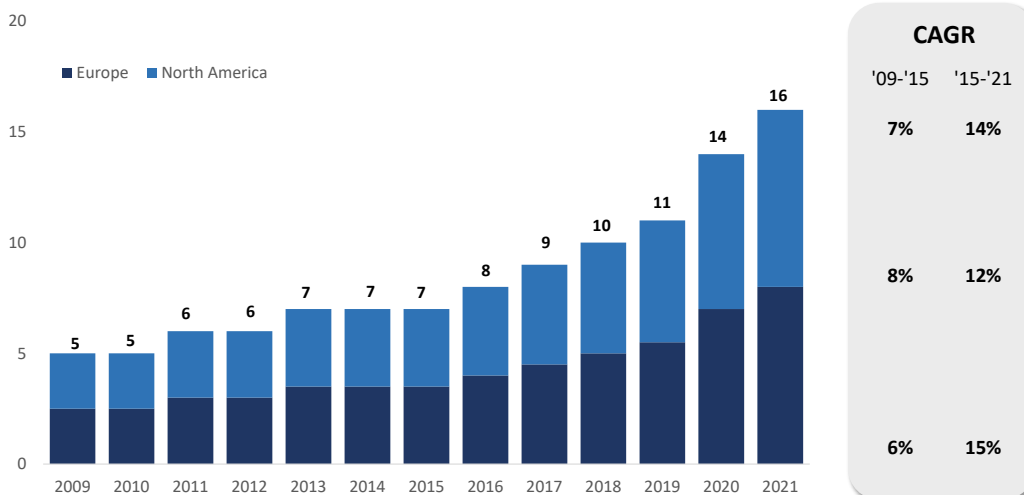


Innovators and insurgent brands have evidently made progress in recent years. Of course, this impression is created by discovering more innovative products on store shelves, but it can also be backed up with solid data. The market value of plant-based products in North America and Europe grew by approximately 300% between 2009 and 2020, to a total of \$16 billion.⁹¹ Plant-based milk substitutes have meanwhile reached a global market share of 12%,⁹² making them a mainstream product. These figures clearly indicate that we are on a path towards lasting change, which is being achieved because alternative protein products are receiving more positive response from consumers as barriers to consumption are addressed through technology advancements. This can also be observed in the case of alternative meat, the global market share of which has been rising steadily and is now at 0.5%⁹³ and could reach growth levels similar to plant-based milk substitutes. That would create a multibillion-dollar opportunity.

EXHIBIT 14

Plant-based foods have outpaced overall growth By 4-5 x

North American and European plant-based market value (\$bn)



However, the most recent GFI report on plant-based sales for 2021 showed some slowdown in the US, with a total growth of just 6% and flat sales for plant-based meat versus the previous year.⁹⁴ Adjusted for inflation, there was actually a decline in unit sales of plant-based meat.⁹⁵ One explanation could be exceptionally high sales figures during the first year of the pandemic and a shortage of raw materials. However, it is likely that the price point, taste, and health aspects all played a role, since some products still use additives that are viewed critically.

In other regions, sales growth remained strong in 2021. In Germany, plant-based meal solutions grew by 27% in 2021,⁹⁶ following a record growth year of 55% in 2020. The regional difference in terms of growth dynamics makes it clear that success depends on local preferences, but of course also on the breadth, depth and quality of the product range.

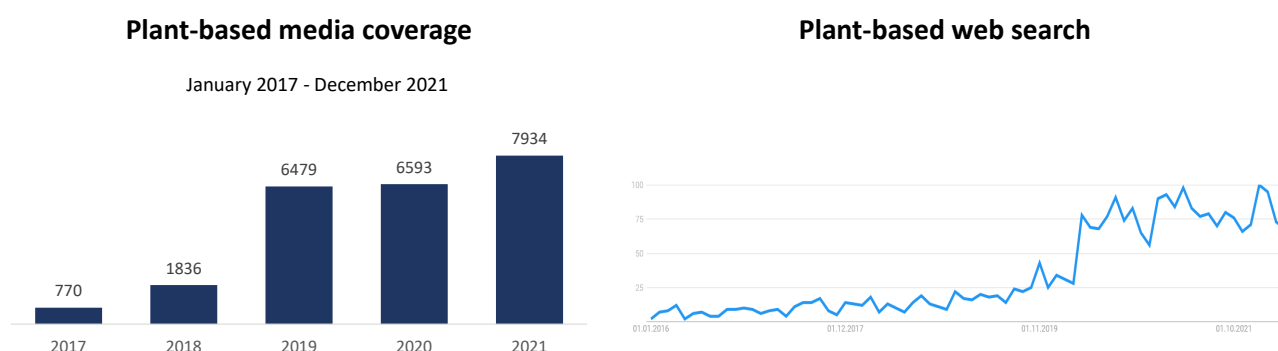
Barriers to market entry seem more surmountable for insurgents. This is due to several factors: direct sales to consumers, new marketing tools that are cost-efficient and very effective, and the co-manufacturing landscape. The proliferation of more channels has certainly helped to introduce new products more easily and inexpensively. The growing relevance of e-commerce for grocery during the pandemic has further solidified market changes. D2C for dry goods and quick commerce proved to be fast-growing routes to market. There is also a significantly increased willingness among leading retailers to include innovative products in their ranges. Quite a few of them have launched dedicated programmes to promote alternative food products.

A significant hurdle for new product introductions seemed to be manufacturing. The rise of contract manufacturing has significantly changed by providing infrastructure that can be used by several brands. These often highly specialised partners are essential to lower investment needs, accelerate time to market, ensure high quality, achieve attractive unit economics, lower the execution risk and reduce complexity for insurgent companies. Contract manufacturing has turned into a relevant part of the food system. In fact, small brands tend to outsource 90%–100% of their production to professional partners.⁹⁷ This part of the industry cannot be overestimated when it comes to successfully bringing innovations to market.

4.2. Media dynamics

An important aspect in reaching a tipping point is public opinion. Over recent years, the public interest in healthy and sustainable food has been growing steadily. The public debate about global warming and the shock waves of the pandemic have amplified these discussions. Several relevant publications have highlighted the role that food can play to improve health and sustainability, one being the EAT-Lancet study, which has had a remarkable impact. This points to ways of overcoming the upcoming challenges in the food sector and has been widely reported in the media.⁹⁸

EXHIBIT 15



Public attention has steadily increased, which is also reflected in the search behaviour of users. Interest in several relevant food tech areas is growing. Media coverage of plant-based products increased tenfold from 2017 to 2022.⁹⁹ During the same period, web searches for content related to plant-based products have also increased rapidly, as a Google trend analysis shows.¹⁰⁰

Another remarkable phenomenon is the number of critical documentaries released about the food system. They have reached millions of viewers on streaming services and created awareness about some of the significant challenges. National broadcasters have picked this up, leading to many documentaries being released to an even wider audience. Media reporting and public discussion act as reinforcing powers towards consumers, but also for entrepreneurs, investors, corporations and politicians.

4.3. Investment dynamics

Improved market circumstances and intensified media attention have also had a positive impact on the investment sector. In general, ESG has gained significant attention in recent years, especially after the Paris Agreement. The value of assets in publicly available ESG funds swelled from \$3.7 trillion in 2020 to \$6.4 trillion at the end of November 2021.¹⁰¹ In a survey conducted among large institutional investors, 95% responded to focus on ESG topics when making investment decisions and 85% when voting.¹⁰² This shows that institutional shareholders have raised their attention to - and engagement with - ESG aspects. This is becoming more and more relevant for companies in the food system because its challenges have become transparent. Investors are increasingly focused on these risks and have publicly declared their ESG requirement for future investments.

