Cognitive Finance
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Future Trend "Alternative Food"

Disruption and Transformation of Global "Food Systems"

"Land sequesters almost a third of all human-caused carbon dioxide emissions, it will be impossible to limit temperature rise to safe levels without fundamentally altering the way the world produces food and manages land."

Stephen Brenninckmeijer, President of the European Climate Foundation

htw

Hochschule für Technik
und Wirtschaft Berlin

University of Applied Sciences

Future Trend “Alternative Food”

Disruption and Transformation of Global “Food Systems”

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Preface

Dear Readers,

the world in the 21st century is characterized by serious environmental problems. Global warming and climate change are only "the tip of the iceberg". Equally important is the question of the future quality and quantity of global nutrition. The current resource consumption of the world's population (8 billion) is growing hourly, leading to drastic side and progressive feedback effects.

Rising meat consumption causes global deforestation, massive land use and a rapidly increasing water demand for agriculture and livestock. Simultaneously, the emissions of climate-damaging greenhouse gases are increasing while the planet's CO_2 absorption capacity is decreasing. The oceans suffer from huge overfishing and hostile warming. Massive species extinction and a rapid decline in biodiversity are clear signals of an existential threat.

The ongoing destruction of natural resources leads to a dead end. New strategies for a sustainable and more efficient solution of the global food problem are necessary in order to forge a radical change in perspective.

The keyword "alternative food" and – somewhat more broadly defined – "alternative food systems" encompasses numerous initiatives, research projects and practical solutions worldwide that could help to remedy this situation. Massive rejection of animal protein and new ways of sustainable agriculture are at the forefront of these efforts.

Keywords such as "smart farming", "vertical farming" as well as "plant-based proteins" and "cultured meat" describe concepts of a radically changed food production. Completely new methods – all using state-of-the-art technologies – will dramatically change the traditional image of "agriculture and livestock farming" and trigger strong "megatrends".

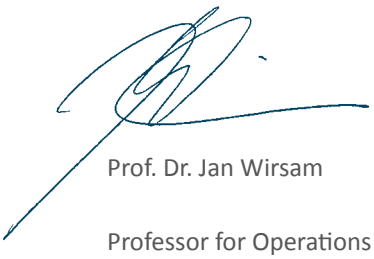
The worldwide "food sector", including downstream areas such as trade and logistics, is facing massive structural change with partly revolutionary upheavals, intensified by changing consumer habits and increasing governmental regulations. These changes will produce losers, but also a multitude of winners unknown today. Strategic investors should therefore focus on the topic "alternative food systems".

The following explanations should help to understand the central ideas, drivers and mechanisms behind the rise of "alternative food".

We wish you an exciting read!

Dr. Heinz-Werner Rapp

Founder & Head of Steering Board
FERI Cognitive Finance Institute



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Preface by the World Economic Forum

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"Recognition is growing that significant and immediate action is required to transform the way in which food is produced, accessed, distributed, valued and consumed if we are to achieve the 2030 United Nations (UN) Sustainable Development Goals (SDG).

A critical aspect of this transformation towards delivering food systems that are sustainable, nutritious, inclusive and efficient is a growing awareness of the need to drive the requisite change by realigning current incentive practices in order to:

- support the repurposing of both public and institutional investment strategies;
- encourage the growing and producing of food to be more sustainable; scale relevant new business models;
- and promote consumer behaviour change.

With 2030 rapidly approaching, as investors and corporations increasingly recognise future success will depend on demonstrating their commitment to helping solve society's challenges, now is the moment for institutional investors, in particular, to set higher standards with respect to how companies target environmental and social outcomes alongside financial returns as a necessary enabler towards achieving this much needed food systems transformation."

"The provision of protein is critical to human nutritional needs, meeting the Sustainable Development Goals (SDG) and achieving the Paris Agreement.

The protein ecosystem is complex and calls for different approaches in different regional contexts, even more so as implications from CoViD19 are impacting food access and food supplies around the world. Alternative proteins – from the novel to the traditional – offer tremendous potential as one of a number of necessary advancements to alleviate the burden that a growing population will pose to the environment and human health as the demand for animal-based protein is set to double.

To move at the speed and scale required to feed the world's protein needs within the environmental, societal and nutritional constraints faced will require unprecedented concerted action from a diverse set of cross-sector stakeholders to evolve production, value chains, market systems, technology and consumer demand at various levels.

A significant influx of capital to the alternative protein market is necessary to allow for a more diversified protein ecosystem to reach consumers all over the world."

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1 Executive Summary

- The traditional concept of global nutrition is facing a phase of **drastic disruption and transformation**. Important – but not exclusive – drivers behind this development are global **population growth**, increasing resource consumption and **climate change**, which can no longer be ignored.

- The spectrum of changes covers the **entire spectrum of "food systems"**, i.e. all levels of agricultural and industrial production, marketing and distribution of food, including political frameworks and significant preferences of private households and consumers.

- By the year 2050, the world population will have increased to around nine billion people. Feeding humanity – not only sufficiently, but also sustainably – is becoming a **central challenge** of the global "food systems".

- **The noticeable shortage of natural resources is exacerbating the problem** as a result of increased global warming. The progressive consumption of nature, the degeneration of important habitats and urgently needed measures for climate protection are mutating into **a social and economic stress test for the coming years**.

- Active **environmental and climate protection** as well as social responsibility for natural resources will therefore be given significantly higher priority in the coming years.

- Especially the **economic relevance** of seemingly "soft" factors will become the **decisive driver** for changes and emerging trends in the future.

- The challenges of global nutrition require an **increasingly efficient and sustainable agriculture**. Agriculture must be equally innovative and resource-conserving, and for this purpose consistently apply **new technological solutions**.

- The large number of possible input and influencing factors results in a high **systemic potential for change in global food and agricultural systems** ("disruption of food systems"). The disruptive potential of these changes will be massive and result in a multitude of consequences that are still underestimated today.

- The change in "Food Systems" is driven by strong impulses from the **environment, economy, society, and politics**. This results in **dynamic feedback effects** that cause further – often abrupt – changes.

The term **"Food Systems"** covers all processes and infrastructures involved in nutrition: cultivation, harvesting, processing, packaging, transport, marketing, consumption, and disposal of food and food-related goods. Food systems are also strongly influenced by a social, political, economic, and ecological context.

- Ultimately this is the scenario of an accelerated disruption, as well as an ongoing **transformation and transition of global "food systems"** towards a very dynamic picture of the future **("alternative food systems")**.

- The driving factor of a rapid transformation is the **superior efficiency profile of alternative food production:** Compared to today's food production, **enormous resource savings, high economies of scale and consequently massive cost reductions** are possible in many cases. In addition, there are possible quality improvements, positive health effects and the advantage of "genuinely" sustainable production.

- Key factors in this transition are mainly **politicians** and **investors**, but also **consumers** and the **food industry**. While **politics** directly shapes the framework conditions and production methods of the "food industry" through subsidy measures and regulation, investors have a decisive influence on the possible return opportunities and value creation potential of "alternative food systems".

- Politics and supranational regulatory bodies are increasingly influencing the **investment restrictions and preferences** of many investors; global capital flows and individual capital allocation are therefore actively channeled into "food systems".

- A current example is the **"Farm-to-Fork" initiative of the EU**, which supports a more sustainable and ecological agriculture and is expected to accelerate the transformation process of food systems in Europe.

- In general, the capital markets are playing an increasingly central role in the transformation process of food systems: Many investors are induced by **national and international regulatory initiatives** to integrate sustainability criteria and concepts based on them stronger into their investment policy.

- Meanwhile, however, "alternative food systems" also open up **interesting strategic investment opportunities**: Disruptive processes always create a dynamic environment and promote innovative and agile market participants; in addition, success and growth in this area are supported by a **targeted orientation of global capital flows**.

Deepening

The present study identifies numerous fields of action and key parameters of **technological innovations, changes in social values, and economic megatrends** that will contribute to the emergence of "alternative food systems" in the medium term.

Novel – often disruptive – lines of development can be found along the entire value chain:

- **High-tech innovations:** The use of robotics, digitization, artificial intelligence (AI) and automation allows a significant **increase in economic efficiency** and drives the change towards alternative food production.

- The modernization of agriculture using digital technologies has produced new concepts such as **"smart farming", "precision farming" and "digital farming"**. One trend-setting development is so-called **"indoor vertical farming"**, which enables highly efficient plant production "on site".

- Although a further **increase in global meat production** to around 455 million tons in 2050 is widely expected (an increase of 36 % relative to 2019!), a **change in nutritional behavior** is already evident in developed countries, which combines the focus topics of sustainability, health and profitability [1].

- Along with changes in the value chain and **changing nutritional behavior, meat substitutes** and other plant-based protein foods are becoming more attractive. This development is already spreading rapidly as **"alternative meat"**, in many cases intensified by the Covid-19 crisis.

- In general, a rapid change towards "alternative food" is taking place worldwide that specifically includes the **development of alternative protein sources**. The focus here is on plant-based proteins (peas, soy, rapeseed and hemp) as well as protein from algae and insects.

- In addition, "cultured proteins", especially **meat cultivated** from living cells in the laboratory **("cultured meat")**, will gain in importance in the future. So-called "hybrid meat", which contains plant and animal components, will also be considered as a long-term protein alternative.

- The transition from animal to vegetable protein sources basically offers enormous **efficiency and scale advantages:** For example, "alternative meat" made from vegetable protein can save around **99 % of the water and 46 % of the energy** consumption compared to meat – depending on the product – while simultaneously **93 % less land** is required and **CO_2 emissions are reduced by up to 90 %** (data for 113 g "alternative" burger patty) [2].

- Simulated calculations show that a **complete change of diet to plant-based products** in Germany could theoretically save over 54 million tons of CO_{2eq} emissions (**reduction of 40 %** compared to the initial situation).

- Serious impulses in this direction are prospectively expected to come from politics, such as via stricter regulation, higher tax rates for meat products or the pricing of CO_{2eq} emissions.

- The central advantage of alternative meat products is their strikingly high **economic and ecological efficiency**. This is

accompanied by strong environmental relief effects and massive cost reductions. The future of "alternative meat" will therefore not only depend on consumer preferences, ethics or environmental aspects; the central driver is rather their massive economic superiority.

- The growth potential for **"alternative meat"** on the US market and in Europe is accordingly high. Current industry studies expect "alternative meat" to achieve a **turnover of USD 140 billion by 2029**, which would then correspond to a share of over 10 % of the global meat market [3].

- By 2040, the share of the conventional meat industry in the total market could **drop to only 40 %** [4]; plant-based "alternative meat" variants, on the other hand, would replace 25 % and "cultured meat" another 35 % of the previous meat consumption. The strongest growth is expected in the new cultured meat sector.

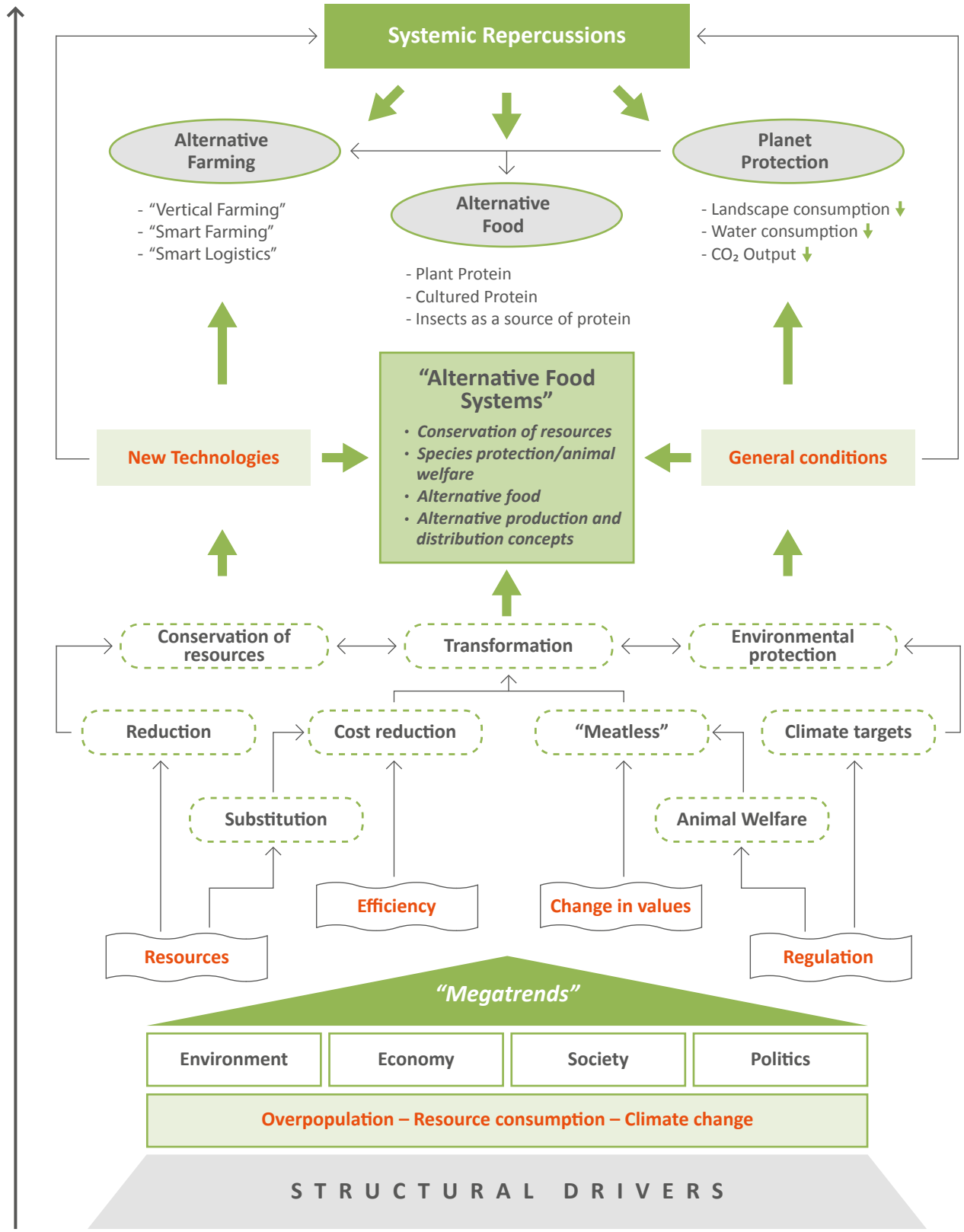
Concluding remarks:

The primary goal of this study is to show the **overall context, interdependencies and possible changes of current and new food systems**. Special attention is paid to possible **"tipping points"** – those being developments that make systemic changes **irreversible** and subsequently initiate mostly **exponential trends**. Especially from the perspective of strategic investors, such "tipping points" are of crucial importance.

Individual statements of the study on transformational processes of food systems are based on **extensive interviews** with top-class entrepreneurs, investors and decision-makers. Central contents of these interviews are reproduced in the study.

> *One thing is certain for us: The transformation of food value creation will have a major impact on the investment preferences of investors.*
>
> Hans-Jürgen Dannheisig, Chairman of the Executive Board at Nixdorf Kapital AG,
>
> Volker Weber, Member of the Executive Board and Chief Sustainability Officer at Nixdorf Kapital AG

COGNITIVE CONCLUSION



Source: FERI Cognitive Finance Institute, 2020

2 Food Systems in Flux and Their Effects on Sustainability and Health

> *Politicians have recognized that food has major influence on public health. However, the misallocation of resources by subsidizing agriculture needs to be rectified. Incentives must be created to change conventional agriculture toward alternative and sustainable methods.*
>
> Volker Weber, Member of the Executive Board and Chief Sustainability Officer at Nixdorf Kapital AG

The global agricultural sector has changed fundamentally in recent years. The quest for efficiency gains, supported by the industrialization of agriculture, is shaping the global picture of food and agricultural systems (collectively: "food systems"). During the last decades, agricultural production and crop yields, as well as the use of antibiotics and the worldwide consumption of fertilizers and pesticides have increased successively. **These developments challenge food security, human health and the overall sustainability of food and agricultural systems**.

Today, food systems that focus purely on economic efficiency are much more fragile and resource-intensive than in the past and only partially meet the global nutritional needs. Hence, on one hand, about 1 billion people worldwide are currently suffering from hunger, while on the other, 2 billion people [5] are fighting obesity due to unhealthy lifestyles and lack of exercise [6; 7].

This seems contradictory at first, but it reveals the global differences and the **massive weakness of current food systems [8]**. People living in poverty either have limited access to food supplies and suffer from hunger, or they consume food that can lead to health problems due to excessive use of sugar, salt or saturated fat.

The UN Resolution 69/315 from the year 2015 has a catalog of 17 sustainability goals in its agenda 2030 (**Sustainable Development Goals** (SDG)), in which the **urgency of sustainable nutrition** in the development sector is explicitly addressed. In particular, SDG 2 ("Eradicate hunger, ensure food security, improve nutrition, and promote sustainable agriculture"), and SDG 3 ("health and well-being") address nutrition-related fields of action and call for concrete solutions [9].

Sustainable Development Goals (SDG): The 17 goals for sustainable development are political objectives of the United Nations, which are intended to ensure sustainable development worldwide on an economic, social, and ecological level.

Currently, the global **corona pandemic** is illustrating – on several levels – the close connection between health and nutrition:

- Pandemics often arise from the transmission of viruses through animals to humans as a part of an unorthodox food supply, for example, due to the consumption of wild animals.
- The course of viral infections is aggravated by a weakened immune system and the corresponding strain on the individual, often caused by years of malnutrition (e.g., obesity, diabetes).
- Consequently, not only the probability but also the extent of pandemics is significantly influenced by malnutrition, diet-related diseases, a weak immune system and inadequate prevention.

A holistic analysis of food systems therefore does not stop at the agricultural and food industry, but goes much further by including burdens on nature, health aspects, and follow-up costs on a global and individual level.

The crucial questions are:

- **Which factors have the greatest influence and who can change and control this system in the long term?**
- **Which actors of the policy, industry, trade, and financial systems have control over the central parameters in food supply?**

The food industry is responsible for approximately **26 % of global greenhouse gas (GHG) emissions** per year [10], of which about 70 % are caused by livestock production [11]. Agriculture, and to a large extent livestock farming, produces many climate-damaging emissions with methane and nitrous oxide.

In order to reduce these emissions, **alternatives to current dietary habits** are needed.

These can be implemented, for example, through a meat-reduced and predominantly plant-based diet [12], especially through substitution with plant-based protein sources [13]. Other important alternative protein sources besides plants are algae and insects. Cultured meat from the laboratory as well as hybrid meat containing plant and animal components are also among the alternative protein sources. In the meantime, research and development has advanced the sensory and taste properties of meat alternatives to such an extent, that they are comparable to conventional meat, but with significantly less environmental impact.

These new foods can be subsumed under the heading "alternative food", which ideally represent healthier and more sustainable alternatives to conventional foods.

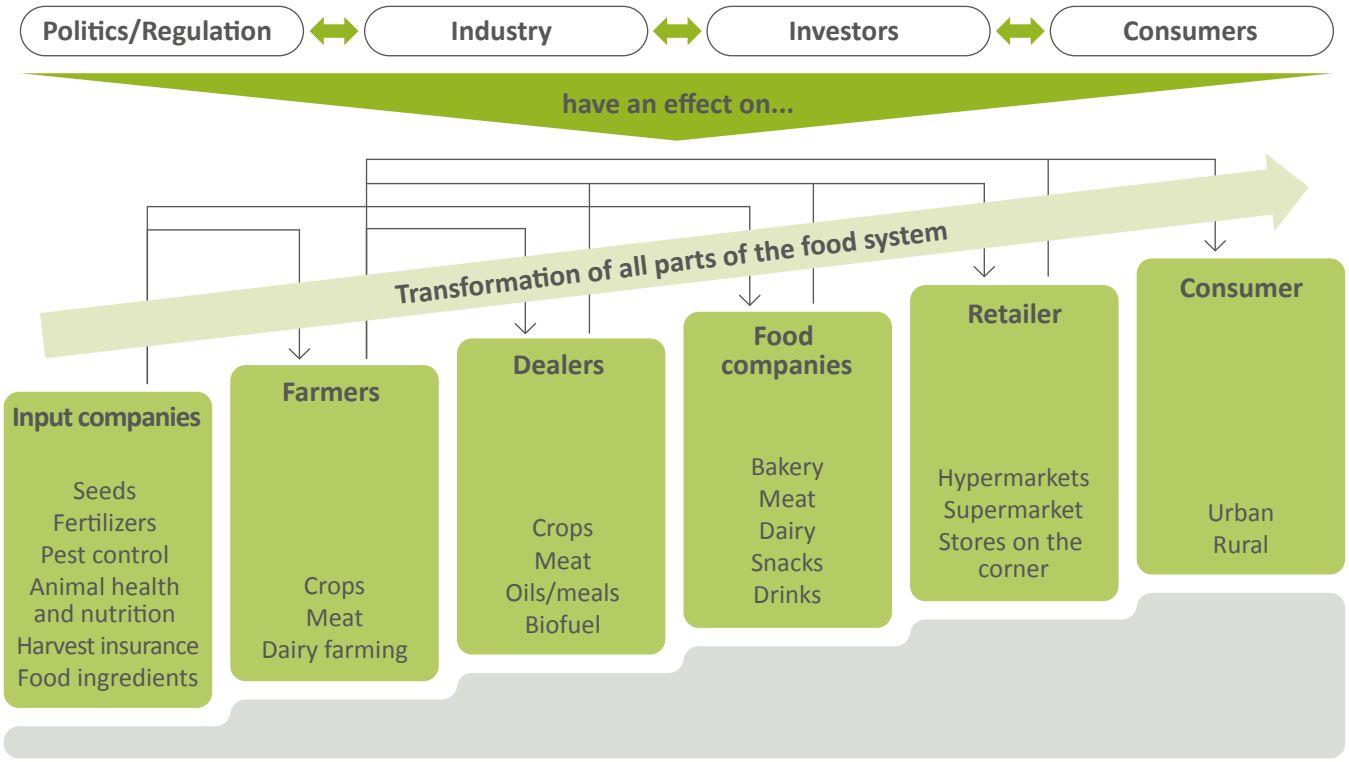
Based on the developments and innovations in the **"alternative food"** sector, this study also analyzes new **"alternative food systems"**.

