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Food

Pathways to decarbonization

Introduction

The global food system can play a pivotal role in reaching climate goals

In 2022, the global population passed 8 billion. As that number continues to rise, the food supply will need to expand by 50% by 2050.[1] Yet, today's food system is not sustainable. It is a major polluter, accounting for 25% of global CO_2 emissions[2], 44% of global methane[3] emissions, and 80% of global nitrogen emissions.[4]

At the same time, food is a major economic sector producing around 12% of global GDP and providing over 40% of global jobs[5]. Unlike some other hard-to-abate sectors, the food industry has the opportunity to become net-positive, by achieving net-zero and acting as a carbon sink for other sectors. For these reasons, the food system can play a pivotal role in the transformation to a net-zero world.

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Transforming the food system is not a straightforward undertaking

Decarbonizing agriculture and food supply chains is a complex puzzle with many factors to consider, such as local regulation, climate change, societal pressure and environmental factors; no one sustainability solution fits all scenarios. In addition, there are several trade-offs that need to be carefully managed:

- In most cases, the existing food production and supply model is designed to be highly efficient. Shifting to low-carbon farming practices could result in deficiencies and higher costs.
- Adopting alternative agricultural practices, such as regenerative agriculture or reduced pesticides, will likely (initially) result in lower yields for farmers.
- The costs of transforming the food system can't typically be passed down the value chain, as consumers are often unwilling or unable to pay higher prices.

The food sector is also intrinsically vulnerable. Climate change is accelerating land degradation and making it harder for food systems to adapt, posing significant threats to food producers. Regarding agriculture, so far only five countries have benefited from climate change, while 21% of overall global agriculture productivity has been lost.[6]

To overcome these challenges, it is vital that the entire food ecosystem works collaboratively to bring about a farm-to-fork transformation. At one end of the value chain, farmers would need to change land-use practices and digitize agricultural practices, while simultaneously dealing with extreme weather and increasingly strict regulatory frameworks. At the other end, consumers would need to change their habits to eat more sustainable food.

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1 World Resources Institute, Creating a sustainable food future, 2019.
2 Poore, Joseph, and Nemecek, Thomas. "Reducing food's environmental impacts through producers and consumers." Science 360 (2018): pp. 987–992.
3 Food and Agriculture Organization of the United Nations, "Key facts and findings", accessed January 17, 2023.
4 Michigan State University, "How much fertilizer is too much for the climate?", accessed January 17, 2023.
5 World Economic Forum, "How can we protect food systems against global shocks? Here's what business leaders say", accessed January 17, 2023.
6 GZERO, "The Graphic Truth: Has climate change hurt or helped farmers?" , accessed January 17, 2023.

Decarbonization levers

Greenhouse gas emissions from food production could be reduced by 90% in the near-to medium-term[7,8]

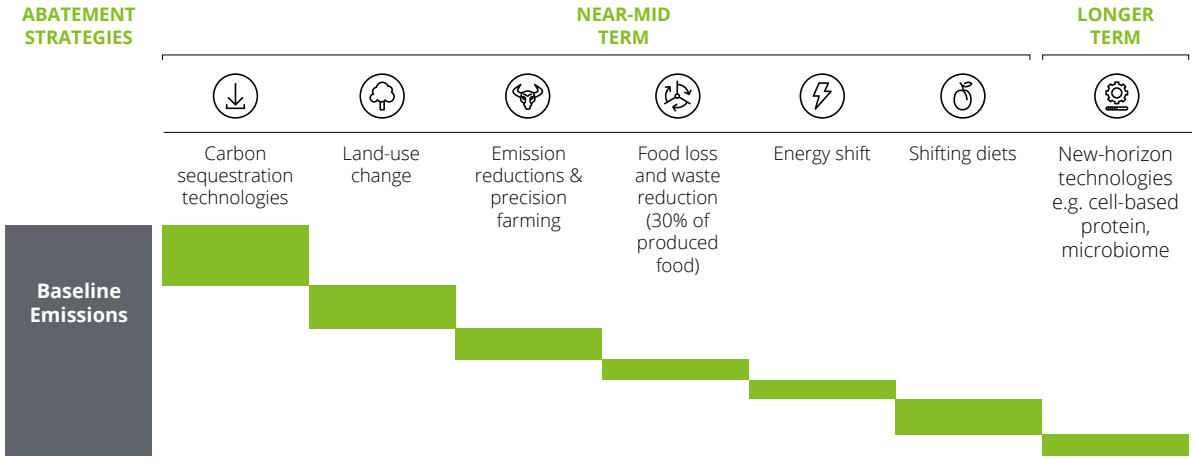

Figure 1: Technological levers to a net-zero food sector
Source: Deloitte Netherlands Insights and Analysis

Although the food sector can be difficult to decarbonize, the technological levers to overcome the manifold challenges are already known and can be implemented in the near- to medium term. Nevertheless, most of the levers require significant investment and a fundamental redesign of the food system.

Near-to medium-term levers:

Carbon sequestration technologies

Food production could play a major role in the removal (and storage) of carbon from the atmosphere. For example, changing the way we treat soil can contribute greatly to the emission reductions needed to decarbonize the sector.

Increasing the organic matter – and therefore the carbon stored – in soils can be done in a variety of ways, such as applying compost, biochar or organic fertilizer. Use of larger root plants, reduced tillage, perennial farming, cover cropping or restoration of degraded soils can control erosion and make sure carbon stays in the soil.

Agroforestry, which combines agriculture with the carbon storage capabilities of forests, is another promising option.