While this change is occurring in the equities market, venture funding is also shifting. For a long time, 'downstream' technology - meal delivery systems, quick commerce and e-grocery - have been in focus. This changed in 2020, which was the first year in which 'upstream' investments related to food production and supply (e.g. precision farming, alternative proteins, food waste management) surpassed 'downstream' investments with a total \$15.8 billion.¹⁰³ Apparently, the momentum continued to grow in 2021, with 'upstream' investments reaching \$18.9 billion.¹⁰⁴ In 2021, the alternative protein sector alone reached a record funding level of \$5 billion.¹⁰⁵

4.4. Framework dynamics

For a long time, the public debate on global warming was focused on the energy and transport sector. In recent years, awareness has grown about the relevance of the food sector. NGOs had been urging this for a long time. The year 2015 marked a turning point with 196 parties adopting the Paris Agreement, a legally binding international treaty on climate change.¹⁰⁶ In the same year, the UN released its SDGs, which have been adopted by all member states. The SDGs have defined a framework to secure peace and prosperity for people and the planet.¹⁰⁷ Many of them have a direct or implicit link to the food system.

Governments around the world have started to respond to a growing pressure from NGOs, media and the public. Several areas have been covered through new regulations or initiatives (e.g. HFSS regulation through product ingredient/formulation tax) to address public health and sustainability.¹⁰⁸

One area to keep in mind is subsidies, which have been traditionally strong for the agricultural sector. The targeted promotion of innovative food tech and agritech approaches can prove to be challenging and require additional efforts.

EXHIBIT 16

Government interventions in the food system



4.5. Uncertainties to consider

Various factors suggest that we might be at the tipping point. However, as with every transition, there remain various uncertainties that need to be considered.

Consumer preferences and buying habits generally change slowly. The recent acceleration in demand for alternative products may also have been extraordinary due to the pandemic.

Some key barriers to consumer adoption will still need to be addressed to unlock the next wave of growth. Some producers struggle to match the taste and texture of the original proteins. Additionally, some alternative protein products do not necessarily meet key health criteria because they can be high in salt, fats and synthetic preservatives and of comparatively lower nutritional value. This tension is becoming even stronger as we see growing consumer demand for natural/clean products. Also, even with perfect taste and format replication, alternative protein products must be cost-competitive to be commercially successful. Price parity is even more important in the current context of inflationary pressures and will be required to achieve mass change.

Another area to watch, of course, is regulation. Governments will have a chance to influence the impact and velocity of change through policies and regulatory initiatives. Shifting resources and changing priorities will obviously create pushback, and how persistent the status quo will be remains to be seen.

Some domains still require 'breakthrough' innovations to turn into alternatives suitable for communities across the world. In many areas, it is not yet clear which technologies will be the right ones to solve some previously mentioned barriers and whether consumers will accept those technologies (e.g. lab-grown meat). It will be necessary to monitor those innovations to calibrate engagement and resource allocation. Timing is of the essence in some of the very progressive areas.

Lastly, it seems advisable to take a holistic view on upcoming change, including the required infrastructure. Scaling some of the promising solutions will require substantial quantities of ingredients and processing capabilities. For example, we see some capacity constraints appearing in the production process of plant-based protein (e.g. availability of raw materials at the right cost, precision fermentation capacity, and economic viability). Market participants are trying to overcome those challenges (e.g. by looking for other protein sources), but there could be at least temporary shortfalls or distortions, which might hinder fast expansion for a short period.



5. Market preconditions

As the transition of the food system starts to unfold, it is essential to assess which preconditions will lead to the most positive impact and change momentum, and in turn affect the structure of the food system and possibly lead to a recalibration. This, of course, has great economic, social and political relevance. In the earlier phase of the transition, advanced markets are likely to lead the way. However, the long-term aim needs to be reaching as much of the global population as possible. Therefore, early adopter markets might play a decisive role to reach economies of scale, and thus serve as catalysts.

5.1. Market attributes

Consumer engagement

Undoubtedly, consumers are the most relevant success factor. Consumers will decide the success and failure of new products through their purchasing behaviour. For alternative food products, that means there needs to be a sufficient awareness and preference for health and sustainability in each market. There also needs to be a solid per capita spending on food that enables early adoption of new food products, which initially might come at a premium price. Having a higher share of millennial and Gen Z consumers might be a helpful factor as well, as they are looking for healthier and more sustainable alternatives and consequently might have a stronger interest in food innovation.

Food culture and heritage

A historically grown and diverse food culture might turn out to be another supporting factor. Consumers who have been exposed to a large variety of choices and to the insights of various diets might be more open to innovation. Therefore, curious consumers will most likely be more inclined to try new products and to make long-term preference switches. They also might be ahead of the adoption curve; succeeding with them could prove the viability of the product. A strong and historically grown food culture will, in all probability, also go hand in hand with trade structures and gastronomy that are open to diversity and innovation.

The number of high-quality restaurants (Michelin star or similar) can be another good indicator of the power of the culinary sector, as can the proportion of independent chefs and the existence of influential associations such as academies. All in all, an advanced hospitality environment should be quite favourable for the successful introduction of new food products.

Culinary sector

Developing and introducing new food products requires substantial expertise to master a wide range of challenges in the process. The presence of strong food incumbents across the value chain will certainly play a significant role because their expertise is incorporated in the larger food ecosystem, with domain experts, service partners and industry professionals. Members of this food community can serve as sounding partners, providing expert feedback on the viability of concepts as well as in various fields, such as farming, processing, marketing and distribution. A strongly established food system can become a positive catalyst for change.

Product innovation and successful scaling are ultimately dependent on talent. Food tech companies will require a wide variety, from R&D through sourcing and supply chain, processing and manufacturing, distribution, marketing, and hospitality. The broader the talent base, the higher the odds of success.

Food value chain expertise

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Academia, research & innovation ecosystem

A significant share of the innovations outlined so far have been built on scientific insights or still depend on pending research results. The presence of leading universities and research institutes could be a great accelerator for the transition. They create the basis for groundbreaking findings and the availability of a sufficient number of experts who can transfer knowledge into commercial applications. Food and agricultural research departments could be a source of underlying technologies that could be commercialised by food tech companies. Thus, they could turn into partners for food tech companies on fundamental R&D work.

However, turning scientific insights into commercial value will require an innovation ecosystem. The presence of an established start-up community paired with an effective and well-capitalised venture funding community seem to be key. Innovation hubs and accelerators, both public and private, can play a vital role in building the bridge between advanced research findings and commercialisation.

Regulatory framework

Food regulation always needs to protect the interests of consumers, especially with regard to health. As such, many regulations have been imposed around food safety over the past decades. Given the high relevance of the food system to address pressing challenges like global warming, healthier diets and self-containment, an adjustment of the regulatory environment seems advisable and is occurring in parts of the world. Authorities can support the transition by laying out a clear policy. This can include incentives for food tech innovation, dedicated departments within the administration to support the transition, investment in research centres, consumer education and nutrition guidelines, and financial incentives for innovators.

Legislators will play a critical role in handling the regulatory approval of new products. This is a highly sensitive issue because it affects the health of the population and thus leaves no room for compromise. On the other hand, every conceivable effort should be considered to accelerate the release process on a scientifically sound basis to take advantage of products that are significantly healthier, relieve the environment and enable a higher degree of self-sufficiency. Social and ecological benefits should be given considerable relevance when assessing regulatory requirements for future products.