- This provides a comprehensive picture of how megatrends and systemic feedback have a disruptive effect on food systems and transform them in the long term.
- With regard to investors, concrete trends and scenarios are derived that identify specific opportunities and risk areas to point out targeted investment strategies.

Alternative Food encloses a range of new alternative foods. The trend towards "Alternative Meat" is currently attracting a great deal of attention. Alternatives to the consumption of animal products have increased in recent years and the term "alternative" has also been associated with food. Alternatives to conventional food consumption are demanded by a variety of groups and initiatives, such as the organic movement, veganism, zero waste or fair-trade initiatives, Slow Food or Fridays for Future. What these initiatives have in common is that they criticize conventional production and consumption models and want more sustainable, fair, healthy, and tasty products.

Alternative food systems are based on the value chains and innovative technologies derived from the new products. The effects resulting from the scaling of the products by new production systems in turn have a massive influence on the capacities, utilization, value chains of conventional suppliers, who still rely predominantly on animal protein processing.

Fig. 1: The Food Systems



Source: FERI Cognitive Finance Institute, 2020

Interview

Daniel Skavén Ruben, Consultant, Food Initiative at The Rockefeller Foundation

What has mankind learned from the corona crisis with regard to our food systems?

After the Second World War, everything was focused on eliminating hunger and feeding the masses, but we did not optimize for nutrition or sustainability. This created a high-risk food system that fed the world, but at the same time ruined our health systems. For example, in the U.S. today more than 40 % of all adults are obese and more than 10 % of all citizens suffer from diabetes. Both belong to the COVID-19 high-risk groups. The consequences are devastating. One could say that the consequences of the virus were also triggered or at least intensified by poor nutrition.

What could be a possible solution?

Our current food system is the main cause of many global problems like poor health outcomes, environmental degradation, climate change and so on. But it will also be an essential part of the solution to all these challenges. So after corona, we need new global solutions.

Where do you see the greatest opportunities for investors to be part of this solution?

"Alternative protein" products have a multi-billion-dollar potential because they could replace most of the global meat and dairy market. If appropriate financial instru-

ments are developed, a global change can be triggered here by large investors. And I am convinced that consumers will quickly adapt to this trend, just as they have become accustomed to driving cars instead of travelling with horses. In addition, automation across the food system, transparency and traceability, personalized nutrition, immunity-boosting ingredients, and sustainability-focused solutions will all play major roles, as consumer demand for healthy nutrition, sustainability, local and nutritious food will increase dramatically, not only because of the corona situation.

"Food caused the crisis."

3 Status Quo and Solutions from the conventional Food Supply

In order to talk about alternatives in the current food supply, it is important to understand and evaluate the initial situation first. On an aggregated level, the current **relevance of meat production and further processing** can be considered. The share of agribusiness in a region with the overall value creation provides a good indication of the size and relevance of the sector. Subsequently, the concepts "alternative food" and "alternative food systems" will be examined in more detail with regard to the ongoing change towards alternative nutrition.

3.1 Key parameters of conventional food supply

"Today's major players are not necessarily the winners of the future, especially in times when entire industries are being completely reorganized due to technological and economic upheavals. Every day, the food industry supplies around eight billion people several times a day, making it one of the most important consumer markets worldwide. Technological, political, energy, climatic, logistical, price, and market-related changes shape this global market as well as changes in consumer behavior. Measured in terms of market size, even 1–2 % gradual change means massive changes in revenue streams. However, many of these changes are not gradual but exponential at a certain point."

Lars Thomsen, Chief Futurist & CEO at future matters AG

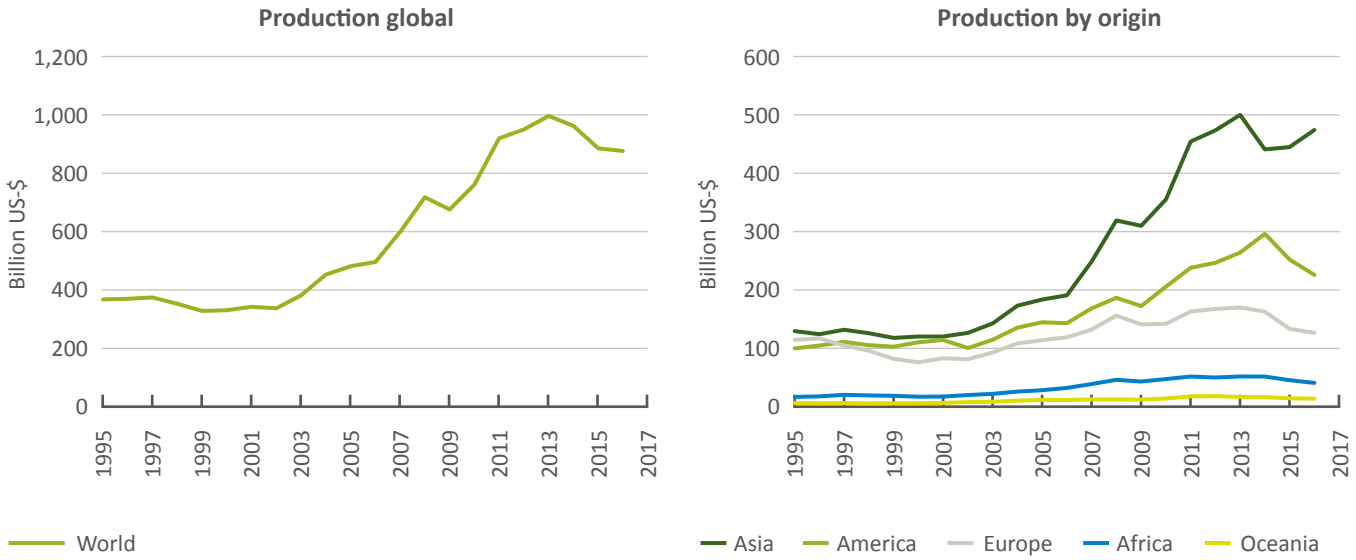
On a global scale, the **meat industry** has achieved a production volume of about 355 million tons and **a turnover of USD 0.8 to 1 trillion per year** in recent years. In particular, the emerging markets in Asia have experienced strong growth since the early 2000s. In the USA and Europe, slightly declining volumes have recently been observed. Asia is currently the region with the largest meat production and **accounts for about half of the global market volume**.

The **largest meat producers** are **China** with a share of 24 %, the **USA** with 17.1 % and the **EU** with 16.9 %. Brazil follows in fourth place with 10.6 %. This results in China being the most important single producer, which it does almost exclusively for its own market. The global market volume for meat exports is 32.85 million tons (measured in carcass weight). The largest meat exporters are the USA with a 23.4 % share of the world export market, Brazil with 21.8 % and the EU with 16.8 %. The largest consumer is China with a share of 26.2 %, followed by the EU with 15.5 % and the USA with 15.2 % [1].

With regard to the three large meat groups – pork, beef, and poultry – developments differ significantly. Pork production has dominated the market in recent years with values of constantly over 100 million tons, but with a recent downward trend. The current decline in pork production is due to African swine fever that has decimated stocks, particularly in Asia [1]. Beef and veal is at a much lower level, with production values between 50 and 60 million tons. Poultry, on the other hand, shows particularly strong production growth. While the production level at the beginning of the 2000s was still around 50 million tons, the following years saw a constant tonnage increase to almost 100 million in 2019.

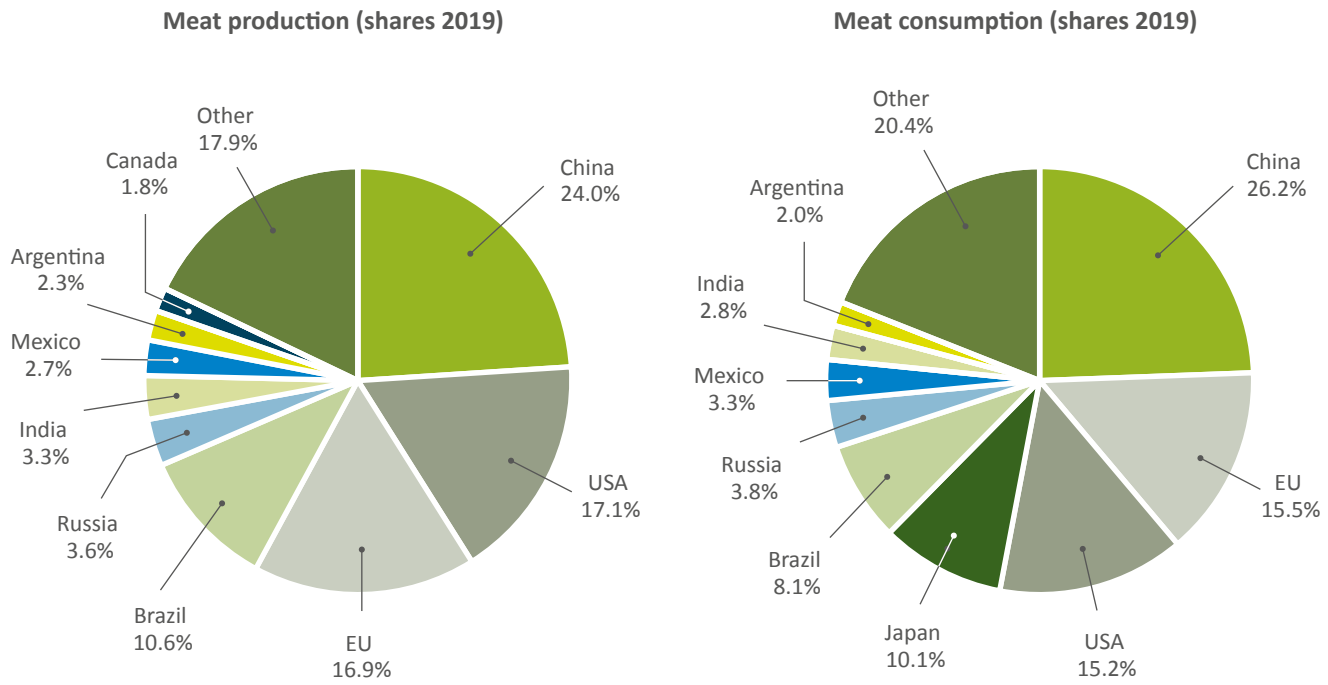
The average increase in the global consumer price index has doubled since the beginning of the 2000s. An above-average increase in the general food prices, with a first doubling as early as 2007/2008, reveals a comparatively sharp rise in prices.

Fig. 2: The trillion-dollar market: Global meat production



Source: United Nations FAO/FERI, 2020

Fig. 3: Meat production and consumption



Source: FERI, 2020

In the last 10 years, however, the price increase has slowed down considerably, at times even with values below the average consumer price development. A similar development can be observed for meat prices. Looking at the last 20 years, it can be seen that in the long run, food and meat prices have experienced a lower price increase than the average increase of the consumer price index.

The share of agricultural and meat production and processing in GDP provides a further indication of the contribution of the individual economic sectors. In African and some Asian countries, agriculture is of central importance, accounting for more than 20 % of GDP [14]. The country-specific analysis illustrates the relevance of the individual sectors for the overall economy.

The countries with the **largest share of meat production in GDP are Argentina (2.5 %), New Zealand (1.7 %), China (1.5 %) and Brazil (1.2 %)**.

In the EU, the share of agricultural value added amounts to 1.7 % of European GDP. Meat production includes about 0.4 %, and the meat processing industry about 0.24 % of European GDP. In relative terms, the figures are even lower in Germany: the agricultural share of GDP is about 0.8 %, while meat production represents about 0.2 % of GDP. The USA shows similarly low value levels.

The following examples refer to the jobs in the meat industry in Germany. In 2019, there were 376 slaughterhouses and 1,105 meat processing factories. The number of employees has fallen from just under 180,000 at the beginning of the millennium to almost 140,000 today, mainly due to the consolidation in the industry towards larger processing companies [15].

At the individual level, **consumption per person** is helpful as a frame of reference. With just under **60 kg of meat per person per year**, meat consumption **in Germany is relatively high** and continues to exceed the recommendations of the DGE, which are 14.4 to 28.8 kg of meat per year (corresponds to 300–600 g of meat weekly) [16].

Fig. 4: Meat price development

Source: IWF/United States Department of Agriculture/FERI, 2020

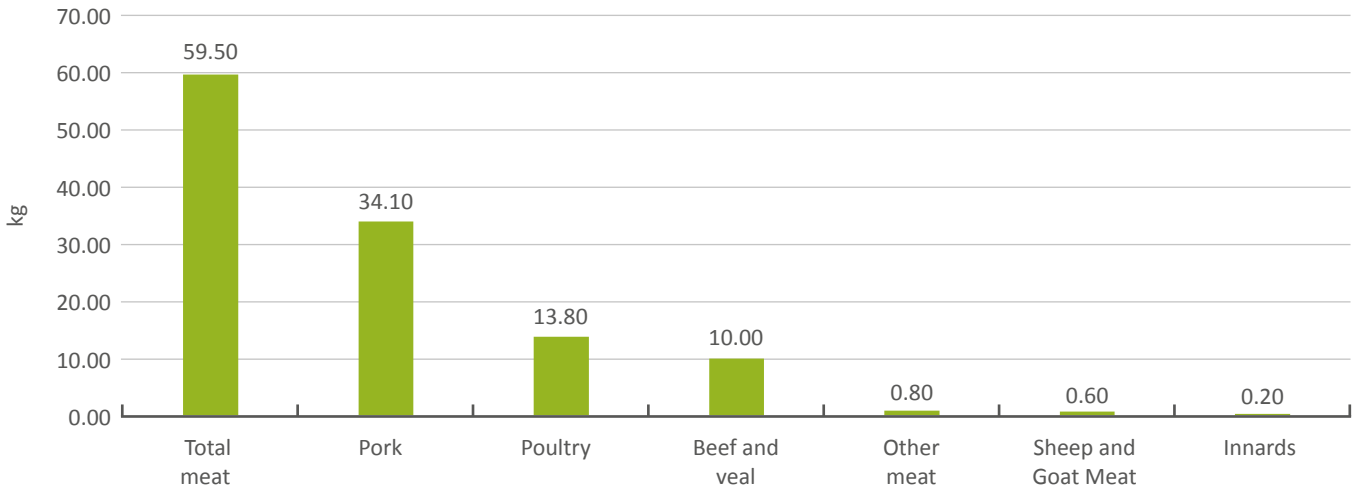
Tab. 1: Share of the agricultural, meat, and processing industries in GDP

Region	Share of agricultural sector in GDP	Share of meat production in the agricultural sector	Gross production value meat production, billion USD	Gross production value meat processing, billion USD	Total value added meat and meat processing, billion USD
Argentina	6.1 %	44.9 %	17.83	23.17	41.00
New Zealand	6.6 %	29.5 %	3.65	7.79	11.44
China	7.2 %	23.6 %	290.17	219.40	509.57
Brazil	4.4 %	30.8 %	51.11	61.96	113.07
Indonesia	12.8 %	10.1 %	13.90	0.55	14.45
Mexico	3.4 %	32.4 %	14.70	7.24	21.94
Russia	3.1 %	26.5 %	18.75	25.00	43.75
Australia	2.5 %	29.5 %	9.74	21.23	30.98
South Africa	2.2 %	32.1 %	5.31	6.90	12.21
India	14.6 %	3.2 %	11.47	3.70	15.17
Canada	1.7 %	24.8 %	9.78	21.75	31.53
EU	1.7 %	25.5 %	89.23	242.81	332.04
Japan	1.2 %	28.9 %	25.28	21.56	46.85
USA	0.9 %	30.0 %	98.37	217.17	315.54
Germany	0.8 %	34.1 %	15.17	54.82	69.99
Total			**674.46**	**935.06**	**1609.52**

* The gross production value is the sum of all economic activity in the production of new goods and services of an economic actor (private company, state, private household) or a national economy.

Source: World Bank, UNIDO, FAO, Eurostat/FERI, 2020

Fig. 5: Consumption of meat per person in Germany, 2019



Source: Federal Agency for Agriculture and Food (Bundesanstalt für Landwirtschaft und Ernaehrung - BLE), Own illustration

The biggest problem is the very low price of meat in Germany. The power of the meat industry lobby drives politics.

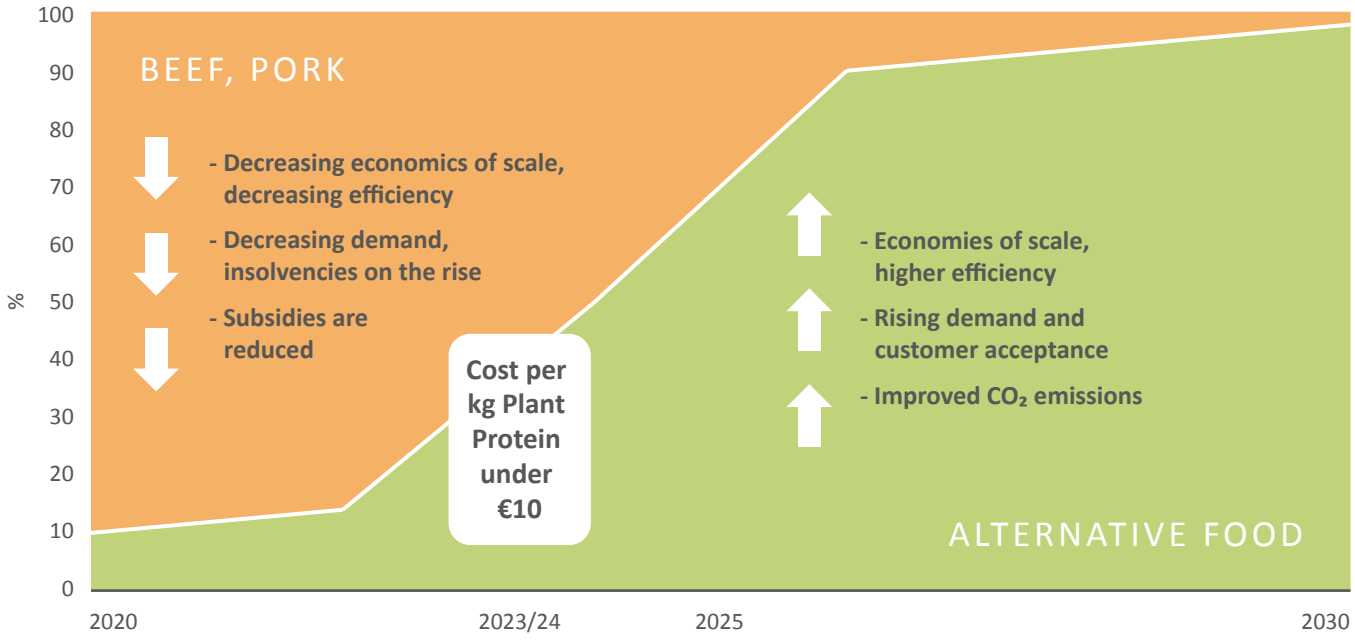
Steen Rothenberger, Investor and Hotelier
at Rothenberger 4XS

Initial assumptions about transformation and disruption potential can be made at the aggregate level by estimating the average values of individual consumption patterns. Overall, transformation depends on the dynamics of the entire food system and is influenced by new products, developments in digitization, political initiatives, reallocation of fixed assets, and the behavior of industry and commerce.

Although global meat production will continue to increase overall due to population growth, absolute consumption per person in Western countries will gradually decline. This will have a direct influence on the economic situation and structures, especially in regional and national markets, with an effect on export activities and jobs. With regard to individual companies, this may lead to plant closures in some regional and local markets due to declining economies of scale and subsidy cuts. At the same time, alternative food suppliers can expect increasing sales figures, which will lead to higher capacity utilization, greater efficiency and higher economies of scale. In addition to the economic aspects, a reduction in CO_{2eq} emissions per kg will also be observed.

- **The absolute turning point will be the inefficiency of animal protein production, if socialized costs (CO_{2eq} emissions, damage to nature and health) are included in the overall view and the relative advantages of plant proteins become obvious.**

Fig. 6: Nutritional Transformation beef and pork



Source: FERI Cognitive Finance Institute/Wirsam, 2020

3.2 Alternative Food and Alternative Food Systems

Alternative Food includes a whole range of new alternative foods. The trend towards "alternative meat" is currently in great demand, as alternatives to the consumption of animal products have increased steadily in recent years. A term, which follows "alternative meat", is "alternative protein", whereby it concerns primarily the development and use of **vegetable protein sources**. The term "plant-based alternatives" further includes substitutes for animal products of all kinds, such as cheese, milk or fish. In this context, insect-based protein sources, which are already occasionally available in marketable products, should be considered.