Lastly, intellectual property (IP) protection will be critical to ensure effective protection of innovation by food tech companies. Innovations will require considerably advanced research and significant investments. The protection of IP will therefore be of great importance when deciding on the location of future technologies. The question of the incentive system for the launch of start-ups will also play a role, as will the question of the transfer of scientific results from academia to industry.

5.2. Reference markets

A few markets have distinguished themselves recently in successfully promoting food innovation. What they have in common is strength in the above-mentioned attributes and a determination to strengthen their self-containment capabilities and food security. Furthermore, they have solid track records in successfully initiating and scaling innovation across various domains.

5.2.1. Singapore

Singapore is a sovereign island city-state and the second most densely populated country in the world. It has developed into an economic powerhouse and is considered to be one of the most competitive economies.¹⁰⁹ Singapore is ranked second by the World Bank for ease of doing business globally.¹¹⁰

Its 6 million residents live on a territory of only 728 km². Though land reclamation has helped to expand the territory by 25% since 1960, there is still little room left for its own agriculture, which represents less than 1% of the space today. As a result, more than 90% of food consumed in Singapore is imported. To improve food security and strengthen self-containment, the government launched the '30 by 30' programme in 2019, with the aim to increase local food production to 30% by 2030. Singapore has declared food tech as a major priority because conventional agriculture and food processing are hardly applicable in the city-state.

Singapore launched the programme from a position of strength in regard to its economic power and innovation capabilities. It has been ranking as the eighth most innovative nation in 2020/21 and has successfully established several innovation hubs like the JTC LaunchPad¹¹¹ or BIS Innovation Hub¹¹² for financial services. Singapore's favourable environment for innovators and investors helped start-ups raise funding of \$8.2 billion in the first nine months of 2021,¹¹³ which was more than double what they raised in all of 2020. It has also established a secure framework for IP protection¹¹⁴ and is highly regarded for its workforce skills.¹¹⁵

Given its diverse cultural background, Singapore has a multifaceted food culture. A great representation of that are the hawker centres,¹¹⁶ where dishes are served that descended from food cultures of different immigrant groups and have turned into distinctive local dishes. The United Nations Education, Scientific and Cultural Organization (UNESCO) acknowledged the centres' impressive cultural significance by including them on its Intangible Cultural Heritage List.¹¹⁷ Singapore has world-class culinary representation, with 49 Michelin-starred restaurants, making it No. 7 globally in the list of locations per capita.¹¹⁸

All these circumstances make Singapore one of the world's favourite investment hubs. To encourage food innovators to consider Singapore as an attractive location, the government has redefined regulation. The Singapore Food Agency (SFA) recently released an update of its requirements regarding the safety assessment of novel foods.¹¹⁹ It is also considering the growing viability of meat substitutes, such as plant-based meats and cultured meats. The regulation intends to encourage companies to apply for approval. Applications will be free of charge, and the SFA estimates a timeline of 9 to 12 months until approval.¹²⁰ The SFA encourages submissions from companies based outside of Singapore, which can be seen as an invitation to localise in the city-state.

To accelerate food tech development and support regulatory responsiveness, Singapore launched the Future Ready Food Safety Hub, known as FRESH, under the government's food R&D Programme in April 2021.¹²¹ It was launched by three powerful institutions: Nanyang Technological University (NTU), SFA and the Agency for Science, Technology and Research (A*STAR). The main goals are to drive food tech science and innovation and to speed up the commercialisation of novel foods.

As a leading global investment hub, Singapore started shifting significant resources towards food tech. Temasek, a major government-owned investor,¹²² launched the Asia Sustainable Foods Platform in December 2021.¹²³ It should serve as an accelerator to advance food tech development through a wide range of services and access to capabilities and investments.

Another vehicle to foster food tech is Singapore's Food Story R&D Programme,¹²⁴ which is led by SFA and A*STAR. As part of the '30 by 30' programme, \$144 million of research funding has been committed to support food tech innovation. In addition, SEEDS - the investment arm of Enterprise Singapore - includes agritech as part of its scope.¹²⁵

All of this has led to significant food tech momentum in Singapore, with a variety of investments across a wide range of new concepts. The political will, combined with several partnerships between institutions, academia and investors, seems to have laid the groundwork for a vibrant innovation marketplace.

5.2.2. Israel

Israel is a strong economic nation with a very powerful innovation profile. It has been ranked No. 3 in the worldwide start-up ecosystem index,¹²⁶ behind only the US and the UK, and is consequently also referred to as 'Silicon Wadi'. It has the highest R&D expenditure ratio in the world, with 4.94% of gross domestic product,¹²⁷ making it one of the most progressive marketplaces.

It is home to worldwide leading universities, such as The Hebrew University of Jerusalem, Weizmann Institute of Science, Ben-Gurion University of the Negev and Technion – Israel Institute of Technology. Israel has the highest share of scientists¹²⁸ in the developed world and is second only to the US when it comes to finding skilled employees.¹²⁹ In recent years, the focus on food tech-related matters has increased with the launch of the Institute of Biochemistry, Food Science and Nutrition at the Hebrew University and the Carasso FoodTech Innovation Center at Technion. Israel has a strong tradition of converting R&D into commercial applications. Technology transfer offices (TTOs) have been extremely successful in convincing universities that rapid commercialisation of research findings is highly beneficial and not harmful. This is one of the main reasons why the number of successful spin-offs is so high and is reflected in the income that goes to universities. As outlined in a report, the Weizmann Institute received almost \$2.6 billion in royalties between 2011 and 2017.¹³⁰ Incubators, which have been supported by the Israeli government for years, play a crucial role in the successful further development of these innovations. They support start-ups with advice, services, access to contacts, and investments. The importance of incubators is also made clear by the government's most recent tender, which included food tech as a focus.¹³¹



The agricultural sector represents only 1% of the gross domestic product (GDP) due to a lack of arable land.¹³² As a result, Israel is a net food importer, with an import share of 10%¹³³ and a total value of \$7.1 billion.¹³⁴ Israel has a strong and traditional food culture and is internationally renowned for its delicacies, such as hummus, falafel, knafeh, shawarma and shakshuka. Israeli food is iconic and a significant part of the country's culture.

Until recently, no significant governmental support programmes were in place for food tech, nor was a dedicated budget attributed to the development of the sector. No sovereign fund is set up to engage in food tech. Nonetheless, activity in the food space has grown since the mid-2010s. Market experts attribute this to the presence of leading biotech, medtech and agritech companies; the well-developed innovation ecosystem; and the fundamental resilience of the Israeli culture, as well as the natural striving for self-sufficiency.¹³⁵ Many varied innovative companies have emerged over recent years. Start-Up Nation includes over 270 start-ups in the food tech domain¹³⁶ and another 390 in the field of agritech.¹³⁷

In 2015, the world's first food tech platform, The Kitchen FoodTech Hub, was launched in Tel Aviv by The Strauss Group, with the aim of helping start-ups in the space. While initiated by private investors, it won support from the Israeli Innovation Authority Technological Incubators Program.¹³⁸ The Kitchen FoodTech Hub selectively invests in companies and has successfully established itself as a key player in the food tech community, serving as an incubator that provides services, lab and office

space, and contacts to experts and partners. Another example of a privately initiated platform is Margalit Startup City Galil (MSCG),¹³⁹ launched in 2021 as part of a global network of innovations hubs. MSCG is focused on food tech and agritech and has gained support from various stakeholders from the industry, academia and government.