Alternative Food Systems represent holistic value chains related to alternative nutrition based on new products and innovative technologies. Serious differences to conventional meat production – especially in the production of protein alternatives, use of raw materials as well as personnel, and in production process selection – become apparent. The effects resulting from the scaling of products through new production systems have a massive impact on the capacities, utilization rates and value chains of conventional suppliers, who still rely predominantly on animal protein processing.

- Alternative food systems will increasingly compete with the traditional food industry and drastically change it over time. **Disruptive effects will occur that will trigger erratic transformation processes**.

- In addition to changing consumer preferences and structural shifts in demand, **economic constraints and efficiency aspects** in particular will trigger significant shifts in the market structure.

The **traditional food systems** were displaced and replaced at the beginning of the 1950s by a far-reaching industrialization of food production. The food systems of the industrial age were characterized by increased automation, in particular by major technical advances in agriculture, optimization of cultivation methods, globalization of value chains and through new marketing structures like supermarkets or discounters.

More recently, the genetic manipulation of seeds and the digitalization of production processes have led to higher efficiencies.

- While traditional agriculture has only cautiously interfered with nature, the **industrialization of food production has led to an excessive strain on natural resources**.

- As a result, planetary health is being irreparably damaged, particularly through deforestation of rainforests, GHG emissions, water wastage, over-fertilization and soil acidification.

Alternative food systems offer a counterbalance to this destructive approach by placing a greater focus on the sustainability of food systems.

Starting from a substitution of animal proteins with high resource input (energy/area/water), currently more and more alternative production systems with lower resource input are being developed.

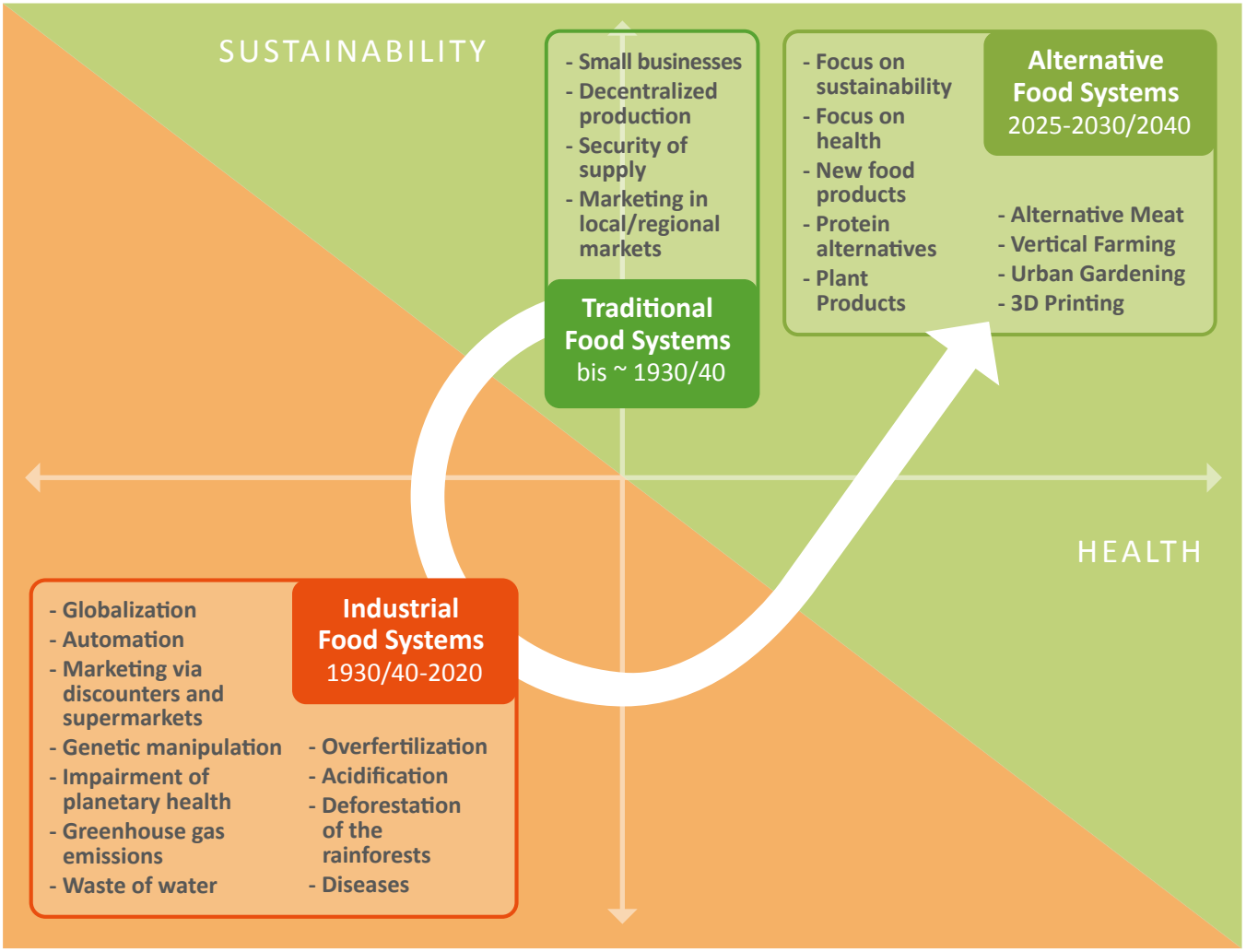
Recent areas of innovation include plant-based products of all kinds and – using state-of-the-art technologies – completely new ways of agricultural production, such as vertical farming, urban gardening or 3D printing of food.

Vertical Farming is a special form of urban agriculture and is a term for a future technology that will enable sustainable agriculture and mass production of plant and animal products in urban agglomerations in multi-storey buildings (so-called farm scrapers).

So-called **3D printing** is a new process for decentralized production of objects and spatial structures using a printer-like system. This process has the potential to revolutionize traditional production processes in many areas of the economy and could massively change global value chains.

Urban Gardening/Urban Horticulture is the mostly small-scale, horticultural use of urban areas within settlement areas or in their direct vicinity.

Fig. 7: Evaluation of food systems based on health and sustainability



Source: FERI Cognitive Finance Institute/Wirsam, 2020

Interview

Rosie Wardle, Program Director at Coller Foundation FAIRR

FAIRR acts as a global network for institutional investors focused on ESG risks and opportunities in the protein supply chain. What is your goal? Why should investors know more about the food industry?

FAIRR works with investors to help them understand material issues in this sector and to integrate these issues into their investment processes and active stewardship programs.

Many investors are not yet aware of the numerous risks associated with investments in industrially produced meat and dairy products, which we believe will impact the performance of companies and therefore affect their investment performance sooner rather than later. FAIRR provides research, best practice tools, and collaborative engagement opportunities to address these issues. Climate risks and human health are two examples of major risk factors, and we believe that environmental, social, and regulatory change linked to issues such as these will impact business as usual going forwards. A carbon tax on meat, and changes to subsidies to promote alternative proteins, are just two examples of potential policy changes that would have a major influence on the market price of meat and impact the business models of companies in the sector. This has great potential to disrupt investment markets. Change is inevitable in this sector, given the massive impacts of animal protein production.

What is your strategy?

There are two primary elements to FAIRR's strategy to close the knowledge gap for investors on ESG issues in protein production, and thereby both to protect investor returns and to help build a more sustainable food system.

Firstly, we produce a broad spectrum of investor research, including assessments of global food companies to help investors understand how these companies are managing ESG risks.

Secondly, we coordinate collaborative engagements with groups of investors, working with companies to adopt responsible policies and practices on these issues.

> *"Business as usual is not an option."*

4 Relevant Influencing Factors of Food Systems Transformation

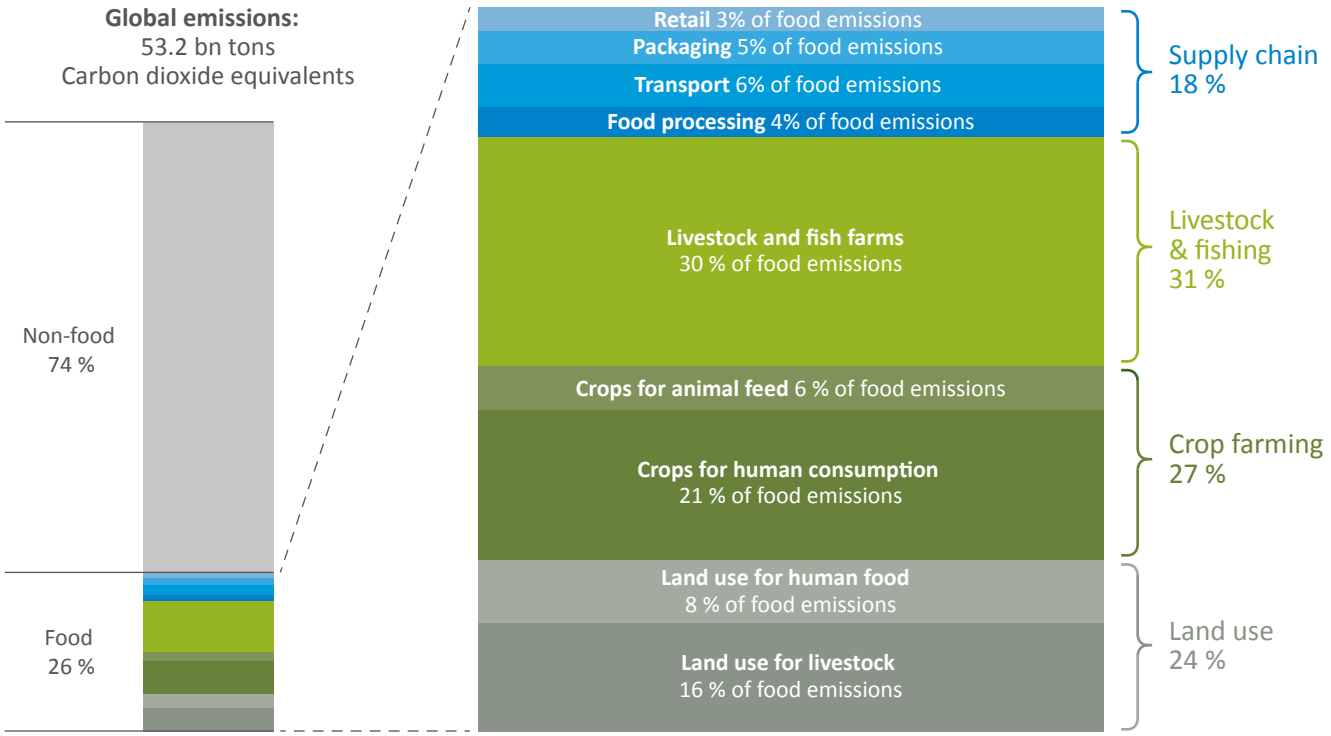
> *Having to address urging global issues like the climate change governments will be forced to redirect subsidies.*
>
> Robbert de Vreede, Executive Vice President Food at Unilever Netherlands

Many factors have an effect on the change in nutrition. The following factors are given as examples: Climate, scarcity of resources, digitalization, millennials, and subsidies. In summary, it becomes clear that local and global food systems are characterized by a multitude of parameters and mutual feedback.

4.1 Climate relevance of nutrition

The starting point for the consideration is **climate change**, which is directly related to human behavior and significantly influenced by resource consumption in the cause of nutrition. Figure 8 shows the composition of emissions from food production.

Fig. 8: Dietary global GHG emissions



Source: Poore/Nemecek, 2018; Ritchie, 2020

The largest **CO_{2eq} emission sources** are **animal food production** and agricultural land use, including plant cultivation.

Interrelationships become clear on closer inspection: **agriculture not only harms** the **climate**; **climate change** also affects the **agricultural industry**. The production conditions for plant cultivation are changing, for example due to extreme weather events, which in turn are caused by climate change. Globally, a negative impact of climate change on agricultural yields is to be expected [17].

The Poore/Nemecek meta-study (2019) shows the global range of scientifically determined GHG emissions, land use, and water use within and between selected staple foods in order to represent resource consumption per food. **The CO_2 footprint of food can be compared in terms of different sizes**. Figure 9 refers to 100 g of protein per food, or in the case of milk and soymilk, to one liter each. Even if the comparative value changes and for example the calories of food are used as a yardstick, it is evident that animal food causes significantly higher CO_2 emissions than vegetable ones.

Fig. 9: Estimated global variations in GHG emissions, land use, and scarcity-weighted freshwater abstraction between selected staple foods

Product	Greenhouse gas emissions (kg CO_{2eq})	Land (square meters)	Water (liters)
Beef (100 g protein)	49.89	163.60	727.78
Cheese (100 g protein)	10.82	39.76	2538.59
Pork (100 g protein)	7.61	10.73	1109.89
Fish (100 g protein)	5.98	3.69	1618.64
Poultry (100 g protein)	5.70	7.06	381.06
Eggs (100 g protein)	4.21	5.65	520.64
Milk (liters)	3.15	8.95	628.20
Tofu (100 g protein)	1.98	2.20	92.88
Soymilk (liters)	0.98	0.66	27.80
Grain (100 g protein)	0.59	1.44	242.03
Peas (100 g protein)	0.44	3.36	178.49
Nuts (100 g protein)	0.26	7.94	2531.41

Source: Poore/Nemecek, 2019

Although the production conditions and transport routes vary depending on the food and region, in summary, the statements of numerous studies are obvious:

- According to them, **plant-based protein sources** such as tofu or beans have a **significantly lower ecological footprint than animal products**. Of all foods, beef causes the largest amount of greenhouse gases [10].

Despite the negative climate effects, global production and demand for meat is not declining. The Food and Agriculture Organization (FAO) of the United Nations expects an **increase in meat production** to about 455 million t in **2050**, which would be an increase of **35.74 %** relative to 2019 (335.2 million t of meat) [1]. Compared to the population growth of about 25 %, this would be a disproportionate increase [18]. The primary reason for this higher demand is **the rising income per person in many emerging markets (especially China)**, which will allow meat consumption to grow.

Interview

Robbert de Vreede, Executive Vice President Food at Unilever Netherlands

What are your most important tasks and opportunities in connection with the transformation of food systems and "alternative nutrition"?

Today's food system is not sufficiently inclusive nor sustainable. In order to ensure that we also have a great planet to live on in 2050, we have to take further action today. We see the realization increasing, but we require further acceleration and more parties joining to drive the needed changes. More inclusiveness to help fight hunger and stimulate economic development of food systems in all regions as also more actions to make our food systems more sustainable. Today 12 crops and 5 animal species make up 75 % of the food we consume. We require a larger biodiversity to allow the earth to regenerate whilst we produce the food to feed the 8 billion people on this planet. A further shift towards more plant-based proteins will be a big contributor towards a more sustainable food system. These changes also offer great business opportunities as consumers and governments are becoming more aware and demanding.

What kind of influence did the current health crisis have?

Corona set the spotlight to the resilience of our food systems. There was a first response to want to focus on 'localizing' strategies. However, apart from resilience, we face huge challenges of having close to eight billion people on this earth, of which more than 1 billion are obese and close to one billion suffer from hunger.

Only a global food system can effectively achieve required scale and efficiency to make good food widely accessible. And experiences in the past have proven that global food systems are more reliable than local ones. So we have to ensure we drive the right change.

On a positive, the increasing demand for healthier and more sustainable food which COVID-19 has accelerated will further leapfrog the required plant-based protein transition. A further shift to "alternative meat" / plant-based protein will bring a significant contribution to a more sustainable food system. Today the price of alternative meat is not yet competitive vs meat, but the increased volumes and further environmental measures and less subsidies for meat will bring prices closer together.

4.2 Resource scarcity: agricultural land and water

In addition to the GHG emissions caused by agriculture, land use is another relevant factor in the sustainability analysis.

For example, **the conversion of rainforests into areas for the cultivation** of animal feed (especially soy) has a negative impact on the climate. Soils play a key role in the carbon cycle, as they absorb carbon dioxide from dead plant material. Plants absorb carbon dioxide from the atmosphere through photosynthesis, which is released into the soil as dead roots and leaves decompose. The carbon is stored in the top layer of the soil. Human intervention, especially through agriculture, results in carbon being released from the soil faster than it can be replaced.

The extent to which soil carbon losses contribute to climate change is difficult to comprehend [19]. **Half of the earth's habitable area is used for agriculture**. A good **two-thirds of this is used for livestock**. Land use is not balanced with meeting calorie and protein requirements. While livestock occupies the majority of agricultural land, it provides less than 20 % of the world's calorie and less than 40 % of its protein requirements.

- **Animal foods therefore not only emit more carbon dioxide, but also require more land than plant foods.** However, they cover only a small proportion of the calorie and protein requirements.

In Germany, agriculture accounts for 51.6 % of the total area. This, in turn, has a considerable impact on the quality of the soil, water, climate, and the environment in general. The total biomass of flying insects, with a decrease of 76 % in the last 27 years, is an example of the environmental impact on the country. The excessive use of resources is therefore accompanied by **a massive loss of biodiversity** [20].

Permanent grassland areas in Germany are declining. Between 1991 and 2019, a loss of 11.9 % of species-rich grassland was observed [21]. One of the reasons for the conversion is the production of bioenergy crops such as corn.

> *... The main problem of the current food system are the enormous resource requirements for our meat and milk production. It is neither sustainable in any way nor is the high consumption of meat and dairy products healthy. Unfortunately, this "sick" food system is still heavily subsidized: 20 % of the EU budget goes to the meat and dairy industry. This is an industry without a sustainable business model, which is completely dependent on subsidies and causes enormous environmental and health costs. Costs which so far have been shifted to the taxpayers, but for how much longer can this be done undetected?*
>
> Sebastiano Cossia Castiglioni, Vegan Investor & Activist at Vegan Capital SA

The grassland areas are an important factor for the climate, as they store carbon under the vegetation cover [20]. Hence, it can be concluded that agriculture is one of the causes of climate change and is itself suffering from its consequences.

Water is one of the scarce resources. About two-thirds of the earth is covered with water, but large parts of the world are affected by scarcity. Only 3 % of freshwater is drinkable for humans, and only one-third of it can be used [22]. Agriculture also needs water to enable the growth of plants. At the same time, people die of thirst every day while other parts of the population waste water.

In agriculture, it is clear that water scarcity is by no means only a problem of the Southern Hemisphere, where there are fewer water resources. Europe is also affected by water scarcity when it comes to supplying arable land and livestock. **For example, around 70 % of the world's drinking water supplies are used by agriculture.**

4.3 Digitization and new technologies as drivers of transformation

> *We see more and more exponential developments in various industries – resulting in new strategies or investment opportunities. Technical and economic tipping points (disruption points) develop mainly from technological innovations (e.g., AI and robotics in food production).*
>
> Lars Thomsen, Chief Futurist & CEO of future matters AG

A historical review of agriculture shows that technical innovations have always been able to significantly increase production yields. Agriculture has continuously developed over thousands of years. Examples include the introduction of the hook plow about 6,500 years ago, modern automation technology, tractors and combine harvesters, as well as new crops and the introduction of genetic engineering, which has contributed to increasing the yield per hectare.

From recent drones to satellite imagery and sensor technology, further innovations and digitization approaches can be observed along the entire value chain. The modernization of agriculture and the use of digital technologies have highlighted new concepts such as **"Smart Farming"**, **"Precision Farming" and "Digital Farming"**. These terms, although often used synonymously, have specific differences in meaning.

Smart Farming is the application of information and data technologies to optimize complex agricultural systems. Unlike Precision Farming, Smart Farming does not focus on precise measurements or the determination of differences within the field or between individual animals. Rather, the focus is on **access to data and the application of this data – in other words, how the information collected can be used in an intelligent way**.

Smart Farming approaches aim to **automate as many agricultural processes as possible, thereby increasing efficiency** while using fewer resources [23].

Smart Farming refers to the modern use of information and communication technologies in agriculture. However, the term only covers a subset of digital process technologies in the context of digitization in agriculture.

- Farmers can use mobile devices such as smartphones and tablets to access real-time data on soil and crop condition, terrain, climate, weather, resource use, labor force, and financing, enabling them to make informed decisions.
- **Driving assistants** are already widely used in agriculture. Among other things, optimized driving routes save fuel.
- Sensor-controlled solutions are used in tractors and combine harvesters, for example.
- **Computer-aided technology** uses GPS, radar and/or sensors and other technical aids to determine the position of the vehicle down to the last detail, **enabling the seeds to be placed precisely**. The same principle is used for the **distribution of fertilizer**.
- Smart Farming is also used in animal husbandry. While **automatic milking** stations are already almost standard, there are many new approaches, such as **monitoring animals by chip** to analyze movement patterns or feeding behavior. Analyses can also be carried out with regard to the state of health.

Precision Farming or Precision Agriculture describes the **use of digital tools in agriculture** to observe, measure and analyze data of plants, soil and air. This technology enables farmers to save costs and resources, to avoid environmental pollution and crop losses and to make their farms more economical through the targeted use of fertilizers and pesticides. The aim is to increase yields through targeted, precise cultivation of the fields. In particular, the development is characterized by larger available data volumes and better analyses possibilities as well as highly developed robotics, drone recordings and sensors.

Precision Farming is the term used to describe a method of locally differentiated and targeted management of agricultural land. The term covers a subset of digital process technologies in the context of digitization in agriculture for monitoring and optimizing agricultural production processes.

- Automation measures are replacing humans in some cases with the help of **robots**. In agriculture, new tasks that would be too time-consuming to complete manually can thus be performed.

- **An image recognition software with artificial intelligence (AI)** evaluates the robot's images and recognizes the information relevant for the farmer. Decisive criteria for measuring success is the accuracy of the AI's decisions [24].

- The use of **drones** is becoming increasingly widespread in agriculture. This means that the growth of plants is permanently observed and analyzed. Algorithms process this data and provide information on stress symptoms of plants, soil pile cover, and pest infestation. This enables the farmer to precisely determine the perfect harvest time or to take preventive measures against pest infestation [25].

- **Measuring stations** collect real-time environmental information. **Sensors** analyze the nutrient requirements of the plants and pass on this information, allowing the farmer to optimize the nutrient requirements very precisely. These values help with fertilization, plant protection, and also with the question whether the field can be used as agricultural land (again) in the next season or should lie fallow.

- Another function within Precision Farming is **Prediction Analysis**. Software systems calculate and anticipate the optimal time for crop rotation, soil management, harvest and sowing time by incorporating all collected data and weather forecasts.

In addition to Smart Farming and Precision Farming, the term Digital Farming is often used. **It integrates both** the Precision Farming and Smart Farming **concepts**. The approach goes beyond the mere existence and availability of data and attempts to derive usable information from the generated data and thereby create added value.

Digital Farming means the consistent application of the methods of Precision Farming and Smart Farming, the internal and external networking of the farm and the use of web-based data platforms together with Big Data analyses.

In this context, software platforms help farmers analyze vast areas of land by collecting and displaying all the data from the fields. **Satellite-based weather data**, images **from drones** and information from **soil sensors** are incorporated into the data processing system. This allows farmers to better analyze their crop yields and optimize the use of fertilizers and pesticides [26]. The use of digital technologies in agriculture offers many benefits, but there are also many challenges for farmers. In particular, the **very high cost of extensive digitization efforts** should be noted. In Germany, the issue of broadband expansion and mobile network coverage must also be named as a major impediment. This is because many rural areas in Germany are not yet sufficiently connected to the digital network. However, since **a fast internet connection** (often 5G standard) is a prerequisite for the use of smart farming technologies, further infrastructure measures are necessary for a broader penetration of digital technologies.

4.4 Decision-makers of tomorrow with new eating habits: Millennials and Generation Z

> *"The most important trend for us (Manor Warenhaus Group) is "Alternative Food". The share of vegan products is increasing massively. The younger generations demand new products, which correspond to their changed consumption and eating behavior.*
>
> Martin Roth, Head of Investments at
> Manor Pensionskasse AG, Basel (Switzerland)

Millennials (born between 1981 and 1996) and representatives of Generation Z (1997 to 2012) make up half of the world's population, and thus influence and change society to a considerable extent [18]. A study by Nahrhaft e. V. and Greentable e. V. found that **Millennials are the dominant drivers of veganism and vegetarianism** in today's society [27].

The issue of sustainability plays a crucial role for millennials and other young people and is clearly reflected in their consumption behavior. According to a recent Shell Youth Study, young people see **environmental destruction as the main problem** that frightens them, while in 2010 other issues such as poverty or fear of unemployment were in focus [28].

It is also interesting to note that, according to a Nielsen study, 48 % of total consumers in the USA would consider changing their shopping habits to live more environmentally friendly. Among Millennials, 75 % would be willing to do so, whereas only 38 % of the previous generation – so-called "Baby Boomers" – would be willing to change their shopping behavior for the sake of the environment [29]. The "Living 2038" study also states that 61 % of Generation Z would like to see more environmentally friendly offerings [30]. Many companies in the food industry have begun to adapt to the demand and changing preferences of the younger generations: Supermarkets, discounters, restaurants and fast food chains are responding to these demands with new product ranges.

- This clearly shows that sustainable thinking continues to prevail among the younger generation by providing important impulses in the food industry.

For both Millennials and Generation Z, not only environmentally friendly but also healthy nutrition is of great importance. They tend to spend more money on high-quality food than previous generations. They are characterized by a conscious, sustainable approach to their diet, and critically reflect on the players involved as well as the exact origin of products [31].

Another characteristic feature is the affinity for the use of **online media** that has emerged in the course of digitization. The influence of the blogger and influencer movement plays a central role here. The food industry likes to use influencers and bloggers for marketing purposes. Influencers or bloggers (with a preference for food) are important multipliers for the players in the food industry and gastronomy because they can reach a broad mass of potential customers thanks to the wide reach of social media.

In their blogs, influencers are increasingly representing the opinion of Millennials and Generation Z that healthy nutrition and sustainability must be given greater consideration in product selection, which is a reflection of the sustainable thinking of the younger generation. For example, **many influencers advocate strategies to avoid food waste** with hashtags like #foodsaver, #stopfoodwaste #circulareconomy and #zerowastekitchen in their channels. These hashtags are now contained in **over 100,000 posts**. Many followers are motivated to rethink their eating habits and initial surveys show clear potential: about **25 % were inspired to a vegan lifestyle by YouTube**, 14 % named Facebook and 12 % Instagram as a source of motivation [32].

4.5 Subsidies as a long-term control instrument

The catalog of state regulations and political influence in agriculture is broad. **Subsidies** in particular play an important role in the individual countries.

In the EU, subsidies are provided within the framework of the Common Agricultural Policy (CAP). Its goals are food security, sustainability, and the promotion of organic farming. Between 2014 and 2020, **Germany received an annual budget of EUR 6.2 billion** from the EU to subsidize agriculture.

A distinction is made between two pillars:

1. The first part relates to **direct payments to farmers**, which are paid according to the number of hectares of agricultural land. The annual subsidies in Germany flow into first-pillar support programs to the tune of EUR 4.85 billion, which thus accounts for a good 78 % of total subsidies. The contributions of the first pillar are intended to reward and safeguard the social achievements of farmers. They also serve to finance the above-average standards in food quality, environmental, animal, and consumer protection worldwide. The direct payments are also intended to secure farmers' incomes. These direct subsidies pay an average of about 40 % of agricultural income in the EU. **Greening requirements** are intended to motivate farmers to implement minimum requirements in the interests of sustainability. For example, 30 % of direct payments are only paid out if ecological priority areas and pure monocultures are avoided.

2. The second pillar comprises the **targeted promotion of sustainable and environmentally friendly farming and rural development**. Approximately EUR 1.3 billion will flow into the second pillar. It serves to secure the future of rural areas and is intended to support the competitiveness of agriculture, sustainable management and the economic strength of rural regions.

One of the main criticisms of the CAP is that environmental and climate protection measures play an insufficient role. The desired "greening" activities of farmers have only a minor effect. Nor does it take the over-fertilization of the soil into account, which means that excessive fertilization is not sanctioned. The funding of the second pillar is widely criticized because it receives only a small allocation of funds and is voluntary for farmers. A further point of criticism is that controls are only carried out on a random basis and therefore no comprehensive overall picture can be drawn [33].

The next budget period for the CAP runs from 2021 to 2027, when the EU will launch a new initiative to strengthen and promote sustainable agriculture:

With the "Farm-to-Fork" strategy, the EU Commission wants to facilitate the transition to a sustainable EU food system and is pursuing three main objectives:

1. **Sustainability**
2. **Organic farming**
3. **Digitization**

In concrete terms, the following key points are called for:

- 50 % less pesticides,
- 50 % fewer antibiotics and
- 20 % less fertilizer.

A total of 25 % of agricultural land in the EU is to be organically farmed by 2027.

This Europe-wide initiative will have a significant impact on both agriculture and the agro-industry in general (see chapter 6.1).

Greening is about environmental measures that are mandatory for European farmers in order to receive direct payments from the EU. Greening has been in place since January 1st, 2015, and is aimed at preserving meadows and pastures in the long term and making arable farming more diverse in order to make a positive contribution to environmental and climate protection.

5 Central Development Lines of Relevant Product Innovations and Technologies

The following chapter discusses and deepens the central lines of development of the food transformation and its influence on the current situation of the industry. In the course of this, a special focus is placed on innovative and sustainable products and processes, which are being promoted within the Alternative Food System on the basis of technological advances.

5.1 Alternative Meat/Alternative Protein

"The (meat) price is the most important opinion leader and also the most important opinion maker!"

Steen Rothenberger, Investor and Hotelier at Rothenberger 4XS

"Alternative Meat" refers to meat substitutes or meat imitations which, in addition to their taste and haptic properties (texture), also have a comparable protein content without including meat in the production process. Essential components of alternative meat products are alternative proteins, for example, derived from soybeans or peas. In addition to these plant-based proteins, there are many other plants that are suitable for new product alternatives.

The proteins are basically divided into two groups. On the one hand, there are **animal protein sources** and on the other **plant protein sources**. The animal protein sources are found in fish, meat products, eggs, and dairy products.

- The biological value of animal proteins is generally higher than that of vegetable proteins because the amino acid structure is similar to those of humans. Therefore, they are also processed faster in the body. The biological value of a protein indicates the extent to which the protein ingested through food can be converted into the body's own protein. The higher the biological value of the absorbed proteins, the less protein needs to be added to achieve a balanced protein and nitrogen balance.

Bastian Fassin, Managing Partner at Katjes Fassin GmbH & Co. KG
Dr. Maon Littek, CEO at Katjesgreenfood

Bastian Fassin (owner of Katjes) has already decided to change the entire production to vegetable recipes in 2010 due to animal welfare and sustainability.

Bastian Fassin: "The future is plant-based! Today's mass animal husbandry is not acceptable, and it would be economically unviable without subsidies. I do not believe in the long-term benefits of government regulation".

Dr. Manon Littek: "Industrial animal husbandry accounts for 30 % of global CO_2 emissions and deals with the resources water and land in a socially uneconomical way. Therefore, plant-based nutrition is not only a trend, but also an urgent necessity in the context of climate change and many other ecological and social challenges.

"The future is plant-based!"

- Vegetable protein sources are found especially in legumes and nuts and, in contrast to animal protein sources, contain hardly any cholesterol, purines or saturated fats.

In the following table selected plant-based protein sources are listed and central production parameters, nutritional aspects and sustainability indicators are compared and evaluated.

Tab. 2: Selected plant-based protein sources

	peas	soya	rape	hemp
Production parameters	World production: 20.6 million tons of green peas, 16.2 million tons of dried peas CHN accounts for over 60 % of the production of green peas. CAN is the world's largest producer of dried peas, with about 28 %. The average yield of green peas was 7.67 t/ha, while the yield of dry peas was about 2 t/ha. (FAO 2020)	World production: about 334.8 million tons of soybeans on about 121.6 million hectares This corresponds to an average yield of 2.76 t/ha. The USA and BRA together accounted for more than 63 % of global production with 117.2 million tons and 96.2 million tons respectively. The largest soy producer in the EU is ITA: with 1 million tons (12th largest producer worldwide). GER occupied 43rd place with 0.04 million tons of soy. (FAO 2020)	World production: 75.0 million tons on about 37.5 million hectares The average yield per hectare is 1.9 t/ha. CAN is the largest region for rapeseed production, accounting for 27 % of world production. With 17.7 % and 11.2 %, CHN and India follow in second and third place, respectively. In GER about 3.6 million tons of rapeseed are harvested, which corresponds to a world market share of almost 5 %.	World production: 142,883 tons of hemp seeds on about 32,140 hectares The average yield is 4.45 t/ha. CHN is the largest hemp producer with about 70 % of the worldwide produced quantity, followed by FRA.
Nutritional/ protein content	23 %	40 %	23 %	25 %
Sustainability [11]				
CO_2 Output per kg product	1.2 kg	2.0 kg	2.9 kg	> 0 kg
Water consumption	595 l/kg	2,145 l/kg	4,301 l/kg	3,685 l/kg
Evaluation	Suitable as protein alternative, highly scalable. Production volumes will increase due to higher demand.	Predominantly used as animal feed in livestock breeding. Worldwide largest cultivation volumes. Constantly high importance in the transformation process with further shifts towards direct plant-based food supply.	Already established in large parts of Europe as a crop for rapeseed oil and biofuels. Further expansion in the direction of protein extraction for alternative products is conceivable.	A positive CO_2 balance can be achieved in the production of hemp seeds. The reason for this is that hemp is a very robust crop that can bind large quantities of CO_2 without any fertilizer and thus represents a very attractive carbon dioxide reservoir.

Sources: Own presentation Wirsam, 2020

Infobox

Lisa Dyson, CEO and Founder AirProtein at Kiverdi

Air Protein is a technology that rewrites the future of meat.

Air Protein is a technology that rewrites the future of meat. Inspired by NASA ideas a novel technology has been developed which combines carbon dioxide, oxygen and nitrogen with water and mineral nutrients. Renewable energy and a probiotic production process are applied to microbe cultures, which convert the elements into nutrients. The process takes place in simple fermentation vessels and takes only a few days versus months or years for plants and animals.

In other words: Just like plants, the technology uses CO_2 and renewable energy as input factors. The output is a highly nutritious protein that is rich in all essential amino acids, vitamins, and bioavailable minerals. To create meat, a combination of pressure, temperature, and culinary techniques are then applied to create different flavours and textures. Delicious analogues to poultry, pork, beef, or seafood without use of hormones, antibiotics, pesticides or herbicides are possible.

Air Protein flour is highly nutritious, having a very high protein content over ~80 % protein (versus 40 % in Soya) and includes essential nutrients such as Vitamin B12, which is lacking in a plant-based diet.

Air Protein is highly efficient and highly scalable. It could disrupt global protein and meat markets. Plus it has a dual impact effect, by using CO_2 as well as producing high quality protein.

Many studies compare plant and animal proteins and evaluate the products based on the parameters water, energy, land and GHG emissions. One of the comparisons included the resources required for conventional meat processing and the key ingredients of alternative meat (water, pea protein, rapeseed, and coconut oil) [34, 35].

- For example, for a 113 g "alternative" burger patty, about **99 % water and 46 % energy could be saved** compared to a conventional "animal" product.
- At the same time, **93 % less land** was needed for production and **CO_2 emissions were reduced by 90 %**.

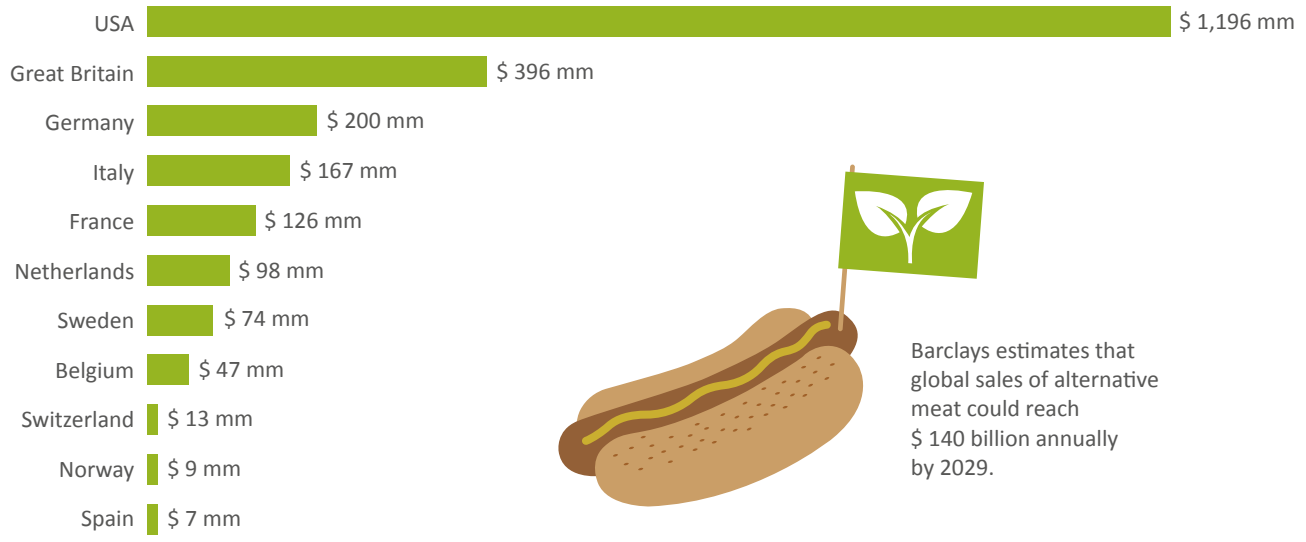
Already the massive differences in resource consumption and efficiency suggest that plant-based "alternative meat" will trigger a massive revolution in traditional food systems. Last but not least, purely **economic considerations** will be a strong driver of disruption, transformation and substitution.

The growth and/or production speed of the vegetable components of the alternative meat products is much faster. With simultaneous increase in demand these factors have the consequence that fewer utilizable animals must be held and **GHG emissions can be reduced**.

The large quantities of feed that were previously required for livestock farming would be significantly reduced. For example, the cultivation of soy, which accounts for 70–75 % of feed production, could be drastically reduced, eliminating one of the main drivers of rainforest deforestation in the Amazon region [36].

The market for alternative meat is growing rapidly and has reached not only the wholesale and retail trade but also fast food chains and large parts of the gastronomy. According to a study by Barclays and Euromonitor for selected countries (2018), the market is expected to grow to a turnover of USD 140 billion by 2029, which would correspond to a **share of over 10 % of the global meat market**. So far (2018), the USA is the strongest market for alternative meat in terms of sales, with USD 1.196 billion. The ten largest EU sales countries together reach a similar level of USD 1.137 billion [3].

Fig. 10: Market size for alternative meat products, sales 2018 in selected countries



Source: Barclays and Euromonitor, 2019

- The growth potential for alternative meat in the US and European markets is expected to be massive in the coming years. Similar growth is also expected for the Asian market.

- The A.T. Kearney study ("How Will Cultured Meat and Meat Alternatives Disrupt the Agricultural and Food industry?") calculated that the global market for meat as a whole (including alternative meat) will grow from USD 1 trillion to USD 1.8 trillion in 2040. Cultured meat will account for 35 % of this, while plant-based alternatives will account for another 25 %. Accordingly, the conventional share of the meat industry will decrease from 100 % today to only 40 % in 2040 [4].

This concludes:

- The transformation of the meat market will be greatly accelerated by increasing the **efficiency of value chains** in the Alternative Meat sector.

- Compared to animal proteins, the economic and time advantages of plant protein production are strong arguments for an **exponentially developing transformation**.

- The **economic efficiency of the production** (price) of plant proteins can be regarded as a tipping point.

The wealth of plants makes it possible to tap new sources of protein. In addition to known vegetable varieties, new approaches are currently being researched to produce **algae** industrially and integrate them into alternative food products.

- Currently, especially the "Chlorella" and "Spirulina" algae are being bred for the food industry. Both are rich in nutrients and are cultivated in farms where transparent, LED-lit tubes are used, so-called photo bioreactors.

- From an ecological point of view, the cultivation of microalgae in appropriate farms is extremely efficient. The process removes carbon from the atmosphere and is therefore net carbon negative. In addition, no herbicides or pesticides are needed, and no waste is produced that contaminates the environment.

- Algae also have more essential amino acids than soybeans. From an economic point of view, the yield per hectare is interesting. First studies indicate that microalgae can produce 4 to 15 tons of protein per hectare annually, compared to 0.6 to 1.2 tons for soybeans [37].

The production of meat alternatives offers a variety of ecological and economic advantages, as production can be made more sustainable, faster, and more efficient, and the use of resources can be minimized. Further positive effects can be expected from the regional cultivation of protein sources.

Tab. 3: Developments in different food systems and their effects on economy, society, health, and environment

Conventional products with animal proteins	Alternative Food Systems
• Demand for animal products declines	• Demand for herbal products increases
• Economies of scale deteriorate	• Economies of scale improve
• Insolvencies on the rise	• Increased number of start-ups
• Subsidies are reduced	• Political support (“Green Deal”)
• Investments decline sharply	• Investments increase
• Central, industrial production, global manufacturing	• Decentralized, smart production, local manufacture
• Massive job cuts	• Job creation, new qualifications
• High dependence on world market prices for raw materials	• Low dependence
• Decrease of agricultural land, rededication of land	• Small areas necessary, partial urban production possible
• Food contaminated with hormones, antibiotics, unhealthy, unwanted side effects	• Clean production possible, no additives that are harmful to health
• Negative effects on health	• Positive effects on health
• Economic damage due to inefficiencies	• Gain for the national economy via higher nutrient supply efficiency
• Tax subsidized production	• Small subsidies required
• High CO_2 emissions	• Low CO_2 emissions, climate-neutral production
• Deforestation for fodder cultivation and pasture	• Reforestation of forests
• Extinction of species	• Species protection
• Very high water consumption	• Low water consumption

Sources: FERI Cognitive Finance Institute/Wirsam, 2020

5.2 Precision Fermentation and Cultured Meat

The fermentation of food is an ancient method that made the production and preservation of many products possible in the first place. Fermented foods are already part of our daily diet in many cases. Making "sauerkraut", kimchi, miso, ketchup and cheese yourself, brewing beer and baking bread yourself is possible with tiny helpers like yeasts and bacteria.

Precision fermentation technology typically involves genetically modifying bacteria, algae or yeast to add recombinant animal DNA. This enables them to produce complex organic molecules which can then be used to manufacture animal products. This includes the production of proteins (including enzymes and hormones), fats (including oils), and vitamins that meet precise, specific properties [38]. For example, gelatin and collagen can be used for the production of leather or casein for the production of milk [39].