Israel has turned into a vibrant food tech market. According to the GFI, Israel food tech start-ups were able to raise a total of \$623 million in funding in 2021. This is an increase of 450% against the previous year,¹⁴⁰ making the country a sector leader with strong preconditions to continue to thrive in this domain.



6. Food Tech – a significant opportunity for Europe

Europe has various strong preconditions for successful development of innovations in the region's food sector. The main aspects are the size and attractiveness of the European food market, the diversity of food culture in Europe and a very strong hospitality sector, leading food science in Europe, and growing support and engagement from the EU and its member states.

6.1. European food market

The size of the population of the EU 27 reached 447 million inhabitants in January 2021.¹⁴¹ Over the last 60 years, the number of European citizens has been growing steadily. At the same time, GDP per capita progressed significantly,¹⁴² reaching €25,000 per head.¹⁴³ Europe has become one of the most attractive markets for consumer goods. In line with this development, the European food market is one of the largest in the world, with a total €1.2 trillion turnover in 2022.¹⁴⁴

6.2. European food culture and hospitality

One of Europe's strong characteristics is its broad diversity of cultures. The EU's 27 member states have many varied traditions and heritages. This is reflected in Europe's food culture, which differs greatly from country to country. Nutrition goes hand in hand with local cuisine that has developed over centuries; it is part of the local culture that consumers identify with. They will invest in good nutrition because it is part of their quality of life. European consumers are among the highest spenders on food on a per capita basis. In fact, 11 out of 20 of the highest per capita spenders on food for 2019 were within the EU.¹⁴⁵



Europe is also famous for its culinary excellence. Many European dishes are admired throughout the world, and several European cities are regarded as the world's best food destinations.¹⁴⁶ Enjoying great food is among the top reasons why tourists love to travel to Europe.¹⁴⁷ One of the characteristics of the European hospitality sector is the large number of restaurants. The EU had 890,000 restaurants in 2018, with the largest presence in France, Italy, and Germany.¹⁴⁸ Of these, the largest proportion are run by individual operators (small- and medium-sized enterprises, or SMEs) from one or a few locations.¹⁴⁹ This is also one of the reasons for its authenticity and strong identity. Local customers and tourists love the original tastes served by passionate chefs and hosts.

Europe is a global leader in high-end cuisine, with strong rankings in the Michelin Guide. In fact, 9 of the top 15 countries with the highest number of restaurants with a Michelin star are in Europe,¹⁵⁰ which also boasts the highest concentration of Michelin-starred establishments, with 14 out of 16 countries. Europe is a highly attractive place for chefs to work due to its diversity of culinary cultures, iconic tourism destinations, and recognition of good culinary art. In the list of top-paying countries for chefs, 10 out of 15 are in Europe.¹⁵¹

When it comes to consumer preferences, Europe has been moving towards quality, health and sustainability. More and more people are becoming aware of how our consumer and eating habits are affecting the environment, climate and animal welfare.¹⁵² Restaurants will take advantage of this trend and offer diners delicious alternatives. For example, the number of vegan restaurants across Europe has grown significantly.¹⁵³

6.3. European food regulation

Food regulation is well defined in Europe. Regulations have been fundamentally shaped by the precautionary principle, which was embedded in the Maastricht Treaty of 1992 and is part of the EU General Food Law. The precautionary principle applies where 'the possibility of harmful effects on health is identified but scientific uncertainty persists' and in practice means the deployment of more stringent measures until a scientific consensus emerges. Following a series of food crises in the late 1990s, including bovine spongiform encephalopathy (BSE), the EU set in place the General Food Law – Regulation 178/2002.¹⁵⁴ EFSA was founded as part of this legislation in 2002 to provide scientific advice and risk assessment associated with the food chain.¹⁵⁵ EFSA operates independently of the European legislative and executive institutions (Commission, Council, Parliament) and EU member states.

The agency has helped to implement robust food safety standards, which are highly respected and used across Europe and beyond, notably the Middle East and Africa. This has helped the EU build a strong position and reputation in other markets (for example, infant formula in EMEA and China). The EFSA serves as an expert body that must be involved in all food regulatory matters. Its scientific panels and scientific committee respond to requests for scientific advice from the European Commission, the European Parliament and EU Member States after thorough review and consultation with national authorities and food safety agencies. However, the final decisions are made by the European Commission Standing Committee of Plants, Animals, Food and Feed, known as PAFF,¹⁵⁶ by a qualified majority vote.

Four key areas of regulation have implications for food tech: (1) novel foods, (2) genetically modified organism (GMO) laws, (3) health and nutrition claims and (4) food nomenclature. These regulations enable Europe to operate from a position of strength in food innovation from a consumer trust and food safety perspective, but these stringent approval processes might also be seen as a barrier to entry.¹⁵⁷

Unsurprisingly, EU Novel Foods regulations are more stringent compared to other key regions, especially the US. For food innovation, EFSA plays a significant role in all cases related to novel food.¹⁵⁸ Novel foods comprise all food products or ingredients not consumed in the EU before 15 May 1997, except for enzymes. This includes new sources of nutritional ingredients, new extracts from existing food, agricultural products from third countries, and new production processes, such as cell cultivation. The authorisation of a new food product or ingredient requires an application for evaluation by EFSA,¹⁵⁹ which requires comprehensive preparation and an approval time of 1.5 to 3 years, with an average time for alternative proteins from application to approval of 28 months.¹⁶⁰ These robust safety standards ensure new products in Europe are safe but take longer to be approved compared to the US. Under the Generally Recognized as Safe (GRAS) FDA approval process,¹⁶¹ an expert panel convened by the applicant assesses the application, and timelines take 9-12 months. The GRAS approach also provides options to accelerate market introduction of new products, assuming that scientific data regarding the substance is widely known and confirmed. To date, there have been 4 alternative protein products approvals in the EU and 18 in the US.

The EU has traditionally taken a more restrictive stance on GMOs than other regions of the world, and all new GMO products fall into the novel food category. The EU classifies something as GMO when the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination.¹⁶² The regulation covers food, animal feed and crop cultivation¹⁶³ and was expanded in 2018 to include gene editing techniques such as CRISPR-Cas9.¹⁶⁴ However, advanced technologies, such as precision fermentation, that are made from GMOs do not fall under this regulation. The regulation of GMOs in Europe might have led some GMO research projects to migrate abroad due to the limited opportunities for development in Europe,¹⁶⁵ and some US-developed food tech innovations are unable to launch in the European market as they wait for approval. The regulation of GMO has led to some criticism. In an open letter, scientists from 117 research institutes called for modernisation of EU gene editing legislation,¹⁶⁶ and the EU's Group of Chief Scientific Advisors criticised current GMO regulations.¹⁶⁷ The EU responded in 2021 by launching a review of EU rules on GMO, acknowledging that new genomic techniques had the potential to contribute to sustainable food,¹⁶⁸ which may eventually lead to a shift in the regulation in this area.

The EU established specific regulation for nutrition and health claims in 2007,¹⁶⁹ setting a clear framework to ensure that any claim made for a food product is accurate and based on scientific evidence. These claims include all associations of food products highlighting beneficial effects related to health and nutrition on the product label or in advertising. Companies can use approved claims for ingredients included in the official EU register.¹⁷⁰ Applications for new claims require significant time and investment. However, this ensures a level playing field for all market participants taking advantage of a strong seal of quality.