Precision Fermentation (PF) is a simple method of **producing alternative food**, as the production cycles are 100 times faster in comparison to other methods to achieve the desired growth. Technological advances have made it possible to significantly reduce the cost of molecule production. It is predicted that the price of PF proteins will continue to fall until 2035 and will be about **one-tenth of the cost of animal proteins** [38].

Specifically, casein and whey proteins, which are essential for milk, are produced by precision fermentation for the production of clean milk. A genetically modified yeast bacterium is mixed with vegetable sugar in a fermentation tank. The bacterium then converts this sugar into casein and whey protein and thus provides the basis for Clean Milk [40]. **The production of Clean Milk will use more than 10–25 times less raw material, 10 times less water, five times less energy and 100 times less land.** This leads to a dramatic reduction in production costs [38]. By adding water, fats, vitamins and other proteins, Clean Milk or other products, such as Clean Milk cheese, are produced.

- **Initial forecasts suggest that cost parity with most animal protein molecules will be achieved by 2023–25.**
- Once the cost of protein production falls below USD 10 per kg, this technology could initiate a significant disruption of traditional forms of milk production.

Origins: The use of **precision fermentation** to produce proteins for human consumption is not a novel innovation. In 1978, the first genetically modified yeast for the production of human insulin "Humulin" for the treatment of diabetes was introduced. Approved by the FDA in 1982, Humulin rapidly replaced the previously used animal insulin. Humulin was more consistent in quality, better tolerated and controlled sugar content more effectively and was quickly preferred to animal insulin, although it was initially more expensive to produce [38].

Precision Fermentation allows further improvements in the properties of microorganisms, such as changing not only the taste or consistency, but also the ability to emulsify, foam or assist in baking. Another key aspect of the cultivation of microorganisms will be the optimization of nutritional values. For example, fat values can be reduced, or additional vitamins or minerals can be added to make the end products significantly healthier. In addition, allergens can already be excluded during production [38].

A particularly important factor in the production of fermented products is the elimination of the harmful environmental factors of conventional production, in particular by significantly reducing the use of resources such as land, water, and energy, while at the same time reducing GHG emissions.

Not only cost and ethical issues play a role in the success of the technology, but also the acceptance of the products by the end consumer. Furthermore, positive support within the framework of legislation and the provision of sufficient investment budgets for further research, development and market penetration are required.

"Cultured Meat" History: The first ideas for cultured meat were already developed in 1927 by John B.S. Haldane, and even more specifically in 1931 by Winston Churchill. In 1950, NASA labs were doing research on in vitro meat. It was not until many years later in 1997 that the first patent for in vitro meat breeding was registered. In 2002, NASA produced in vitro meat for the first time, using muscles from goldfish [41].

The term Cultured Meat refers to biologically cultivated meat or the so-called in vitro meat. In vitro, Latin for "in glass", means "outside the organism under artificial conditions, in a test tube". Other names for Cultured Meat are also: meat from the Petri dish; cultured meat; safe meat; clean meat; victimless meat. Cultured Meat corresponds to the structure and characteristics of animal meat.

The value chain of cultured meat begins with the production of stem cells. These are taken from living animals during a muscle biopsy. The stem cells multiply with calf serum, which is propagated in a bioreactor. In the next step, the cells are divided to grow into muscle strands in a culture medium. From these, muscle fibers are formed from which cell layers are formed, which are compressed into cell clusters. These can be processed into minced meat, for example, a burger patty [42].

Researchers are currently working on producing whole pieces of meat in the laboratory. Recently, the Israeli start-up Aleph Farms successfully produced thin in vitro steaks for the first time [43]. At the same time, the industry is trying to reduce costs, as market acceptance is not yet possible with values between USD 50 and 100 per pound [44].

The negative effects of conventional livestock breeding, in particular the considerable impact on water and land resources as well as biodiversity, are avoided with cultured meat. Compared to conventional meat production, cultured meat requires less land, water, GHG emissions and other pollutants [41]. The technology is therefore **ecologically more compatible** than conventional animal husbandry, since the climate and natural resources are protected and fewer harmful substances are released into the environment [45].

According to a 2019 study by meat replacement manufacturer Veganz, it is clear that cultured meat still meets with **great skepticism from the consumer's perspective** [46]. Studies in connection with cultured meat and human health are not yet available. However, since excessive meat consumption has been shown to have negative effects on human health [41], **cultured meat could contribute positively to health**. Possible end products could be characterized by lower fat content and additional nutrients [41]. Other positive effects of cultured meat are the absence of antibiotics and the exclusion of other harmful substances in meat.

The making of cultured meat holds promising opportunities for future food production. **Conventional factory farming** could be dispensed with, thus reducing energy, land, and water consumption. In addition, **animal suffering**, an inglorious "trademark" of conventional factory farming and slaughter, could be **completely avoided** with the technology without having to forego meat [47].

Cultured meat thus offers many opportunities for future nutrition. It remains open whether mass suitability can be achieved in the foreseeable future, especially since corresponding products are also in competition with "vegetable" alternatives.

- **More and more players**, including large companies, are active in the field of cultured meat research and are researching new solutions and alternatives.
- **The challenges** of cultured meat currently lie in the **financial, technical, and also legal dimensions**.
- The broad availability and acceptance by consumers is expected in 10–20 years at the earliest [48].

5.3 Alternative Farming: Vertical Farming

"Many regions as well as cities will be forced to build at high altitudes and make food production highly efficient even in buildings."

Mark Korzilius, Entrepreneur and Investor
as well as CEO at &ever

Suppliers from the **agricultural engineering and agrochemical** sectors are working on innovative solutions, as are companies from the sensor and software industry. **Digital platforms** are used to plan, control, monitor, automate and optimize agricultural processes (see Chapter 4.3 on Smart Farming).

Indoor Vertical Farming (IVF)

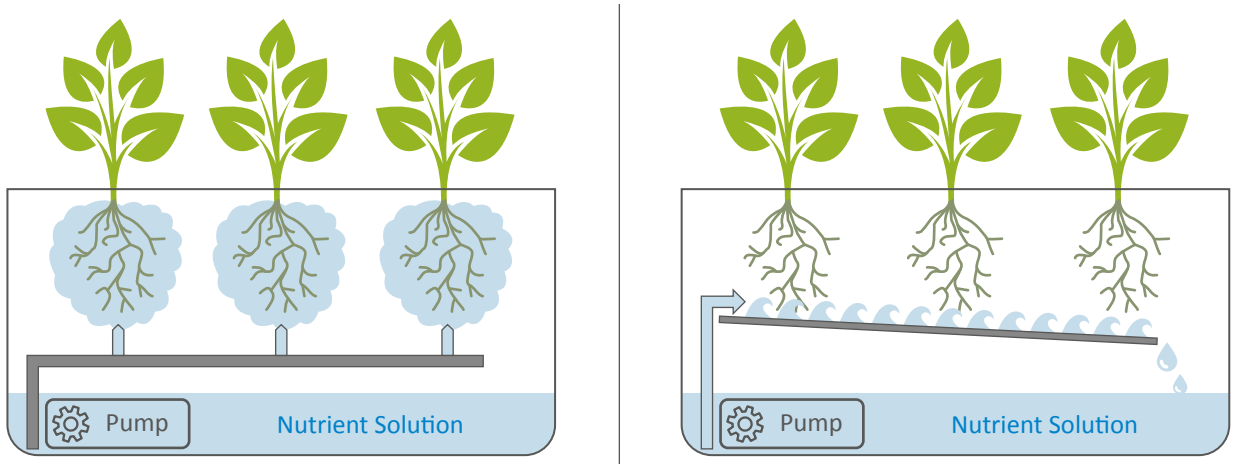
In conventional agriculture, plants grow outdoors and in direct sunlight in natural, nutrient-rich soils, mostly fertilized. The plant draws the required amount of water and nutrients through its roots. Pesticides (insecticides, herbicides and fungicides), usually chemical or synthetic-based, are used in conventional agriculture to eliminate all kinds of pests.

In contrast, **Indoor Vertical Farming** (IVF) shifts the majority of plant growth processes to a **controlled environment** (buildings/"indoor"). The technology allows **year-round, weather-independent and with constant yields in the desired quantity and quality with a small area input**. It simulates the natural steps of plant breeding along the germination and growth phases by artificially regulating temperature and humidity, nutrient and oxygen supply, and the photosynthetic reaction. The cultivation area is "vertical" and "indoor", which means that the plants are grown inside buildings (in high-rise buildings).

From a technical point of view, so-called **hydroponics** is used for plant breeding, which makes the use of pesticides obsolete. This method offers a number of other advantages, but also requires complex technical solutions [49]. The basic idea of hydroponics is to allow plants to grow without soil in a nutrient solution. Different methods are used for this purpose. In aeroponics, for example, the plant roots are constantly surrounded by a very finely atomized nutrient mist. Another method is flood irrigation, in which the plant roots are suspended in a temporary water bath (Figure 11). The water flowing in and out aerates the roots and provides an exchange of oxygen and carbon dioxide. In most methods, the excess nutrient solution is collected, replenished if necessary, and returned to the process [50; 51].

Example: The Israeli start-up Tevatronic shows just how great the financial savings that can be made by using artificial intelligence in agriculture can be. The company has developed an autonomously functioning irrigation system in which AI relieves humans of the decision as to when, where and how much water to irrigate a field. The data for this is provided by sensors in the field. According to Tevatronic, three quarters of the amount of water and fertilizer that would otherwise be needed could be saved by using the system with pinpoint accuracy [44].

Fig. 11: Irrigation systems in vertical farming



Hydroponics – Aeroponics

Hydroponics – Flood Irrigation

Source: https://www.pflanzenfabrik.de/systeme-der-hydroponik/

In general, IVF significantly **reduces water and fertilizer consumption** compared to conventional agriculture. However, it is problematic to determine and create the optimal nutrient composition for each plant species. Due to the water treatment and temperature control, the energy requirement for a hydroponics plant is still comparatively high and maintenance-intensive.

The interplay of techniques for irrigation, lighting, nutrient supply and aeration creates many advantages that make vertical farming attractive.

In addition, GHG emissions can be saved through consumer-oriented production and shorter transport distances.

- Considering all advantages and disadvantages mentioned, vertical farming offers a **sensible alternative to conventional farming** and can noticeably improve the food supply in urban areas.

- Even if the costs of products from vertical farming are still comparatively high, **technological developments will lead to increased efficiency** and cost reduction.

- Particularly noteworthy are the **avoidance of pesticides and genetic manipulation** as well as the reduced consumption of fossil fuels and fresh water, which will curb further environmental damage.

- In addition, **robots**, standardized processes, and automated process control allow a **significant increase in automation** up to autonomous production lines, which considerably reduces both personnel deployment and resource consumption.

Infobox

Mark Korzilius, Entrepreneur and Investor as well as CEO at &ever

Indoor high-tech vertical farming companies (IVFs) are THE solution to many of the trends outlined in this study – local sourcing, food safety, food quality, sustainable agriculture, and water conservation.

An IVF is defined as a completely closed plant production system using LED light. The multi-layer propagation area within the main building is thermally well insulated, almost airtight, and allows full climate control on each vertical layer.

Currently, IVFs most commonly produce "functional plants" such as leafy vegetables (lettuce and herbs, etc.) and microgreens (young leafy vegetables, sprouts, etc.), followed by fruit vegetables such as cherry tomatoes and fruits like blueberries or strawberries.

Compared to IVF, traditional farming methods do not operate sustainably but pose a major challenge to the environment and resources. Huge plantations (in Spain or Holland) consume a lot of energy, land and water and are also dependent on climatic influences.

The advantages of IVFs include

- **high resource efficiency**,
- high and **reliable annual productivity** (up to 15 harvest cycles per year) and
- the production of **high-quality nutritious plants**, but
- **without the use of organic and synthetic pesticides.**

Current challenges are the high initial investment (plant), labor costs, and above all the primary energy source. The next generation of intelligent IVFs, such as the one from &ever (Germany), uses compact, energy-efficient propagation cells that implement a high degree of intelligent computer automation (for sowing, transplanting, harvesting, transport and even packaging) to increase efficiency at all levels, drastically reduce labor and operating costs, and significantly reduce energy-related costs.

6 Key Players in the Value Chain and their Potential for Action

In the following, the effects of the key players in industry, trade, customer as well as politics, investors and media are critically examined with regard to their potential for transformation and disruption. The multi-layered consideration and evaluation of these payers is essential in order to derive fundamental tendencies of a disruptively changing value chain in the long run.

6.1 Politics

Key player politics:

> *A "new" political insight: Public health has to do with food. Food production and agriculture must be reconsidered. The misallocation of subsidies to agriculture prevents real incentives to perform; for a change in conventional agriculture towards sustainable production.*
>
> Volker Weber, Member of the Executive Board and Chief Sustainability Officer at Nixdorf Kapital AG

Historically, **organizing agriculture** and providing food to the population has always been a task for government and politics. Comprehensive sets of rules to safeguard jobs and the domestic market, intervention mechanisms, standardization of product quality or guarantee of the supply situation, and promotion and subsidy programs are the corresponding political tools.

Within the **EU**, the member countries coordinate their policies within the framework of the CAP, which determines important objectives and distribution mechanisms in 7-year cycles. The current program is summarized under the **"Farm-to-Fork" strategy**.

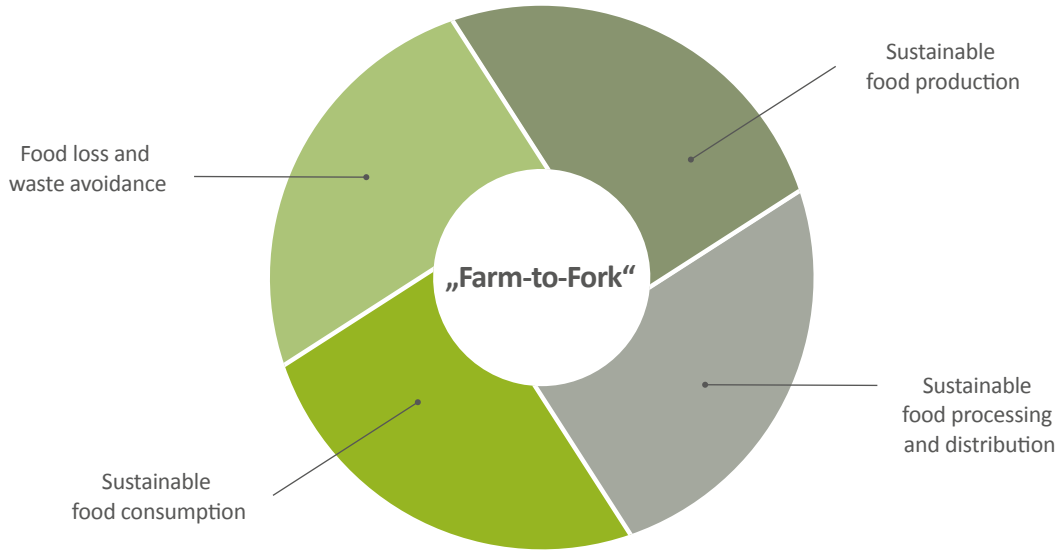
The goals of the **"Farm-to-Fork" strategy**, within the framework of the EU Green Deal, are

- **sustainable food production**,
- with **biological diversity** and
- to achieve a **fair, health-conscious, and environmentally friendly food system** within the EU by 2030 [52].

▶ Among other things, the share of **organically farmed agricultural land** is to be increased from the current 7.7 % to 25 %, the reduction of GHG emissions is to be pushed forward towards 50 % or 55 % compared to 1990, a **50 % reduction in the use of pesticides** and **antimicrobial agents** for farm animals and aquaculture is to be achieved, as well as a **20 % reduction in the use of fertilizers** to improve soil fertility and counteract nutrient losses. The Commission also wants to accelerate **the introduction of high-speed broadband internet** in rural areas, in order to reach the target of 100 % access by 2025.

In addition to a sustainable EU food system, **access to a healthy diet should also be ensured**, while at the same time reducing negative climate impacts and securing the livelihoods of the food producers involved.

Fig. 12: EU Farm-to-Fork strategy



Source: European Commission, 2020

Further objectives include updating and revising existing animal welfare legislation, the use of sustainable feed, the promotion of agroecology and agroforestry in addition to organic farming, to set legally binding EU targets for the restoration of nature, 30 % of land and sea under protection, to plant about 3 billion new trees by 2030, and to take action against the decline of pollinators such as bees [53].

As a focal point, the "Farm-to-Fork" strategy also includes **the preservation of biodiversity**.

The aim is to protect Europe's biodiversity and to increase it again by 2030. In addition, the aim is to be better prepared for future crises – such as the corona pandemic – and to become the first climate-neutral continent through a sustainable EU economy [53].

6.2 Investors

"After corona investors have to re-think their general long-term risk investment strategy. In terms of which asset class and companies offer most resilience and quick adaption within continuous instable situations."

Robert de Vreede, Executive Vice President Food at Unilever Netherlands

Investors are an important influencing factor for the development and implementation of innovations, but also in the substantial transformation of food companies.

Private investors and specialists from the venture capital market **support young companies, innovations and founders via targeted financing**. This is an important prerequisite for producing innovative technologies, enabling global efficiency improvements and expanding the demand for alternative food products.

In the area of conflict between population growth, changes in meat demand, fundamental transformation of the food value chain, and numerous innovations in the "alternative food" sector, numerous new investment opportunities arise.

▶ The allocation of risk capital will therefore have a significant influence on which alternative protein sources and "alternative foods" are preferred in the future. The market's success will also substantially change the value chains.

More and more private and institutional investors note that environmental, social and governance **criteria (ESG criteria for short) are becoming increasingly important to companies**. The influence of investors is manifested here not only through the pure purchase decision, but also through **direct influence as shareholders** (shareholder engagement) and active disinvestment from unsustainable business activities that are harmful to health or the environment.

This trend towards the inclusion of sustainability investment criteria is clearly reinforced by the comprehensive and **numerous initiatives at global, European, and national level**, which specifically focus on the financial sector and regulated major investors (see 7.1). They aim to steer global financial flows towards a more sustainable economy. Actors at the global level are the G20, the signatories of the Paris Climate Convention, the UN, but also the central banks and the Coalition of Finance Ministers and other international platforms.

Interview

Martin Roth, Head of Investments at Manor Pensionskasse AG, Basel (Switzerland)

As an institutional investor, how do you see the investment opportunities in the alternative food sector?

The regulatory and political pressure on pension funds is growing, so that the asset management industry is also challenged to offer sustainable solutions with attractive returns. However, our own sustainability policy clearly demands an economic decision-making process.

Unfortunately, purely theme-oriented investments have had a negative impact to date, as many mistakes were made in the past during implementation.

However, when you look at the entire value chain of food systems, this topic still offers exciting aspects.

A new asset class, "Alternative AgriFood-Technology", could offer scalable and high-yield options similar to healthcare or IT tech, encouraged and demanded by the trend of pension funds to invest in impact investments.

6.3 Industry

> *Lobbying can delay upheavals, but it cannot stop them permanently. If the economy is right, the struggle of the old industries no longer makes sense.*
>
> Lars Thomsen, Chief Futurist & CEO at future matters AG

The recycling of agricultural products can be roughly divided into two areas:

(a) the **primary production** of agricultural products of all kinds, and

(b) **further processing** by food companies.

In between there are numerous intermediaries, wholesalers and logistics partners. The value chain is also supported by numerous technology partners, such as providers of agricultural technology, food processing machinery, and software houses.

The few globally operating groups are managed under the name "Big Food". Oligopolistic global and regional structures characterize this market structure. In the USA, the ten largest food companies control half of all food sales [54] and worldwide this share is about 15 % (with increasing tendency). A global duopoly can be observed for soft drinks [55].

Due to the low intensity of competition and a manageable number of market players, **optimization is largely based on the shareholder value principle**. As a result, this also determines which products are produced and ultimately which ones reach the end consumer via retail trade. Global expansion takes place from largely saturated markets to rapidly growing regions in Asia and developing countries [56; 57].

The responsibility of "big food" for health and ecological side effects of food systems must be considered **very high**. In particular, "Big Food" is seen as the driving force behind the worldwide increase in the consumption of **hyperglycemic soft drinks** and food fortified with salt, sugar and fats [56]. This is directly responsible for **increasing obesity and diabetes** [58] and cardiovascular diseases [59]. Conversely, "big food" can also have positive effects, such as improved regional economic performance, the use of new technologies or the development of knowledge as well as reducing the risk of malnutrition [60].

> All listed companies in the food industry are currently exposed to a strongly growing pressure to change, as investors, as described in chapter 6.2. expect new standards of responsible action with regard to environmental issues and society to allocate their money accordingly.

Some responsible companies are already driving and supporting innovations, new methods and technologies that make a positive contribution in a targeted manner or protect the environment and people. They adapt their long-term strategies and existing processes.

- However, there is currently no sign of a cross-industry change in behavior; but it could be quickly accelerated by aggregating the measures of various actors and triggering short-term transformation or disruptive movements.

6.4 Retail

Especially in the food sector, the range of products offered by our department store chain has changed significantly, from the supply chain to the product range. The corona crisis currently has a major impact on the activities of our Group and our daily work. At the same time, however, it has significantly strengthened the Group's focus on sustainability.

Martin Roth, Head of Investments at
Manor Pensionskasse AG, Basel (Switzerland)

Food retailing plays a key role in the value chain, as this is where the final price is set, and direct customer contact takes place.

The interests of the food retail trade are primarily economic, but they also fulfill a **system-relevant supply function** for the population. At the same time, food retailing is an important **economic driver**.