Lastly, labelling is another area of regulation that affects food tech. For example, alternative food products have historically faced pushback from incumbent players when using words that make direct comparisons to traditional products like 'burger' or 'milk', yet this is shifting. In 2017, the European Court of Justice ruled that terms like 'milk' cannot be used for alternative products.¹⁷¹ Nonetheless, in 2020 a proposal initiated by lobbyists to ban the use of terms like 'burger', 'sausage' and 'steak' on labels for plant-based alternative products was rejected by EU parliament after strong opposition from consumers, NGOs and even large FMCGs.¹⁷² Similarly, the EU parliament rejected Amendment 171, which was intended to ban dairy alternative using descriptors like 'creamy'. This vote also came after campaigns by consumers, NGOs and dairy companies.¹⁷³ Large corporations are also increasingly campaigning for a more liberal approach to product labelling, indicating that they, too, are increasingly recognising the onset of change as an opportunity, not a threat. Europe has robust safety standards that helped it achieve a leading position in the global food market. However, as the food transition accelerates and intensifies, it will be important to see how regulation needs to evolve, which regulators are already addressing as exemplified above.

6.4. European food academia

Academia is a helpful force in the development of food innovation. Europe is home to many leading universities that focus on food science. The University of Wageningen in the Netherlands, Ghent University in Belgium and the University of Porto in Portugal are regarded as leading universities in the world.¹⁷⁴ In fact, in 2020, 13 out of the top 30 food science universities were in Europe.¹⁷⁵ The increasing importance of food tech in European university teaching is reflected in dedicated programmes such as the FIPDes, a two-year Food Innovation and Product Design programme across four European universities supported by Erasmus+ of the EU.¹⁷⁶ Besides universities, many highly respected food and agriculture research institutes are in Europe. The Information System for Agriculture and Food Research counts more than 5,000 research institutes.¹⁷⁷ Among them are leading platforms like ETH Zurich of Switzerland and Germany's Fraunhofer-Gesellschaft. It is important to note that many FMCGs operate quite sizeable R&D centres within Europe. They also continuously advance research in the fields of food tech and often serve as a partner for academia.

Furthermore, the EU launched the Food 2030 research and innovation policy,¹⁷⁸ which aims to support the transformation of the food system and is part of Horizon Europe. This programme will significantly increase the prerequisites to further intensify research.

There is clearly no shortage of scientific competence and highly qualified experts in Europe. However, one of the major challenges could be the incorporation of outstanding research findings into business operations. Scientists might find it hard to commercialise their research results; in fact, they might often feel restricted or disincentivised. To protect the IP of the university or institute, there are often strict requirements regarding commercial uses of research results. This is not without reason, as misuse should be prevented. On the other hand, this can lead to an extremely complicated and slow development process, which can become a problem. Compared to the US and Israel, Europe and the UK seem to have a substantial disadvantage,

mostly driven by the demand for high equity shares (as high as 25% to 50%) from institutions.¹⁷⁹ This leaves much less room to attract talent and investors than in comparable situations in the US, where the requested equity share rarely surpasses 10%.

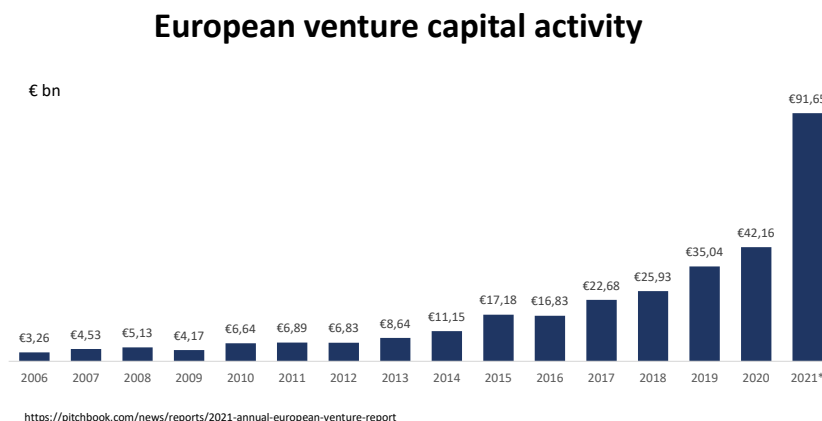
University TTOs can play a vital role in solving this problem. They aim to find mechanisms to commercialise university research and to accelerate and foster value creation for society and the economy, as well as financial gain opportunities for the university. Universities need a clear licence agreement that entitles the commercialisation and in return grants an equity stake of the spin-off for the university. This requires a measured approach to the interests of the university, the supporting institutions and the researchers who want to launch a start-up with the research results. It obviously also requires considerable finesse. Some figures suggest that an attractive incentive scheme for founders could be advantageous. For example, Oxford University, which has on average taken a 24% stake in spin-offs over the past decade or so, managed to initiate 26 companies between 2010 and 2014, while Stanford University, which claims only 10%, achieved almost the same number of spin-offs in 2015. Besides the financial aspect, culture obviously plays a huge role in encouraging spin-off launches and taking the risk of starting a business. Therefore, in exchange, entrepreneurs can benefit from additional help and access to resources and connections. With entrepreneurship potential and numerous inventions lying dormant within universities across Europe, returns might surpass expectations.



6.5. European investment environment

Europe venture capital (VC) activity has grown from €6.9 billion in 2011 to a total deal value of €91.7 billion in 2021, a staggering ramp up of 13 times in just 10 years.¹⁸⁰ In Europe, exits reached a value of €142.5 billion, an increase of more than 600% versus the previous year,¹⁸¹ though they recently cooled in the first half of 2022. These numbers illustrate that momentum in the VC market has increased significantly globally, including in Europe. A number of Europe-based VC funds could successfully establish themselves with appealing portfolios and strong performance metrics. In addition, several US VC funds started their activity in Europe,¹⁸² underlining the growing attractiveness of the European investment environment.

EXHIBIT 17



However, Europe investment is significantly lower than in the US, where VC-backed companies raised \$329.6 billion in 2021.¹⁸³ Even more impressive is the annual exit value created by US VC-backed companies of \$774.1 billion in 2021. Most exits were realised through public listings, either as an initial public offering or a special purpose acquisition company.

One reason for the gap between Europe and the US has been a restrictive fund allocation for institutional investors imposed by the Solvency II EU regulation in 2009 as a response to the financial crisis.¹⁸⁴ An amendment was approved in March 2019 to encourage long-term investments.¹⁸⁵ However, the gap remains significant. As an example, alternative investment portfolios of the 200 largest US retirement funds climbed sharply in 2021.¹⁸⁶ The US also has a large number of start-up founders-turned angel investors, driving VC funding in the US. Obviously, successful exits are a main driver for interest in VC. Benchmark cases illustrate the attractive return profile and generate liquidity. An exit ecosystem that works well is essential. The US market has continuously outperformed the rest of the world in that regard through corporate mergers and acquisitions and, in recent times, mostly through public listings. Furthermore, the secondary market is relevant because it provides a mechanism for early-stage investors or start-up associates to sell their shares. This appeared to be quite complicated, with a lot of work needed to agree and clear a transaction. In recent years, several platforms have emerged that essentially manage the whole process.¹⁸⁷ This provides various advantages as early-stage investors generate their returns, new investors with a longer time horizon join in, and employees can unlock value. Most importantly, it generates liquidity, which will partially flow back into the investment cycle. So far, there is no corresponding platform in Europe.

Tax treatment is another factor in how and where VC money is invested. For example, capital gains in the US from the sale of assets held for more than a year can be as low as 0% or up to 20%, depending on the taxpayer's tax bracket for that year. In 2015, the US Congress granted a tax exemption on capital gains from investments in companies with annual revenues below \$50 million.¹⁸⁸ The limit of the exemption applies on the greater of \$10 million or 10 times the initial investment. This has been a significant incentive for business angels and seed funds to support start-ups throughout all sectors. By contrast, in Europe, tax rates vary among member states between 15% (Hungary) and 42% (Denmark).¹⁸⁹ The EU responded to this challenge by initiating a consideration of tax incentives, which led to 11 EU states implementing tax incentive schemes for VC and business angel investment.¹⁹⁰

In general, the EU has increased its support for the investment sector in recent years. Several programmes were started to improve the investment environment in the EU.¹⁹¹ The European Investment Bank, and especially its European Investment Fund division, play a vital role in advancing the investment ecosystem. Several programmes have been put in place to support

innovation and entrepreneurship especially for SMEs,¹⁹² both through direct investment and through investment in VC funds. This will be an important building block towards a powerful investment sector.

Though the food tech sector has been growing rapidly to a total global deal value of \$19 billion, it can still be considered a nascent investment domain. While most investment interest regarding food was on the downstream side (that is, meal delivery, e-grocery, quick commerce), there has been a recent change towards upstream innovation. European agritech and food tech investments came close to €2 billion in 2021.¹⁹³ The innovation pipeline is, of course, a precondition for future investments. In recent years, several food tech incubators and accelerators have been launched across Europe.¹⁹⁴ These platforms can play a vital role in fostering innovations and turning them into real business. There are a variety of accelerators in Europe, with different scope and different partners from industry, research or the VC community. The rise of food tech programmes is a strong signal regarding the innovation momentum in the sector and the attractiveness of future deal flow.

6.6. European framework

The EU has been increasing its focus on sustainability in recent years. The European Green Deal has been a milestone in that trajectory. It was announced in December 2019,¹⁹⁵ and the detailed plan was published by the European Commission in July 2021.¹⁹⁶ The Green Deal aims to overcome climate change and environmental degradation. Several ambitious targets have been set, including EU climate neutrality in 2050, and several are linked towards the food system, such as:

- ▣ reduction of fertiliser utilisation by at least 20%
- ▣ reduction of chemical/more hazardous pesticides utilisation by 50%
- ▣ increase of farmland under organic development to a share of 25%
- ▣ reduction of sales of antimicrobials by 50%

All these targets should be achieved by 2030. A significant element of the programme is the Farm to Fork Strategy for a fair, healthy and environmentally friendly food system. Through its various pillars, it aims to enhance the prerequisites for successful innovations in the food sector and to accelerate the transition to a sustainable food system that should:

- ▣ have a neutral or positive environmental impact
- ▣ help to mitigate climate change and adapt to its impacts
- ▣ reverse the loss of biodiversity
- ▣ ensure food security, nutrition and public health, making sure that everyone has access to sufficient, safe, nutritious, sustainable food
- ▣ preserve affordability of food while generating fairer economic returns,
- ▣ fostering competitiveness of the EU supply sector and promoting fair trade¹⁹⁷

EXHIBIT 18

European Green Deal – Farm to Fork



Other food-related parts of the programme are the Biodiversity Strategy for 2030,¹⁹⁸ which includes the new EU Forest Strategy to improve the quantity and quality of EU forests; a 10% target for high-diversity landscape features until 2030; and the Fit for 55 Package,¹⁹⁹ which aims to reduce CO₂ emission by 310 Mt of CO₂ by 2030 in land use, forestry, and agriculture and to incentivise regenerative agriculture.

The will and the commitment of the EU to engage towards a more sustainable and healthier food system is visible across various policy domains. This is reflected in Horizon Europe,²⁰⁰ the EU's research and innovation programme. Horizon Europe has defined clear missions, of which four out of five directly support the European Green Deal. Horizon Europe is also responsible for managing the food tech R&D activities, with a focus on fields, farming systems transition and sustainable foods systems, with a total amount of €9 billion.²⁰¹ However, this represents about 2% of the total EU budget 2021–2027 of €386 billion for food and agriculture (natural resources and environment).²⁰²

The new Common Agricultural Policy (CAP) received approval in June 2021, after three years of negotiation, with the aim of shifting support spending towards the food transition. CAP represents a third of the EU's total budget.²⁰³ Nevertheless, there has been criticism that the policy would fail to fight climate change because most measures are weak or voluntary. In fact, approximately 80% of subsidised land belongs to 20% of the beneficiaries, strongly supporting large landowners and agro-industrial firms.²⁰⁴ The agreement includes a requirement to distribute at least 10% of CAP funds to smaller farms and 3% to young farmers. As a general precondition, farmers will need to comply with environmental rules, like setting aside 3% of arable land. Critics observed that CAP failed to address climate change and the urgent need to transform the food system.²⁰⁵ The example shows how the debate about the transition of the food sector is intensifying in politics, but it also shows how difficult it might be to shift resources.

As part of Horizon Europe, the EU established a platform in 2008 that should drive innovation across the union: the European Institute of Innovation and Technology (EIT), which collaborates with organisations from education, research and business. It has developed a wide range of services for innovation, education and entrepreneurship and also runs dedicated projects.²⁰⁶ One of its eight innovation communities is focused on food. EIT Food is fully focused on supporting the transition of the food system.²⁰⁷ With a budget of €600 million, EIT Food can be regarded as the leading food innovation initiative in Europe. It focuses on six domains:

- ➡ protein diversification
- ➡ circular food systems
- ➡ digital traceability
- ➡ sustainable agriculture
- ➡ sustainable aquaculture
- ➡ targeted nutrition

With its focus on education, EIT Food aims to strengthen the food skills of students, consumers, professionals and organisations. Enhancing the talent base is certainly an important pillar of the food transition. Furthermore, the EIT wants to foster entrepreneurship through accelerator programmes tailored for different stages of start-ups (launch, accelerate, scale). EIT Food also acts as an investor, providing direct funding of up to €300,000 to selected companies. In March 2021, it launched an early-stage investment vehicle, FoodSparks®,²⁰⁸ managed by a VC partner.

There is encouraging activity on the member state level. Denmark approved €168 million funding for a five-year programme to support farmers and innovators to grow plant-based protein crops and to develop 'green proteins' for human consumption and animal feed.²⁰⁹ The Netherlands also awarded €60 million to support the development of a domestic cellular agriculture ecosystem.²¹⁰

The EU has set a clear vision and target through its Green Deal. It has also put in place a wide range of entities and initiatives to work on the transition of the food system. Lastly, it has allocated significant financial resources. An aspect to watch will be the conversion velocity and intensity, especially in comparison with other parts of the world.



7. Grabbing the chance

The facts seem to speak clearly: the transformation has begun, and it will not be reversed. The indicators of changing consumer behaviour, urgency to mitigate the ecological footprint of the industry and imperative to develop new food sources are now undeniable. The good news is that scientific and industrial advances have laid the foundations for successful transformation. Though the path will be difficult and seemingly expensive, it will be much cheaper than facing the consequences of continuing the status quo. This was underpinned by the work of The Economics of Ecosystems and Biodiversity (TEEB) initiative launched by the UN Environment organisation. In 2018, TEEB introduced the concept of 'eco-agri-food systems', which takes a holistic view on cost, including human health and environment.²¹¹ It should help policymakers take into account the 'full cost' of the current food system. The Rockefeller Foundation came to the conclusion that the true cost of food in the US (including impact on human health, the environment, and social and economic inequity) was \$3.2 trillion, which was three times as high as US consumers' annual spend on food.²¹² This suggests a substantially positive business case for the transition of the food system because it will create huge value for society, the economy and the environment.