In Germany, the food retail trade has an annual turnover of EUR 158.3 billion. About 778,000 people are employed in just under 38,000 stores. The discounters are among the largest retail players with a turnover of about EUR 72.3 billion. They are followed by the supermarkets with EUR 46.7 billion, with EUR 15.7 billion for the large supermarkets and EUR 18.8 billion for hypermarkets [61]. **The market in Germany is characterized by duopolies and oligopolies**.

Retail and industry therefore have a large influence on how sustainable and healthy consumers eat. As a central interface, food retailing also functions as a **mediator of certain values**. It can thus motivate itself and consumers to take a greater interest in the conscious use of resources and a more sustainable and healthier lifestyle.

In recent years, the focus of retail has been on the intensive communication of "**offer prices**". As a result, consumers have become accustomed to receiving food at dumping prices. **The bidding of low prices** was passed on to suppliers and pre-suppliers, which resulted in various yield optimizations in the value chain.

As a result, **intensive agriculture and livestock farming** have been significantly increased in recent decades, which among other things, led **to considerable environmental pollution**. [62]

The changes in agricultural value chains are still not transparent for the end consumer and are rather controlled by offensive marketing measures of the trade. Trade has the greatest influence on the consumer and can contribute to achieving a **high degree of efficiency in the transformation of food systems** by increasing the range of organic and fair-trade products and providing transparent information on the sustainability and health of products.

6.5 Consumer

Strengthened by corona a large social upheaval takes place: Eating at home, cooking together, quality of food "do it yourself – together" Quality and enjoyment are central themes of everyday life, more attention is being paid to the body: living consciously and eating consciously is also taking place in the "bourgeois" sphere, i.e. among the broad masses - this change in behavior has enormous economic potential.

Ulrich Siekmann, former managing partner at SieMatic

The typical consumer uses food several times a day. They choose from a variety of products from all over the world. For many people, regional foods are a kind of security because they feel they know what they are buying. Decisions are influenced by a variety of factors, including habits, experiences and physical, cognitive, social, and cultural influences [63].

The decision-making process includes value judgements, routines, rules, and **conscious and unconscious choices in food selection** [64]. In the sociocultural environment, food costs and availability play a major role. Sustainable and healthy nutrition therefore requires a whole package of measures to reach the customer.

Supermarket shopping is often characterized by the products on offer, advertising measures and price labeling. **Through targeted placement**, the purchasing process is consciously influenced with the aim of maximizing the retailers' sales and margins.

The average share of a consumer's food expenditure in **Germany** amounts to approximately **13–14 % of net income**. In international comparison, countries such as the USA and Switzerland are below 10 %. In some **developing countries**, higher values of **more than 40 %** were recorded [65].

▶ Nutritious, organic products are usually significantly more expensive than conventionally produced food. Poverty therefore restricts access to healthy and sustainable food. However, access to healthy and sustainable products can be facilitated through appropriate training or financial assistance [66].

The quality of food is more and more often in the Focus of public debates. Consumers want products that are as cheap as possible. At the same time, quality and safety must be as high as possible [67]. The Nutrition Report 2018 of the Federal Ministry of Food and Agriculture shows, among other things, that German consumers are aware of their influence on better food quality, but do not use it enough:

- 90 % say they would spend more on food if the animals were kept in better conditions
- Only 23 % use their influence for better food quality according to their own assessment
- 82 % of consumers see the refusal to buy as the most important influencing factor
- Media reports influence buying behavior: 66 % of consumers have changed their buying behavior due to media reports [68].

Since crucial information on the package is often missing or incompletely represented, consumers find it difficult to make purchasing decisions, since they cannot guarantee the quality of the product. **More transparency in the food industry** through labeling obligations such as the nutrition traffic light, the display of prices per kg, restrictions on marketing measures and also sales restrictions as well as pricing instruments are effective and target-oriented tools. In principle, the industry, food retailers and politicians have the greatest scope for influencing the purchasing process for food on a broad scale. A comprehensive strategy is needed to improve health and sustainability in the long term.

6.6 Media

"Images make decisions: Particularly in the nutrition sector, communication and education in the media is a significant factor that determines consumer preferences and changes the resulting offers in retail."

Steen Rothenberger, Investor and Hotelier at Rothenberger 4XS

At the turn of the millennium, television and print media determines the communication with consumers and shapes different images of what food they should buy.

Today, **social media** and apps **dominate the daily flow of communication**.

In fact, social media channels offer an easily accessible way to learn about nutrition. The Internet offers a surplus of nutrition experts, bloggers, influencers, cooking instructions, weight loss apps, and research results. This creates a diffuse picture of the correct nutritional form for the consumer.

In addition to the health claim, a new form **of moralization of food** through aspects such as ecology, ethics, sustainability, and "naturalness" seems to be emerging. In addition, the movement of "Foodies" represents a nutritional image that, in contrast to blogs on healthy eating, is not aimed at renunciation but rather at enjoyment and eating culture [69].

NGOs such as PETA, Greenpeace and WWF but also consumer organizations like Foodwatch are intensively involved in social media. They know how to activate a large number of users for a campaign and ensure a political understanding of nutritional issues among users. Accordingly, topics such as the environment and animal protection, human rights or world nutrition are intensively discussed online, often also with regard to individual players in the food systems.

In theory, social media offers many prerequisites for revolutionizing communication on nutrition.

Possible starting points for this would be:

- changing the role of experts and thus a less hierarchical expert-layman discourse,
- influence on the image of individual players in the food systems,
- greater importance of everyday knowledge,
- more participation in political issues,
- changing the reach of nutritional messages,
- new possibilities for the scientific exploitation of large data sets and
- new approaches to the evaluation of scientific findings. [69]

The power of social media is now particularly noteworthy when, for example, **abuses at food companies** are uncovered that have a direct impact on the **reputation** of a company. This usually results in rapid decisions and often changes the communication of companies profoundly.

6.7 *Interplay between actors' potential for action and speed of transformation*

Based on the individual consideration of important key actors, a complex transformation field emerges that is determined in terms of content and time by the actors' potential for action. Their interactions, including possible feedback and self-reinforcement processes, create the "playing field" on which **the strategic transformation of food systems** takes place. In essence, this involves a shift in market shares from industrial food production to alternative food and, accordingly, to new alternative food systems.

Across all key players, central parameters move the transformation process.

- Based on **sustainability issues and health aspects**, it was shown that market-related, but also **industrial fields of action** are essential drivers of change.
- In the foreground are **new technologies**, various process and product innovations and the massive **efficiency increases and problem solutions** triggered by them.

In conventional food production, sales and margins are expected to decline due to an accelerating decrease in demand. In addition, investments in business models based

on the processing of animal proteins are becoming increasingly unattractive.

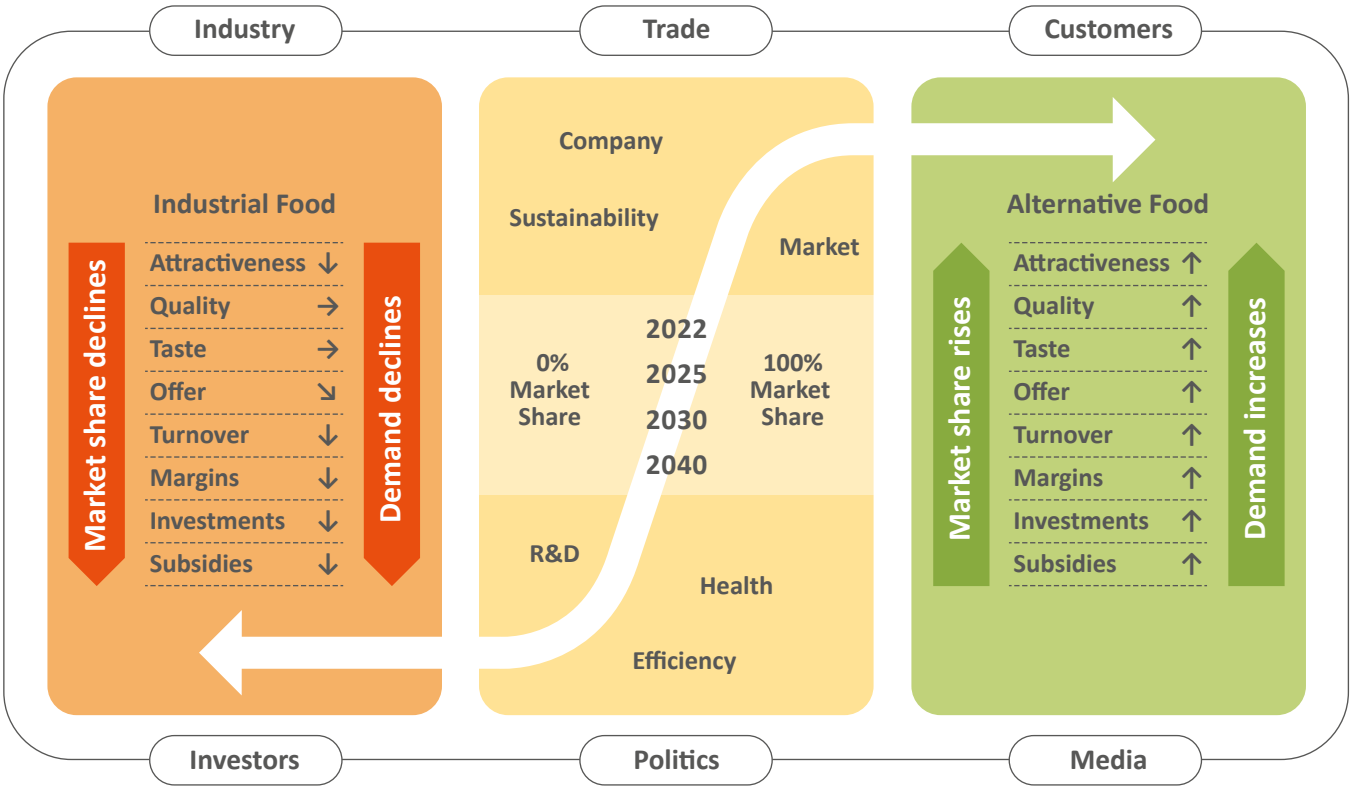
The principle of subsidizing climate-damaging production processes is already being critically questioned and will lead to further changes. The demand for alternative food products will continue to rise due to **increasing quality awareness**, innovative industry players, and **a greater acceptance of alternative food products**.

Rising demand means that industry and trade are successively expanding the range of products on offer and therefore increasing sales, margins, and investments. Start-ups and traditional food companies will be keen to participate in this market growth.

When and if there will be a complete disruption of the existing food systems remains open. However, significant changes can already be seen today.

▶ The enormous pressure to act due to progressive environmental damage and increasing climate change, as well as the motivation and willingness to act on the part of the players involved, will remain decisive in the future.

Fig. 13: Cooperation of key players in the food transformation



Source: FERI Cognitive Finance Institute/Wirsam, 2020

Interview

Sebastiano Cossia Castiglioni, Vegan Investor & Activist at Vegan Capital SA

What are the risks associated with the traditional food system today?

From an investor's point of view, I see several levels of risk – what happens to direct or even indirect meat and dairy investments if the above-mentioned subsidies disappear? For the United Nations, the biggest global health risk is human resistance to antibiotics due to its massive use in factory farming.

We have now learned the hard way that a food system based on animals is the main source of pandemics, so there are also major reputational risks for companies and investors.

From an investor's point of view, all these risks are not included in the current prices and valuations of meat and milk producers as well as consumer goods companies.

What could be the reason for a comprehensive change or even disruption of the existing food systems?

The price, that's it. If the alternative, plant-based products are cheaper than the original and taste the same, then they will replace meat, fish or dairy products in a very short time. Because the majority of consumers worldwide choose by price.

At the same time, however, consumer demand for healthier and more sustainable alternatives is growing rapidly. And the corona situation has reinforced this trend.

So who could fill the gap in this market of several trillion meat and dairy products?

Unfortunately, most large corporations are slow. Their research is outdated, and they do not invest enough in research and development. Their only strategy is to buy up external innovations and start-ups, but there are hardly any internal change processes.

Who could be the driver here instead of the big companies?

There are already many great innovative young companies that can fill this gap.

However, the biggest challenge for many of these companies is production capacity. There is not yet a major producer of plant-based products. This offers enormous opportunities for investors. Especially in the growth and private equity business, in transformation and in scaling up production.

Additionally there are many other advantages for investors, such as no lengthy dependencies within supply chains or precise demand planning. Moreover, these "alternative" companies are much more resilient in times of crisis like these.

7 Future Perspectives

The seventh chapter discusses and summarizes future perspectives on previously identified development paths to form projections that enable well-founded statements to be made for the further allocation of resources. The concluding part of this chapter presents the various tipping points both at the macro – in the form of global initiatives – and micro level in relation to visible changes in nutrition and evaluates them in terms of their respective transformative power.

7.1 Global initiatives as transformation accelerators

Future food systems will be influenced by global initiatives (including regulations and target agreements), providing a framework in which options for action by individual countries and actors are defined.

At the global level, the **Framework Convention on Climate Change of the United Nations** has had a decisive influence on the commitment of 196 countries to significantly reduce greenhouse gas emissions. All countries assume joint responsibility to limit the increase in temperature on earth to 1.5 degrees compared to the pre-industrial level. With the coming into force of the Kyoto Protocol, many measures were coordinated and adopted. This international initiative ensures that the country-specific inventories of GHG emissions are standardized and that, among other things, regulations for financing climate protection and programs for national climate protection contributions are negotiated. Agriculture is also regularly reported as a separate item in the inventories. It is therefore the focus of climate protection measures [70].

The United Nations has set further political objectives by adopting the **17 SDG**. The goal is to ensure sustainable development worldwide, both economically, socially and ecologically.

At the European level, the **Green Deal initiative** is pushing the issue through two approaches. The Green Deal is the EU roadmap to make a sustainable EU economy a reality. Climate and environmental policy measures should be perceived in all policy areas as an opportunity to achieve a fair transformation to a modern, resource-efficient and competitive economy [71].

With regard to the transformation of food systems, this is being done on the one hand through the **farm-to-fork strategy** (see Chapter 6.1), and on the other hand, with investors in mind, through the "sustainable finance" approach.

The EU will thus become an active co-designer of the transformation of the food systems and will reward positive behavior with appropriate subsidies and at the same time sanction counteracting behavior by reducing or eliminating subsidies. The farm-to-fork strategy is guided by the achievement of climate targets. The change to a more plant-based diet was also welcomed.

From an investor's point of view, the **"Sustainable Finance" initiative** should be highlighted, as it sets out guidelines for investments in the sense of the Green Deal. Sustainable financing should take environmental, social and governance – ESG aspects – into account when making investment decisions. To this end, the EU has initiated a high-level expert group to steer public and private investments more strongly in the direction of sustainable investments and to develop a risk management system that includes environmental risks and establishes regulations throughout Europe [72].

The European Green Deal is a concept presented by the European Commission on December 11, 2019, with the aim of reducing net emissions of greenhouse gases in the European Union to zero by 2050, making it the first continent to become climate neutral. The European Green Deal comprises a series of measures in the areas of financial market regulation (sustainable finance), energy supply, transport, trade, industry, agriculture, and forestry.

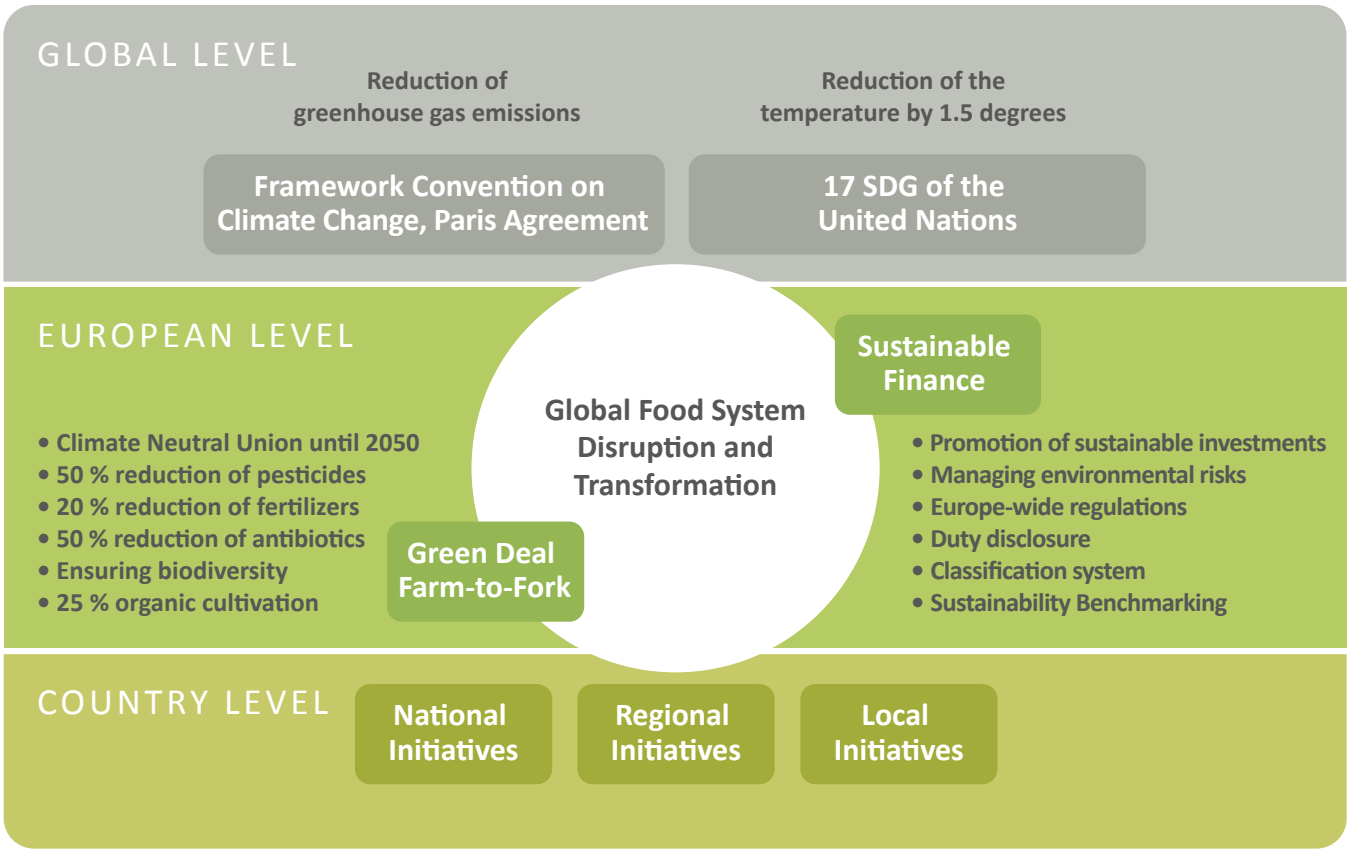
A Technical Expert Group was also formed within the EU to develop the concrete implementation measures of the EU Action Plan for Sustainable Finance of March 2018. Concrete recommendations for action include **the EU Taxonomy** for assessing the sustainability of economic activities, the EU Green Bond Standard to ensure that the EU's climate targets are met, as well as benchmarks and **disclosure guidelines** for climate-relevant information [73].

Since the interactions between the environment and food systems are important, it can be assumed that the scope of action of the "Sustainable Finance" initiative will also **provide valuable impulses for a transformation of food systems**.

The initiatives are currently being adjusted in light of the corona pandemic in order to take greater account of other risks in investment decisions. These include man-made risks, climate change, loss of biodiversity, and the strengthening of the sustainability and robustness of the economy and society.

▶ At all levels, the will to act more quickly and decisively on climate-damaging factors is evident. International cooperation has been manifested through the initiatives of the UN, particularly in the course of the Framework Convention on Climate Change, and made binding by the Paris Climate Change Convention. The initiatives are also increasingly focusing on the issue of nutrition and health and the associated environmental impacts. The political and financial tools used and the will of the actors to use them consistently are crucial.

Fig. 14: Global initiatives influencing the disruption and transformation of food systems



Source: FERI Cognitive Finance Institute/Wirsam, 2020

7.2 Disruption through food change

> *The dominant factor in the transformation of food systems will be the consumer; not governments, not capital. The way we eat has already changed dramatically, and the Millennials are hardly buying traditional industrial products anymore. Nowadays, there are more concerns about "what can you eat". The corona situation has also accelerated this trend. All our investment decisions are therefore based on the changed consumer behavior.*
>
> Jonathan Berger, Investor & Entrepreneur as well as CEO at The Kitchen Food Tech Hub by Strauss Group

In particular, the change in nutrition is a shift away from climate-damaging food to climate-friendly food.

The replacement of animal proteins by plant proteins, the change from livestock farming to sustainable and healthy alternative food products, the change of global, national, and regional food supply chains are the results of a changing nutritional style. In addition to a variety of reasons, such as food scandals, animal suffering, health and ethical concerns and misallocation of subsidies, the climate balances of conventional food systems have recently come under criticism. Here, aggregated data allow the comparison of climate balances based on simulation calculations.

Starting point of the simulation calculations are the **CO_{2eq} balances of** omnivore, flexitarian, vegetarian and vegan **lifestyles**.

Omnivore: "All Eaters"
Flexitarian: "All Eaters" and now and then vegetarian/vegan
Vegetarian: no meat, but eggs and milk
Vegan: no animal products

According to the Handelsmarkenmonitor 2018, it can be assumed that about 63 % of the German population is omnivorous, 32 % flexitarians (i.e., who eat an omnivorous diet from time to time and a vegetarian/vegan diet from time to time), 4 % eat a vegetarian diet and about 2 % are vegan.