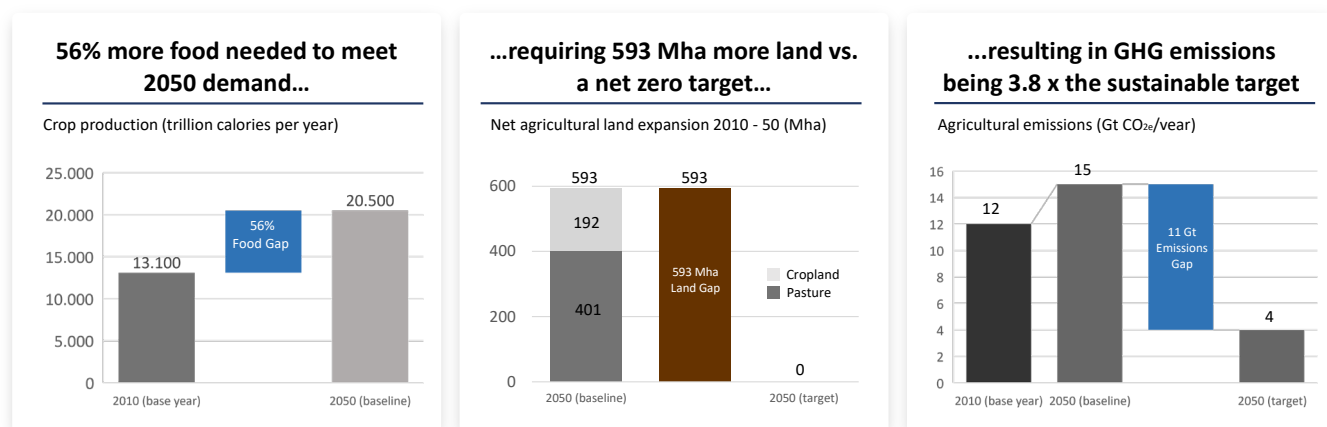
However, this transition will require decisive action from all parts of the food system.

7.1. The opportunities are numerous

The need for change in the food system is as clear as can be. If the ecological impact and health aspect were not enough, the unassailable fact that food supply needs to be secured for coming generations would make the case alone. Growing demand for food would require a massive land expansion for agriculture, especially feedstock, and would therefore cause GHG emissions that would be substantially above the target set for holding global warming below a 2°C change (to limit change to 1.5°C, reforestation would also be needed).²¹³

EXHIBIT 19

Implicit agricultural land expansion / GHG emissions growth



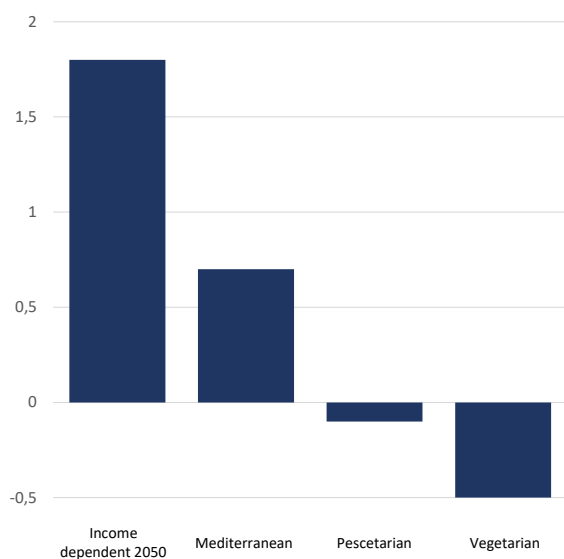
How can this be avoided? What steps must be taken? The answers lie in how today's food system has caused today's ecological pollution. It must be possible to ensure a healthy, tasty, safe and affordable food supply for people with significantly less land use and fewer GHG emissions. But how is that supposed to work? Part of the answer to this very complex question lies in consumers' diets.

An analysis from 2014 shows that switching to a plant-based diet would significantly reduce land use and GHG emissions.²¹⁴ The study took the global average diet as a baseline and developed a projection under the assumption that recent trends would simply continue, depending on income levels. Consequently, by 2050 GHG emissions could increase by up to 1.8 Gt, and land use would need to expand by roughly 600 million hectares. The study suggests that switching to alternative diets would significantly reduce these effects. The projection also illustrated that a transition to a vegetarian diet would actually reduce GHG emissions and could reduce land use.

EXHIBIT 20

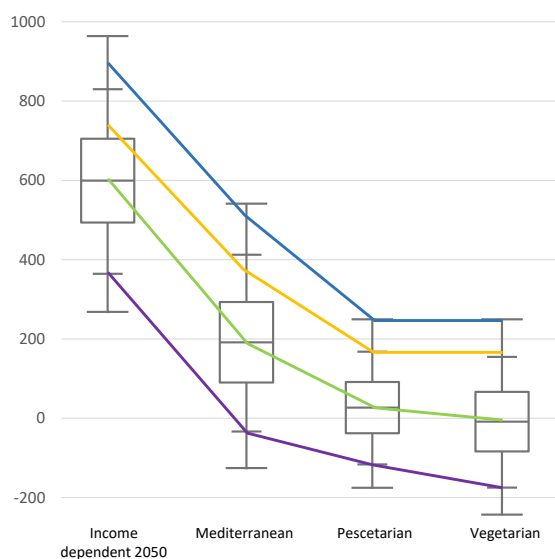
2050 Production emissions relative to 2009

Global GHG emissions (Gt CO₂-Eq per year)



2050 Land use relative to 2009

Change in cropland (million ha)



Does that mean that all consumers have to become vegetarian? Definitely not. What becomes clear through the study, though, is that reducing dependency on livestock will play a major role. In contrast to 2014, many promising alternatives have emerged that would allow consumers to switch diets without too many compromises.

But how to get there? If the target image of the food system is taken as the starting point for consideration, then it becomes much clearer how far-reaching the change could be. In a world in which the food industry has largely switched to new processes to ensure security of supply, enable access to healthy and high-quality food for the entire population and at the same time significantly reduce the burden on the environment, essential components of the value chain must have changed. What sounds like utopia today can - or indeed must - become reality in the coming years if a good future is to be ensured for coming generations. Is achieving such a target state conceivable? Many encouraging advances in recent years provide strong hope that this is not only conceivable but also realisable.

There is no shortage of suggestions and ideas regarding the necessary measures to achieve such a target state. In 2018, the WRI published a comprehensive catalogue of measures that described how to sustainably feed 10 billion people by 2050.²¹⁵

This change requires investment and certainly government support and funding to facilitate the transition. To achieve this goal, further significant advances in research are required. These must be purposefully promoted both in the research institutes and in companies' development departments. The transition to commercial use must also be accompanied by great attention to developing the advantages in a timely manner. Investments must be increased significantly to finance the upfront costs of these innovations. Though none of this will work if the status quo is maintained, abruptly and disruptively reallocating government

funding will not work either. A skillful balance must be found to strongly promote the urgently needed innovations on the one hand and to take the many contributors of the value chain along on the other. Admittedly not an easy task, but one without alternative if one wants to address the current and emerging urgent problems of the system.