Based on this assumption, different scenarios can be developed. According to the BMU, the omnivorous diet causes about 1,720 kg CO_{2eq} per year. The vegetarian lifestyle equates to approximately 1,160 kg CO_{2eq} and the vegan lifestyle to approximately 940 kg CO_{2eq} annually [74]. For the flexitarian lifestyle, an average value of 1.440 kg CO_{2eq} is assumed. From this, the dietary climate balance for 83.2 million inhabitants in Germany can be derived and set in relation to the total GHG emissions of about 805 million t per year [75].

Tab. 4a: Initial situation

	omnivore	flexitarian	vegetarian	vegan
Distribution	63 %	32 %	4 %	2 %
CO_{2eq} footprint p. person in kg p.a.	1,720	1,440	1,160	940
Quantity	52,416,000	26,624,000	3,328,000	1,664,000
CO_{2eq} footprint p. nutrition in kg p.a.	90,155,520,000	38,338,560,000	3,860,480,000	1,564,160,000
Total CO_{2eq} footprint in kg p.a.		133,918,720,000		

Source: Wirsam, 2020

Transformation scenario 1: A slight reduction in the proportion of omnivores is in line with current developments. The number of flexitarians, vegetarians and vegans increases slightly. In total, about 7 million t CO_{2eq} are saved, which corresponds to a reduction of 5.27 %.

Table 4b: Transformation scenario 1 – Reduction to 50 % omnivore and slight increase in flexitarians, vegetarians, and vegans

	omnivore	flexitarian	vegetarian	vegan
Distribution	50 %	35 %	9 %	6 %
CO_{2eq} footprint p. person in kg p.a.	1,720	1,440	1,160	940
Quantity	41,600,000	29,120,000	7,488,000	4,992,000
CO_{2eq} footprint p. nutrition in kg p.a.	71,552,000,000	41,932,800,000	8,686,080,000	4,692,480,000
Total CO_{2eq} footprint in kg p.a.	126,863,360,000			
Total CO_{2eq} savings in kg p.a.	7,055,360,000			
CO_{2eq} savings	**5.27 %**			

Source: Wirsam, 2020

Transformation scenario 2: In this scenario the number of omnivores is halved and a strong disruption towards veganism occurs. Starting point can be the price parity of animal and alternative food products, for example due to the reduction of subsidies or the introduction of a CO_{2eq} tax. The savings would correspond to approximately 27 million t CO_{2eq}, which would mean a reduction of 17.74 %.

Table 4c: Transformation scenario 2 – Reduction to 30 % omnivore and increase in vegans

	omnivore	flexitarian	vegetarian	vegan
Distribution	30 %	32 %	4 %	32 %
CO_{2eq} footprint p. person in kg p.a.	1,720	1,440	1,160	940
Quantity	24,960,000	26,624,000	3,328,000	26,624,000
CO_{2eq} footprint p. nutrition in kg p.a.	42,931,200,000	38,338,560,000	3,860,480,000	25,026,560,000
Total CO_{2eq} footprint in kg p.a.	110,156,800,000			
Total CO_{2eq} savings in kg p.a.	23,761,920,000			
CO_{2eq} savings	**17.74 %**			

Source: Wirsam, 2020

Transformation scenario 3: The consumption of vegan products becomes the normal case due to the CO_{2eq} efficiency. The food production strengthens the sales of alternative food products and dominates thereby increasingly the nourishing picture. To maximize production efficiency, almost exclusively plant-based proteins are produced. The CO_{2eq} savings per year amount to about 40 million t, which is equivalent to a 30 % reduction. Meat consumption in this scenario is only on very few days per year.

Table 4d: Transformation scenario 3 – Reduction to 1 % omnivore and strong increase in vegans

	omnivore	flexitarian	vegetarian	vegan
Distribution	1 %	32 %	4 %	64 %
CO_{2eq} footprint p. person in kg p.a.	1,720	1,440	1,160	940
Quantity	832,000	26,624,000	3,328,000	53,248,000
CO_{2eq} footprint p. nutrition in kg p.a.	1,431,040,000	38,338,560,000	3,860,480,000	50,053,120,000
Total CO_{2eq} footprint in kg p.a.		93,683,200,000		
Total CO_{2eq} savings in kg p.a.		40,235,520,000		
CO_{2eq} savings		**30 %**		

Source: Wirsam, 2020

Transformation Scenario 4: The complete changeover to plant-based products enables the greatest CO_{2eq} savings. With more than 54 million t saved, this results in a reduction of 40.67 % compared to the initial situation. At a price per ton CO_{2eq} of EUR 25, this would be converted a value of EUR 1.3 billion. Reasons for this scenario could be a sharp increase in the price of meat products due to higher tax rates or the high prices of CO_{2eq} emissions. Further reasons are new production processes, economies of scale, and the absolute acceptance of all market participants to sell only plant-based products.

Table 4e: Transformation Scenario 4 – Reduction to 1 % omnivore and disruption to 97 % vegan

	omnivore	flexitarian	vegetarian	vegan
Distribution	1 %	1 %	1 %	97 %
CO_{2eq} footprint p. person in kg p.a.	1,720	1,440	1,160	940
Quantity	832,000	832,000	832,000	80,704,000
CO_{2eq} footprint p. nutrition in kg p.a.	1,431,040,000	1,198,080,000	965,120,000	75,861,760,000
Total CO_{2eq} footprint in kg p.a.		79,456,000,000		
Total CO_{2eq} savings in kg p.a.		54,462,720,000		
CO_{2eq} savings		**40.67 %**		

Source: Wirsam, 2020

The calculations can be transferred to other countries and extended to a world population of almost 10 billion people in 2050. It also becomes clear that today's eating habits must be more strongly integrated into resource-saving food systems.

Alternative food can make a crucial contribution by creating products that are more sustainable and healthier. Although a slight transformation of nutrition habits will lead to a reduction of CO_{2eq} emissions, if the rapid and consistent achievement of the UN climate goals is to be realized, the transformation scenarios outlined, and the associated reduction of animal products are the more consistent and successful way forward.

7.3 Tipping Points of the transformation of Food Systems

The diversity of the food system and the need for everyone to eat opens up room for innovation, but at the same time it also creates the opportunity for the development of new products. However, with regard to the end consumer, we find ourselves in a very challenging decision-making environment, which is characterized by a multitude of habits.

The parameters that influence the disruption and transformation of food systems are therefore very diverse. In the course of the elaboration, essential attributes could be identified:

- **Relevance of the CO_{2eq} emissions**
- **Wasting of resources**
- **Efficiency/costs**
- **Subsidies**
- **New technologies**
- **Decision-making behavior of future generations**
- **Health aspects**
- **Taste and quality**

Starting from the conventional food systems, tipping points can be identified in each case, which can accelerate the transformation and disruption towards alternative food systems through central actions of important key players.

CO_{2eq} emissions in the production of conventional food are in the critical range and must be reduced. The production of alternative food makes it possible to reduce CO_{2eq} emissions both now and in the future. The consideration of which measures can accelerate the transformation process or even trigger a disruption quickly leads to sanctions for excessive CO_{2eq} emissions. The key action here is a pricing or taxation of CO_{2eq} emissions or the introduction of a meat tax, initiated and enforced by governments.

So-called **tipping points** are turning points that mark the transition from one state to the next, often accompanied by an exponential development. An example of this is the introduction of the iPhone, which replaced cellphones with keyboards in a very short time. The relative advantage of the new "smartphones" was significantly higher than that of the old solution.

Resource consumption. The consumption of resources such as water in conventional food production is too high. Here, sanctions would lead to a change in food systems, too. Key activities include the introduction of taxes on the waste of resources or – as a positive incentive – facilitating investment in resource-saving projects. In addition to politics, investors in resource-saving business models are increasingly in demand. Alternative food systems make it possible to take resource conservation into account right from the design stage of new products.

The currently favorable **cost structure** in the production of conventional food can be attributed to the exhaustion of technical possibilities while maximizing production quantities. However, process efficiency along the entire value chain

is achieved through the use of environmentally harmful substances such as pesticides, fertilizers, and antibiotics. With regard to declining sales volumes due to the shift in demand, it is becoming increasingly difficult to operate cost-efficiently. Another challenge for conventional food production is the cost optimization of alternative food production. Here, positive economies of scale are to be expected, as larger quantities can be produced due to the shift in sales volumes. The clear cost advantage of plant proteins over animal proteins can therefore be regarded as a tipping point. This can be achieved through corresponding research activities on the part of the industry and by reaching a critical mass that shapes new customer demand. Due to the still low sales volumes, alternative food producers are currently still at a disadvantage. However, an increase in sales volumes will quickly improve the profitability of the producers.

Subsidies are essential for the survival of conventional food producers. Subsidies ensure that a basic supply is secured, especially in agriculture. However, historically developed subsidy structures tend to promote traditional types of agriculture, so that innovative concepts are disadvantaged and find it more difficult to assert themselves on the market. The right approach here should be to promote sustainable behavior. Politicians could decide on a reallocation of subsidies.

Technologies have made conventional food systems more efficient and increasingly successful. A variety of technologies has repeatedly helped agriculture to leaps in efficiency. Most recently, genetic manipulation of seeds has led to a doubling of yields in corn and soybeans, for example. The tipping point here is **increased efficiency**. What is needed here are visionary investors and players from the industry in particular, who can accelerate new processes and their market penetration through targeted research and appropriate capital resources. Current investment rounds now generate 9-digit amounts, for example to further establish vertical farming or cultured meat.

The next generations ("Next-Gens") are numerically the most important decision-makers of the future. It can be observed that even today the younger generations are already thinking very critically about their nutrition and question products more strongly with regard to health and climate-relevant aspects. With their wallets in the supermarket, they also have the most effective tool in their hands and determine which products are presented through their buying behavior. The tipping point here is the change in behavior. Evidence-based information and appropriate communication via media channels of all kinds accelerate the change. Key players here are the media and the customers themselves. Alternative food products already score points today due to various advantages and are therefore positively evaluated. Conventional products are currently being criticized more often and lead to negative image effects for corresponding companies due to the decentralized distribution of information.

Health aspects of nutrition are increasingly coming into focus, both on a social and individual level. Products of conventional food systems are mainly considered containing sugar, fat and salt [6]. Corresponding initiatives to initiate changes already exist in various countries. However, most health care systems around the world focus on treating symptoms and neglect the causes, especially prevention measures. The tipping point here is therefore **prevention behavior**. Politicians and health insurers need to set up an appropriate system that puts preventive measures in the foreground. Although the production of alternative food products is currently still carried out with the aim of imitating the texture and taste of animal products as far as possible, nutritional considerations are increasingly being incorporated into product development. At present, the products are still provided with long lists of additives, but they already avoid the use of potentially harmful substances such as antibiotics.

Taste is an essential factor in the decision-making process of daily nutrition. Especially the first alternative food products had recipes that took some getting used to and did not reach the mass of consumers. In the meantime, developments here have made significant progress and there are products in almost all food categories that have only a slight difference in taste.

Quality continues to be an important attribute for convincing the buyers. Different quality categories relating to sustainability, nutrient supply, freshness or shelf life will be integrated into the decision-making process. Consumer acceptance is the decisive factor. Industry and investors should invest in research to improve quality attributes to ensure broad consumer acceptance. Alternative food products certainly still have potential for improvement, but due to intensive research and development they also have the possibility to set new quality standards.

Table 5 summarizes the individual tipping points, key activities and players and provides an outlook into the future. The evaluation is based on the traffic light colors and shows that reaching the tipping points will lead to a positive development and, in addition, to the establishment of alternative food systems.

Interview

Lars Thomsen, Chief Futurist & CEO at future matters AG

Where do the greatest opportunities arise from the impending disruptions?

Thomsen: We expect that already from 2030 onwards it will in many cases be more sustainable and cheaper to grow a range of plant foods in Controlled Environment Agriculture (CEA) such as vertical farms than to transport these foods and only regionally available goods halfway around the globe all year round.

Independent of weather and season, Vertical Farming can be used in virtually any climate 365 days a year to grow and harvest, the yield per hectare is almost 400 times higher than growing in the open air, and the product quality is significantly better because no pesticides are used. Due to the extensive independence of climatic conditions, a local production of vegetables, fruits, legumes, and starchy plants is possible almost everywhere locally and independent of the seasons, so that even in arid areas with little water, issues such as undernourishment or malnutrition could be successfully addressed.

In our view, this technology will replace substantial parts of today's traditional land-based agriculture in various phases over the next 1,000 weeks.

Where do you see tipping points and the relevance for investors?

Thomsen: We see high-tech vertical farming companies as a completely new sub-industry in the food production of the future, which will serve a massively large and sustainably growing market. We distinguish between 1st-tier and 2nd-tier players like suppliers, as known from other industries such as the automotive industry. A completely new industry is currently being created here, which could already reach a significant size by the end of the decade – especially since other trends such as climate change, urbanization, and consumer behavior are acting as powerful accelerators. All this creates a highly exciting environment for investors in the coming decades to invest in the "Daimlers", "Continentals" or "Bosses" of the future of food production.

> *"Any trend that brings about major disruptions starts small but shows exponential growth early on."*

Tab. 5: Fields of action, actors, and tipping points in food transformation/disruption

Conventional			Transformation/Disruption			Alternative		
2020	**Conventional animal proteins**	**2030**	**Tipping-Points**	**Key Action**	**Key Actor**	**2020**	**Alternative Food, plant-based proteins**	**2030**
	CO_2 emissions		Sanctioning of excessive CO_2 emissions	Taxes on food with excessive CO_2 emissions, "meat tax"	Policy		CO_2 emissions	
	Resources		Sanctioning, waste of resources	Taxes on waste of resources, investment relief in resource conservation	Politics/ Investors		Resources	
	Costs		Costs of vegetable proteins clearly more favorably than animal	Critical mass/ efficiency/ research	Industry/ Clients		Costs	
	Subsidies		Promotion of sustainable behavior	Reallocation of subsidies	Policy		Subsidies	
	Technology		Work simplification, efficiency	targeted research/ increase in capital endowment	Industry/ Investors		Technology	
	Next-Gen		Changes in behavior	Evidence-based information/ communication	Media/ Next Gen		Next-Gen	
	Health		Prevention through healthy nutrition	Change in health care system towards prevention/ evidence-based information/ communication	Politics/ Health insurance system		Health	
	Taste		Consumer acceptance	Research/ habituation	Industry/ Investors/ Society		Taste	
	Quality		Consumer acceptance	Research/ improvement of quality (sustainability, nutrient supply)	Industry/ Investors/ Society		Quality	

Source: FERI Cognitive Finance Institute/Wirsam, 2020

8 Relevance for Investors

> *Large and institutional investors have strict guidelines and investment quotas, in which innovative investment strategies often have no place. The opportunity here lies, on the one hand, in the major regulatory changes in the financial industry, which also aim to include non-financial risks in investment guidelines and will trigger a rethinking of ecological and social risks. The agri-food market could thus become an important component of sustainable portfolios, similar to "renewable energies".*
>
> Hans-Jürgen Dannheisig, Chairman of the Management Board at Nixdorf Kapital AG

The food sector is attractive for investors simply because of its size. According to a study by AT Kearney, the global meat market alone accounts for USD 1.8 trillion [4].

In addition, the value chain of food companies is characterized by synergies, which can be evaluated transparently and objectively for the investor due to the availability of extensive market data, scaling options, and comparisons. An analysis of market shares and growth opportunities must be implemented in a targeted manner, which can be a great advantage when assessing the risk of the investment. Despite this, food companies were long considered consistent and stable, but unspectacular and accordingly received little attention from analysts.

Basically, as in all other industries, the two most important financing structures are private equity (equity, private equity, venture capital) and the public markets (exchange-traded securities).

The latter produced food stocks that were usually considered relatively "safe" but promised little growth potential and were often more appreciated for their dividends. The market assumed that people always have to eat, but not much more or differently.

But recent history has significantly changed this perception. In some circles, the food industry is attributed the same or a much more significant investment potential than consumer goods or even technology. This development is attracting more and more private investment.

Once innovative food companies are recognized as a stable investment, they attract the interest of numerous private investors. According to one estimate, venture capital alone, which is mostly limited to newly founded companies, has invested almost USD 10 billion in food companies since 2013. Private equity investors are already involved in all areas of the food systems value chain, including large companies.

Venture capital investments were still almost exclusively "vertically" focused on pure technology companies in the 1990s but have since spread horizontally to almost all industries. Today, venture capital investments in technology companies are still perceived as having significantly higher growth expectations than food companies, but this view is currently changing more and more.

A corresponding global financing volume in established novel vegan meat replacement brands, such as Beyond Meat, Field Roast or Impossible, amounted to USD 900 million by 2018 [76].

Much of this change dynamic is due to the **shift in consumer expectations** – and to the industry's success or failure in meeting those expectations.

- Keeping pace with the significant changes in demand has proven difficult for many of the largest and oldest food companies. This has created a **market opportunity** for smaller, **"faster" companies** which in turn has created a significant demand for private financing.

Numerous private investor companies have distinguished themselves as specialists in the "alternative food" sector. They are trying to close a market gap that seems to have arisen due to the cumbersome nature of large food companies, and thus develop products for the "new" buyers more quickly.

Large companies (mostly from the USA) in particular have so far found it difficult to respond to new trends, as their main focus is on quarterly profits. Innovation takes time, and companies have neither enough time nor patience to finance the development of healthier and new products over five or seven years.

Today, however, there is a **clear turnaround in the global food companies**, which have been systematizing their innovation processes for some time now by providing promising new "alternative food" start-ups with funds, support and know-how through their venture capital units. In this way, they can leave potential default risks outside their profit and loss accounts, can better control their development and research expenditures and at the same time quickly purchase innovative knowledge and ideas.

One of the first companies to adopt this approach was Coca-Cola, which founded a venture capital unit in 2007. It eventually acquired several of the companies it financed in this way, including Honest Tea and Fairlife Milk. General Mills has funded more than half a dozen companies through its unit "301 Inc.". Other major food companies that have established venture capital funds include Kraft Heinz, Tyson Foods and Kellogg Co..

The alternative food sector is currently seeing **major movements and activities**, especially the "big players". While Tyson Food presents its own plant-based solutions, Unilever (The Vegetarian Butcher) and Nestlé (Sweet Earth) use independent brands and linked start-up solutions. Even the world's largest food company, Cargill (USD 115 billion turnover in 2019), has publicly announced that it will also be offering alternative meat products in the future. Even retail giants like Amazon are already investing in the alternative food market (with the Whole Foods brand).

However, investors should make a clear distinction between public marketing promises and **substantial changes in corporate strategy** and direction. Of course, all large corporations, with large marketing budgets, are jumping on the megatrend "sustainability" and "alternative food". However, the activities are usually not much more than lip service or high-profile marketing ideas.

- Investors who want to invest in truly sustainable companies must consider the overall strategy of the company and include both the operational conditions (e.g., production processes, employee conditions, governance structures, etc.) and the strategic orientation of the entire product range in their analyses. This requires a lot of know-how, comprehensive non-financial data (ESG data) and also own in-depth analyses of the companies.

Interview

Hans-Jürgen Dannheisig, Chairman of the Executive Board at Nixdorf Kapital AG
Volker Weber, Member of the Executive Board and Chief Sustainability Officer at Nixdorf Kapital AG

Mr. Weber, Mr. Dannheisig, you are well-known experts in the field of sustainability and now also an investor for Nixdorf Capital. Has your investment strategy changed during and after the corona crisis?

Weber: Corona has not and will not change our investment behavior. Investing with impact and the focus on sustainability has remained for us. For us, the following still applies: Economy, ecology, and social behavior are not mutually exclusive!

Dannheisig: But we are convinced that the awareness and behavior of many other professional and private investors will change. We would like to set an example here.

What major challenges do you currently see, particularly in terms of society?

Weber: Politicians have recognized that public health has to do with food. However, the misallocation of funds by subsidizing agriculture needs to be rectified. Incentives must be created to change conventional agriculture towards alternative and sustainable methods. Socially, changing consumer behavior is one of the major challenges: "Renunciation is unattractive".

Dannheisig: Especially the necessary strengthening of the regionality of food production has a multitude of social challenges, which must not be considered in isolation.

Do you see possible solutions?

Weber: Alternative food options must also be wanted and accepted by consumers. Important aspects are price and reliability: firstly, the price premium between industrial production and secondly "organic" must no longer be serious. Stable production costs and acceptance security are the main drivers of an economically sustainable food supply.

Dannheisig: There is no alternative to the fact that also all additional costs of industrial food production are more strongly integrated into the pricing and are not socialized.

Where do you see the opportunities and challenges for investors here?

Dannheisig: The more sustainable aspects a portfolio can tap into, the lower the risks and the higher the total return from financial return and ecological and social impact.

> *"Economy, ecology, and social behavior are not mutually exclusive!"*

8.1 Significance, opportunities, and risks for regulated/institutional investors

One of the most important parameters for institutional decision-makers is – in addition to meeting regulatory requirements – always ensuring that the purpose of the institution is fulfilled. In the case of pension schemes, the basic purpose and the overriding objective is the payment of pensions and annuities. In the eyes of most European (regulated) institutional investors, therefore, social or ecological responsibility is (unfortunately) often (still) in second place.

Long-term risks as well as **attractive investment opportunities** are always **the primary drivers of strategic** asset allocation, which is crucial for institutional investors. It is important to recognize that non-financial factors also have a significant influence on their economic decision-making. This is increasingly demanded by regulators, as already stated clearly in January 2020 in the BaFin (Federal Financial Supervisory Authority) leaflet [77].

However, most large institutional investors (pension institutions, insurance companies, etc.), especially in German-speaking Europe, still do not provide a clearly differentiated and comprehensive definition of their sustainability approach.

The most important prerequisites and hurdles for a significant paradigm shift of institutional investors towards a sustainable investment strategy would be:

1. The investor-**specific financial requirements** (risk/return targets, liabilities) must always be at the forefront of all considerations

    a. The catalog of **non-financial risks** must be expanded to include sustainability aspects.

    b. **Investment limits** must take the new risks into account.

    c. New/alternative forms of investment must be re-examined and, if necessary, expanded against the background of the **social task** (example: corporate investments and VC).

2. The decision-making horizon of large investors is usually based on rather short-term risks and key performance indicators (1 year). The short-term observation periods are contrasted with the long-term risks. This is an obstacle **for long-term strategic reorientation** of companies as well as the risk/return profile of company investments, especially in growth markets or young companies.

3. **Limited resources** (few staff) within pension funds often do not allow the necessary analysis of new strategic issues and investment opportunities, which require a great deal of in-depth knowledge and prudent decision-making. This requires building up market know-how and making use of specialist knowledge.

The current efforts of global, European, and also national initiatives are aimed at establishing a uniform market standard, a common understanding, and concrete regulatory guidelines. This would make it possible to significantly increase the influence on the transformation of companies and the real economy and to steer large capital flows toward a more sustainable economy (as described in section 6.1.).

Thus, the general inclusion of non-financial risk factors and criteria and the embedding of sustainability goals in asset allocation will have a direct impact on the portfolio composition of investors.

Certain investments and companies will be excluded due to new sustainability criteria. In the case of various criteria, this also affects companies in the food industry and thus indirectly forced them to adopt a more sustainable approach.

A growing number of institutional investors, for example from the Netherlands or Scandinavia, are also playing a very **active role as shareholders**, who are already shaping the prospects and strategies of many companies in every sector. The investors, including their asset managers, see their social responsibility as shareholders in a comprehen-

sive "engagement strategy" that directly influences the decisions and future issues of companies and demands a clearly sustainable orientation.

The regulatory paradigm shift, coupled with a **comprehensive understanding of the social responsibility** of institutional assets, will make a reorientation of the food industry inevitable. Effects on food systems companies are already visible today and will lead to significant changes in production processes, supply chain conditions and also in the product portfolio.

▶ **Only companies that are already developing a clear strategy for the future, which takes social and environmental factors into account, will continue to receive support from investors.**

"Especially for the listed companies, it will be absolutely necessary to adjust to the massive changes in the food market and to align their own operative processes as well as their product range more sustainable. However, above all the management must be convinced and stand for transparency."

Jochen Spethmann, Entrepreneur, Co-owner and Supervisory Board Member at Laurens Spethmann Holding AG & Co. KG

In general, it can be said that investments in individual industries are rather rare among institutional investors due to the decision-making processes described above, since their strategic long-term planning is basically oriented towards traditional asset classes. These asset classes are predominantly structured regionally (European equities, US bonds, etc.). Individual subject areas rarely occur and are at best used on a short-term (tactical) basis. So far, only the technology sector has usually played a noticeable role in this.

However, a more **topic-specific investment orientation** is emerging, particularly in the case of large international institutions, which define **"impact investing"** as a target orientation for themselves. Here, among others, the Dutch pension funds should be mentioned, some of which carry out a direct efficiency measurement of their investments in relation to SDG and already in 2018 invested a quota of 15 % of their assets in Impact Investments related to SDG.

Even though theme investments, such as food investments, are not yet widely implemented in the liquid investment sector, they could offer new investment opportunities, strengthened by regulatory requirements and the realignment of strategic target benchmarks.

Furthermore, it is interesting to note that an investment in listed companies in the food industry – including all parts of the value chain – shows positive and diversifying risk-return profiles.

The massive changes and possible exponential development in food systems with regard to new technologies may have only indirect influence on the strategic investment method of institutional investors in the first step. Substantial investment quotas in venture capital (VC) or even start-ups are little or not at all feasible due to the long-term obligations and corresponding regulations for institutions (in Europe). Only in the USA does the VC sector have a different status and a different perception of risk.

Although there are promising initiatives by European investor groups to also address young technologies and companies by pooling joint know-how and building up their own "accelerator platforms", the numerous investment opportunities in innovative ideas, young companies, and disruptive technologies are mostly reserved for the second group of investors, the private investors.

Impact Investing refers to investments made in companies, organizations, and funds in order to achieve measurable, beneficial social or environmental impacts while generating a financial return.

8.2 Significance, opportunities, and risks for private investors

The biggest advantage of private investors is that they only follow personal risk-return guidelines and do not have to comply with strict regulations. This **personal degree of freedom** is particularly evident in the area of entrepreneurial investors, including many family offices. Here, **innovative technologies and strategic megatrends** are implemented much faster in the investment portfolio. Sustainability and impact investing are also already playing a greater role.

For private investors, all investment phases (startup, venture, PE up to shares) of food companies offer attractive opportunities, which of course have different risk profiles.

The most important decision for entrepreneurial investments is the preference for direct or indirect investments. Direct investments allow many opportunities for **co-designing**, but also demand a high level of **personal commitment** and often mean a rather concentrated investment risk, since usually large sums are tied up in individual projects for a long time. Indirect investments (in PE, VC funds or fund of funds) allow a broader diversification across different start-ups or companies. Although the personal commitment and the possibility of intervention are limited, one can benefit from the expertise and experience of the acting managers.

Professional venture capital firms generally invest in start-ups or in companies that are not long past the start-up phase. Most of these are investments with high-risk and high profitability, but also with a correspondingly high default rate. In the food sector, there are usually focused and very specialized growth capital providers, most of whom come from the sector itself and can contribute a high level of knowledge and expertise to the young companies.

Another group of investors for start-ups are so-called **angel investors**. These are wealthy individuals who provide their money to finance a new company. They usually do this for more personal reasons, either related to the founders (friends or family) or for overriding and ethical reasons. Angel investors are playing an increasingly important role in start-up financing, especially in areas where "early" seed capital is required. Venture capital investors join in when the concept of the company is viable.

Beyond Meat, the publicly traded, plant-based, analogue meat company, started out with a number of angel investors, including Bill Gates and Leonardo DiCaprio, who invested out of a belief in making the world a better place with alternatives to meat. Prominent angel investors significantly increase public awareness of the overall topic and thus often contribute very directly to the success of the young companies.

A **business angel** is someone who invests financially in companies and at the same time supports the founders of new businesses with know-how and contacts in a typically very early phase of company development.

In principle, private capital investors seek a certain degree of control over companies, ranging from a seat on the supervisory board to full ownership. Venture capitalists tend to demand a high degree of control – especially in early stage companies. Highly committed impact investors may be more likely to see themselves as angel investors to provide personal assistance to the companies they support and to help drive their mission forward.

Many of the already active angel or venture capital investors have the positive impact of investments in alternative food companies on health but also on the environment in the focus of their investment strategy. These impact investors can significantly increase their positive impact thanks to the ongoing change and numerous innovations in the food industry and fulfill their claim of an intended "impact" on people and the environment in the best possible way.

▶ In conclusion, it can be stated that companies from all parts of the value chain in Food Systems, in every phase of development and in all forms of investment, offer interesting opportunities to participate in the unstoppable transformation and the foreseeable massive upheavals in this gigantic market.

Private investors should above all be aware of their willingness to take risks with regard to the duration and amount of their commitment. The liquid stock markets offer a promising opportunity to include the overall theme in one's own portfolio without having to forego liquidity. There are numerous listed companies that are already established but still offer a very high degree of innovative strength and also a sustainable corporate strategy. Investments in young companies and technologies, on the other hand, offer a more direct participation in the disruptive changes in food systems described in this study.

Interview

Dr. Manon Littek, CEO at Katjesgreenfood
Bastian Fassin, Managing partner at Katjes Fassin GmbH & Co. KG

Where do you see the biggest changes in the food value chain (Food Systems)?

Fassin: We are currently seeing a significant change in consumer behavior. After the Second World War it was all about securing the basic supply, the production of cheap calories was the goal here. Selling large quantities at the lowest possible price was subsequently reinforced by the discounters. Now food suddenly got a new function – "You are what you eat". Strongly driven by the Millennials, to which topics such as health, transparency, regionality or even ethical consumption are important. The "new" consumer is better informed and above all interested.

Social media is becoming the challenge of "big food", as consumers publicly punish irresponsible behavior. Consumers are increasingly focusing on sustainable alternatives like factory farming are open to healthy innovations and are also willing to spend more money on quality. Plastic packaging is being pilloried and even the classic distribution models are changing in the context of digitalization. The entire food supply chain is on the move, and these trends have now even been accelerated by the corona situation.

What does this mean for you as an entrepreneur but also as an investor?

Fassin: At Katjes, we adapted to this development at a very early stage, as well as reorganizing production, and we are benefiting greatly from this. The consumer has accepted this positively. Four years ago we then took the next logical step and founded Katjesgreenfood as an independent sister company.

Littek: With our clear focus on investing only in high-growth, plant-based impact companies, we are pioneers in Europe. We firmly believe that these companies, which are shaping the food revolution, will become the market leaders of the future.

> *"Food is the new gold."*

What is your experience after four years of investing in food start-ups?

Fassin: You could say "Food is the new gold". Our experience is that the risk-return profile of food start-ups differs positively from early-stage tech companies. We have not had any defaults in our portfolio so far. The companies develop more slowly and are more capital intensive through procurement, production, and distribution. But they are much less risky, less cyclical, and the returns are very steady. It is a very stable investment in the long term and as a "safe bank" offers continuous increases in value.

Littek: The food industry has proven to be relatively crisis-proof during the corona crisis. In general, sales in the industry are growing faster than the economy as a whole. Within the food industry, the growth of the vegan market is also above average. These developments offer many opportunities in the medium and long term for those companies that have recognized the food revolution and the rapidly increasing demand for plant-based, sustainable food in time and have established themselves as pioneers in this field.

8.3 List of selected AgriFood VCs and Start-Ups worldwide

As an orientation for interested investors, a survey of the world's leading food VC companies was conducted by Mr. Andreas Schwarzhaupt, CEO of NooVentures. These companies each named their 10 most interesting start-up companies. This resulted in the following overview.

The list of VC funds and start-up companies serves only as an overview and is not a recommendation to buy.

Tab. 6: Global AgriFood VCs – Examples

Company*	Country	Contact
Anterra Capital	NL	www.anterracapital.com
Astanor Ventures	BEL	www.astanor.com
Atlantic Food Labs	GER	www.foodlabs.de
Better Food Ventures	USA	www.betterfoodventures.com
Blue Horizon Ventures	CH	www.bluehorizon.com/venture
CPT Capital	GB	www.cptcap.com
Finistere Ventures	USA/IRL	www.finistere.com
Five Seasons Ventures	FRA	www.fiveseasons.vc
Kitchen Hub	ISR	www.thekitchenhub.com
New Crop Capital	USA	www.unovis.vc
Omnivore Capital	IND	www.omnivore.vc
S2G Ventures	USA	www.s2gventures.com

* In alphabetical order, best-known start-ups

Source: Special mentioning; AgFunder/USA; AgTech media company & VC

Tab. 7: Global AgriFood start-ups/growth companies – Examples

Company*	Country	Contact
Aleph Farms	ISR	Cultured Meat
Apeel Sciences	USA	Organic coating on fruits/vegetables that increases shelf life
BlueNalu	USA	Cell-based fish
Heura Foods	SPA	Plant-based meat
Innovopro	ISR	Protein Alternative products based on chickpea
Mosa Meat	NL	Cell-based meat
New Wave Foods	USA	Plant-based shrimps
Odontella	FRA	Salmon and fish filet based on algae
Perfect Day Foods	USA	Fermented dairy alternatives
Planted Foods	CH	Plant-based chicken
Pulp Culture	USA	Fermented fruit alcoholic beverages
Shiok Meats	SGP	Cell-based crustacean meats (shrimp, crab, lobster)

* In alphabetical order, best-known start-ups

Source: Survey conducted by Andreas Schwarzhaupt, CEO, NooVentures, in June 2020

9 Conclusion

Final theses:

1. ***The topics of nutrition, health, environment, and politics are directly related, with a multitude of direct interdependencies.***
2. ***Current changes in the field of "alternative food" have a highly disruptive effect on the traditional food industry as well as the entire value chain of current food systems.***
3. ***Innovative technologies, alternative products, and new consumer behavior will change exponentially in the context of "alternative food".***
4. ***This will open up attractive investment opportunities for strategic investors in a very fast-growing market.***
5. ***At the same time, the conventional food systems sector is faced with increasing disruption risks, which should be explicitly evaluated.***

Today, it is undisputed that the challenge to global nutrition, health and the environment cannot be met or answered for in the long term within the framework of traditional food production – which is based on massive exploitation and waste of planetary resources. Changes are urgently needed and are increasingly being initiated – not least due to new political guidelines.

As the results and core statements of the present study clearly show, a broad spectrum of new and goal-oriented approaches to solving these problems is currently developing with great dynamism. These are known as "alternative food" and are attracting increasing attention worldwide. Already today, there are many active companies and serious projects that are vigorously promoting "alternative food", meaning the alternative production of urgently needed basic foodstuffs. The underlying approaches range from "Smart Farming" and "Vertical Farming" to technologies for plant-based meat substitutes and targeted cultivation of microorganisms. **The primary goal is a sustainable, environmentally friendly and resource-saving production and provision of important nutritional bases for a growing world population.**

For a better understanding of the topic, it is helpful to place it in the context of global "food systems":

In addition to the existing structures of agriculture, agrochemicals, production, and trade, "food systems" also include the most important influential players such as politics (with the control instruments of regulation and subsidies), large-scale industry, environmental organizations, the media, and consumers.

Already today, the outlines of completely new "food systems" are emerging, which will operate in a significantly different way than traditional structures. The developments in the field of "alternative food" will lead to **massive changes** due to very significant influencing factors at each stage of the value chain. Thus, the system of the traditional food industry is at the beginning of a **drastic disruption and transformation**.

The central drivers behind this development are manifold and should be analyzed and understood holistically:

Not only the **paradigm shift in global climate and environmental policy,** with new societal demands – especially from the younger generation – for a **sustainable future**, is crucial to this. Even more important is the progress, penetration, and **interaction of new technologies**, which is already driving the advance of **digital and "intelligent" concepts** in agriculture and food production. The targeted use of biotechnology and biosynthesis ("cultured meat"), but also robotics, sensor technology, artificial intelligence, and the increased use of systems capable of learning play an important and highly synergetic role.

Accordingly, the **efficiency** of the production of "alternative food", in terms of resource use and process economy, is significantly (usually many times) higher than in the traditional food industry. Today's meat industry, which operates predominantly on the basis of unethical and environmentally harmful factory farming, is especially confronted with **massive cost advantages** of plant-based proteins and innovative meat substitutes ("alternative meat").

- Superior process efficiency and high scalability allow decreasing marginal costs, which will generate **exponential growth** in many alternative protein and meat solutions in the coming years.

This clearly highlights a crucial point that is often still underestimated:

- **The breakthrough for "alternative meat" will in future be determined less by questions of ethics, but primarily by sober economic calculation. Decisive factors are the low use of resources, the potentially high (industrial) scalability, and the possibility of extremely competitive prices.**

The field of **plant-based food** is also being changed similarly by new technologies. Here, especially concepts such as "smart farming" and "vertical farming" should lead to high resource savings, optimized logistics, and, **in the long term, unbeatable efficiency gains.**

This leads to an important insight:

- The future of "alternative food" will depend less on "morality", "lifestyle", and changes in consumer behavior than on purely **economic benefits**. In addition, **targeted political measures** will further accelerate the issue. This aspect is identified in this study as crucial for the breakthrough and future strong growth of "alternative food".

In addition, "alternative food" offers a massively improved **ethical and ecological footprint**, since, by definition, the aim is to actively protect nature and animals. From an overarching perspective, the **achievement of global climate protection goals** will also require stricter measures in the area of traditional "food systems" in the future, which in turn strongly supports the development of alternative "food systems".

This implies another key insight:

- The aspect of sustainability is to a large extent covered by "alternative food" design. This point is also extremely relevant for strategic investors.

Both **responsible politics and sustainability-based capital flows** will therefore increasingly turn their attention to the topic of "alternative food". At the same time, companies from the "traditional" food industry will come under pressure on the capital markets if they do not (or too slowly) adapt to the rules of the new "alternative food systems". Not only in the area of venture capital investments but also on **liquid securities markets**, the investment topic "alternative food" will therefore soon play an increasingly important role.

- **This opens up highly interesting perspectives for investors, which offer very attractive investment opportunities in the medium to long term.**

"Alternative food" and "alternative food systems" thus have the potential to set in motion a new, very comprehensive, and strategically dominant "megatrend" in the near future. Entrepreneurs, investors, and asset owners should approach this topic with an open mind, concentration, and positive energy.

Because nothing is stronger than an idea whose time has come.

Appendix

Interview Partners (alphabetical order)

Jonathan Berger, investor & entrepreneur and
CEO of The Kitchen FoodTech Hub by Strauss Group

Stephen Brenninkmeijer, Impact Investor and
President of the European Climate Foundation

Sebastiano Cossia Castiglioni, Vegan Investor and
Activist at Vegan Capital SA

Hans-Jürgen Dannheisig, Chairman of the Executive Board
of Nixdorf Kapital AG

Lisa Dyson, CEO and Founder Air Protein at Kiverdi

Bastian Fassin, Managing Partner of Katjes Fassin GmbH
& Co. KG.

Mark Korzilius, Entrepreneur and Investor
as well as CEO at &ever

Dr. Manon Littek, CEO at Katjesgreenfood

Martin Roth, Head of Investments
at Manor Pensionskasse AG, Basel (Switzerland)

Steen Rothenberger, Investor and Hotelier
at Rothenberger 4XS

Daniel Skavén Ruben, Consultant Food Initiative
at The Rockefeller Foundation

Ulrich Siekmann, former Managing Partner
at SieMatic

Jochen Spethmann, Entrepreneur, Co-owner
and Supervisory Board Member
at Laurens Spethmann Holding AG & Co. KG

Lars Thomsen, Chief Futurist & CEO
at future matters AG

Robbert de Vreede, Executive Vice President
Food at Unilever Netherlands

Rosie Wardle, Program Director
at Coller Foundation FAIRR

Volker Weber, Member of the Executive Board
and Chief Sustainability Officer at Nixdorf Kapital AG

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The interview partners are important protagonists of alternative food systems. Through their commitment and influence, they drive the development towards an environmentally friendly and resource-saving production of food and are therefore leading representatives of a sustainable economy.

List of Abbreviations

AG	Stock corporation
BEL	Belgium
BLE	German Federal Agency for Agriculture and Food
BMU	German Federal Ministry for the Environment
BRA	Brazil
CAP	Common agricultural policy
CAN	Canada
CEA	Controlled-Environment Agriculture
CEO	Chief Executive Officer
CHN	China
CO_2	Carbon dioxide
CO_{2eq}	CO_2 equivalents, unit of measurement for standardizing the climate impact of the various greenhouse gases
DGE	German Society for Nutrition
e. V.	Registered association
EU	European Union
EUR	Euros
ESG	Environmental, Social, Governance
FAO	Food and Agriculture Organization
FDA	Food and Drug Administration
Fig	Figure
FRA	France
g	Gram
GDP	Gross domestic product
GER	Germany
GHG	Greenhouse Gases
GPS	Global Positioning System
HTW	University of Applied Sciences
IND	India
IRL	Ireland
ISR	Israel
IT	Information Technology
ITA	Italy
IVF	Indoor Vertical Farm
kg	Kilogram
mm	Million
bn	Billion
NASA	National Aeronautics and Space Administration
NGO	Non-governmental organization
PETA	People for the Ethical Treatment of Animals
PF	Precision Fermentation
SDG	Sustainable Development Goals
SGP	Singapore
t	Ton
UN	United Nations
UNIDO	United Nations Industrial Development Organization
USA	United States of America
USD	US Dollar
VC	Venture Capital
WEF	World Economic Forum
WWF	World Wildlife Fund

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Julia Bahlmann is Associate Director at the FERI Cognitive Finance Institute and has been involved in the founding and orientation of the FERI Institute since 2015. In addition to her work at FERI, she is doing her doctorate on impact investing at the University of St. Gallen. She completed her studies in Heidelberg and Marburg, accompanied by study visits to Europe and America, and graduated with a German-French double master's degree in International Business Management. Julia Bahlmann is a member of oikos, a student-led initiative that promotes sustainability in business, society and the environment.

External interviews

Andreas Schwarzhaupt

Andreas Schwarzhaupt enabled and supported the external expert interviews on this study through his international network. Together with Antje Biber, he was responsible for and managed the content, organizational preparation and carrying out of the interviews.

As owner of the consulting firm NooVentures, Schwarzhaupt advises institutional investors, NGOs and international organizations on the topic of impact investments with a focus on "Transforming the Global Food Supply Chain". Here, he works closely with institutions like the World Economic Forum (Food System Initiative) and UPLINK. The WEF/UN joint venture UPLINK promotes and scales young companies that contribute to the 17 UN-SDG with their business model.

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