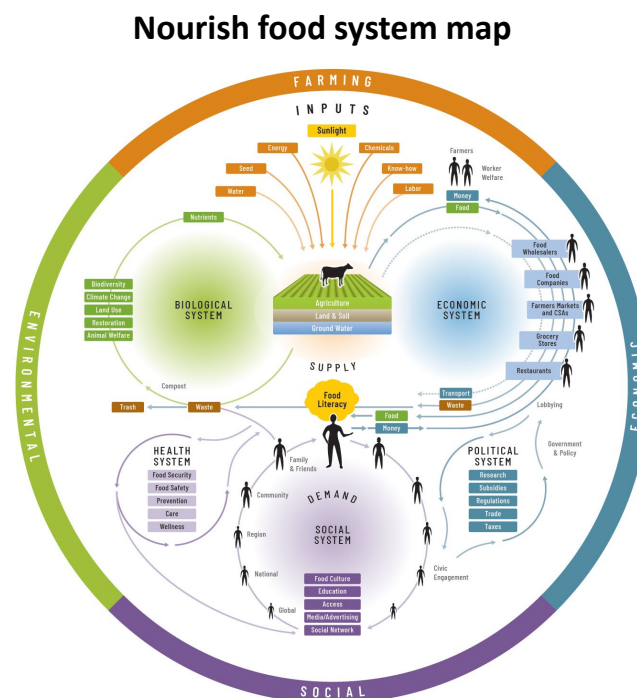
The transition is unavoidable and a constantly increasing dynamic of change will set in. Like every other economic turning point before it, this change will open an enormous variety of opportunities.

The transformation of the food industry will affect almost all areas of the economy and society. It starts with R&D, goes through agriculture and the agricultural industry to processing companies and food producers and finally to distribution, trade and gastronomy. The interdependencies with other sectors such as logistics, the energy sector and the chemical industry are substantial. In all areas, a variety of sometimes far-reaching changes will be necessary. This intensity of change - this turning point - opens the door for innovation and redesign. It offers those who invest early the prospect of achieving attractive returns. Of course, it will be important to find the right timing and to carefully assess the framework condition while keeping one thing in mind above all: in the end, it is customers who decide about success or failure in the food industry with their purchasing decisions.

7.2. A collective effort will be necessary

The food system is highly complex. It involves an enormous number of stakeholders. Nourish, a non-profit educational initiative, has developed a comprehensive illustration of that.²¹⁶ The chart displays the many interconnections and interdependencies of the food system, making it apparent that change can only occur through a collective effort involving as many stakeholders as possible.

EXHIBIT 21



Source: Nourish - <https://www.nourishlife.org/teach/food-system-tools/>

As always, competition stimulates business. Of course, this also applies to the transition of the food system. Nevertheless, entering the right partnerships at an early stage could be extremely important for the successful introduction of innovation, whether it concerns R&D, which must ensure continuous access to new knowledge, or ensuring access to the right quantity and quality of raw materials and production infrastructure. The same applies accordingly to logistics and distribution. The links are manifold and require systematic management. Legislators are able to develop a supportive framework that promotes the interaction of the different stakeholders in a decisive, deliberate manner. It will be important to develop partnerships and build a community that can work together on effective implementation.

7.3. Watch out – there will be challenges, of course

Innovations are fascinating. The search for the next best variant, the disruptive new solution and the development of completely new possibilities has always inspired researchers, entrepreneurs, consumers and, of course, the capital market. This also applies to food tech and is reflected in recent product innovation successes that are known worldwide, the enormously increased presence in the media and the interest from capital markets. All of this is promising, but it is important to remain vigilant and attentive during this transition, despite all the enthusiasm around the potential.

An example of what can happen when enthusiasm gets too high could be observed during the dot-com development of the late 1990s. At that time, the euphoria about the internet knew no bounds. This led to a breathtaking speed of innovation and a rally in the capital markets. To a certain extent, the industry and the stock exchanges got ahead of themselves. The consequence was the bursting of the dot-com bubble in March 2000. Today, no one will question the tremendous impact and benefits of the internet, and yet this setback happened. What were the reasons? At the end of the 1990s, the technologies were not yet ready to implement the visions, some of which were groundbreaking. In particular, the network infrastructures of the time were unsuitable, but other important infrastructures, such as payment mechanisms, were also missing. In short, one can say that the amount of time required to set up the ecosystem was underestimated. Building the infrastructure, enabling technologies and services taken for granted today took years and significant investment. Without a doubt, however, this transformation has paid off massively. In the same breath, one must also state that the potential for value creation turned out to be vastly higher than anticipated at the time. This is clearly reflected in today's valuation of tech firms.

What does this mean for food tech? An analogy can be made because changing the ecosystem will be a complex undertaking that must involve many parties. Therefore, one should also recognise that, for groundbreaking success, many framework conditions and an adequate infrastructure must be created. With this in mind, it should be possible to weigh which areas of the food system are most likely to change more quickly. There will be short-term setbacks, yet at the same time, real potential for long-term transformation of the food system. Like the assessment of the dot-com sector in 2000, it is possible that the value creation potential ahead of us is once again underestimated.

As illustrated earlier, consumer preferences have changed considerably over recent years. However, it should not be ignored that consumption habits typically do not change that fast. Many product introductions have failed, not because they would not make logical sense, but because of slow and/or weak customer response. This might also be the case for some food tech innovations if they reach out too far from existing habits; that's why taste parity is so important. It is also why the origin of ingredients (that is, the kind of species or plants they originate from) plays a significant role.

Regulation can also slow the pace of the food system transition. In parts of the global food system, new introductions might turn out to be complicated or even impossible. Assessing the regulatory preconditions is therefore extremely important. On the other hand, bearing in mind the significance of a more sustainable and healthy food system, regulators can have a huge impact. Setting up a framework that attracts and incentivises innovation and supports multilateral collaboration can be a huge catalyst for the upcoming change.

Other areas to watch are accessibility of ingredients and the processing and manufacturing infrastructure. Recent supply chain disruptions have certainly sharpened awareness of the extreme importance of being in full control of the upstream part of the value chain. However, that might come at a cost, which might disrupt economic assumptions.



8. The way ahead

It is impossible to predict exactly how the food tech sector will continue to develop; there are still too many variables for that. However, there are signs that the tipping point may have been reached and that the momentum will continue to intensify in the coming years. By definition, this means that sizeable chances will arise as an \$8 trillion industry is transformed. What does that mean for an organisation and for individuals? Here are a few suggestions:

Share the message – the more people become aware of the need for change and the immense opportunities that such change can offer, the higher the odds of success. The transition of the food system will need as many ambassadors and supporters as possible.

Stay curious – as this report is released, the world will already have moved on. In times as dynamic as these, some groundbreaking additional change may already have occurred. Therefore, staying tuned in and up to date will be essential. Plenty of food tech platforms, blogs and podcasts are sharing the latest news from start-ups and researchers, as well as food and beverage companies and investors.

Capture opportunities – as new opportunities emerge, it will be important to choose the right moment to take advantage of them. Just waiting may not pay off with this transition and may prove to be disadvantageous in retrospect.

Keep challenging – as with every transition, not every promise will be kept, and not every concept will work. So, keeping a healthy scepticism and challenging hypotheses and projections is advisable. The sector will benefit as, in the end, a fact-based, controversial debate usually leads to better solutions.

Repeat – as the transition progresses, successes will be celebrated, but mistakes will also be made. Sharing those with peers will accelerate the learning curve and increase the positive impact.

Turning promise into opportunity is not only possible, it appears to be without alternative. The chances for a positive transformation of the food system seem higher than ever. Now is the time to resolutely grab these opportunities for the benefit of people, the environment and the economy.

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