However, these carbon sequestration technologies can only reach their full abatement potential if the measures are implemented consistently and continuously. Otherwise, renewed degradation of the soil will re-emit the bound CO_2 back into the atmosphere.

Land-use change

Natural ecosystems, in particular forests and peatlands, are major carbon sinks. A large amount of agricultural land was historically peatland, while ongoing peatland degradation continues to release large amounts of carbon into the atmosphere. Therefore, increasing yields, which would reduce the need to convert more land for agricultural use, is a potentially huge lever for a sustainable food system. Greater land rehabilitation through enclosures and afforestation could also help.

[7] Roe et al. "Contribution of the land sector to a 1.5°C world." Nature Climate Change 9 (2019): pp. 817–828.
[8] Costa et al. "Roadmap for achieving net zero emissions in global food systems by 2050." Scientific Reports 12 no.1 (2022): 15064.

Low-carbon farming practices

Low-carbon farming practices can greatly reduce both CO_2 and CH_4 (methane) emissions. Rice and livestock are the main emitters of CH_4 in agriculture. Improving water and residue management can significantly lower the CH_4 production of rice paddies. Improving manure management and adding methane inhibitors to livestock feed stops fermentation processes that generate high amounts of CH_4.

Precision farming and efficiency gains

As in many sectors, efficiency gains can make food production more sustainable. For example, smart packaging, demand forecasting and other supply chain efficiency measures can reduce raw material consumption and the distance food needs to travel. Meanwhile, alternative or biological crop protection and precision fertilizer management can lower the emissions associated with fertilizer use.

Shifting diets

Even though many consumers are unwilling or unable to shift their diets away from animal products[9], there is still immense scope to reduce consumption-related CO_2. Accounting for the "true cost" of food, including externalities, would help unlock this potential, as would educating consumers on diet choices, such as plant-based proteins, through public health policies and consumer campaigns. At the same time, scaling alternative sustainable proteins can make them more affordable and accessible, while the development of new foods can be an important lever in boosting consumer acceptance.

Food loss and waste reduction

One third of globally produced food ends up as waste[10], while still emitting CO_2 during production and distribution. Options to reduce this waste include:

- Valorizing food system waste;
- Implementing food waste reduction in agricultural and supply chain operations;
- Establishing circular economies that involve converting waste and by-products into value-adds, such as biogas;
- Exploring shelf-life extensions; and
- Educating consumers on responsible consumption.

Energy shift

Although it is not a major lever, switching to renewable energy sources to power food production and distribution can lower emissions. The food sector could also produce energy from waste using (for example) bioreactors, creating a bioeconomy.

Longer term levers:

New-horizon technologies

Even though many of the technologies and practices needed to transform the food sector are already mature, making the sector net-zero by 2050 may require further research and development. As the amount of carbon stored in soil is highly dependent on microbial activity, targeted plant and soil microbiome engineering could improve the carbon storage capacity in soil. Meanwhile, gene editing could enable crops to adapt to climate change, increasing yields to allow for land-use change. Methane capture technologies (similar to the carbon capture, utilization and storage mechanisms in the steel or chemical industry) could also be an important tool for the food sector.

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[9] Dagevos, Hans. "Finding flexitarians: Current studies on meat eaters and meat reducers." Trends in Food Science & Technology 114 (2021), pp.530–539.

[10] Intergovernmental Panel on Climate Change, Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse gas fluxes in Terrestrial Ecosystems. Summary for Policymakers, 2019.

Call for action

Most of the levers require significant investment and fundamental redesigning of the food system

Realizing the technology levers will require significant financial investment and changes across the food ecosystem. With the exception of food loss and waste reduction, there are no quick wins. Many specific factors and barriers to overcome need to be considered. But, from an overall perspective, concerted action in the following three areas can bring about a fully decarbonized food system by 2050:

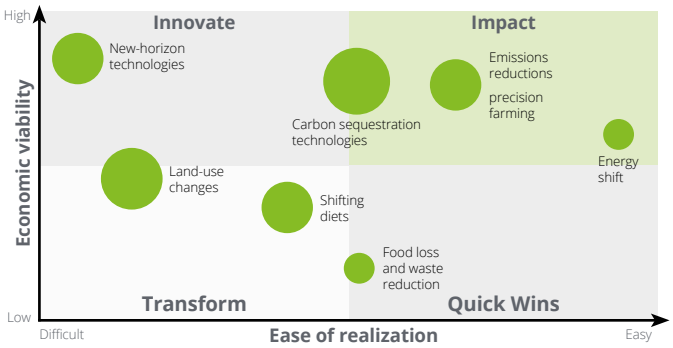


Figure 2: Evaluation of food decarbonization levers; Bubble size indicates potential carbon reduction
Source: Deloitte Netherlands Insights and Analysis

1. System collaboration

The entire food ecosystem needs to transform together. In particular, there will need to be massive uptake of supporting technology (digital and data) platforms, underpinned by new coalitions, to drive production in a sustainable manner. Thoughtful collaboration with other sectors and suppliers may also be required to switch to renewable energy through, for example, the adoption of hydrogen and electrification.

The overall transformation is likely to be led by the food processing and food retail industries, which are being driven by demand from consumers and the importance of sustainability to brand perception.

As they set and enforce sustainability standards, regulators will need to balance these measures with rising consumer prices, geopolitical tensions and societal disruptions (e.g., farmer protests).

2. Transparency and responsible metrics

There needs to be greater transparency through the adoption of common sustainability labeling and life cycle assessments, underpinned by internal key performance indicators and monitoring/reporting of the carbon impact of operational processes.

At the same time, there is a need for new financial investments, solutions and evaluation metrics, such as secure farmer yield for regenerative agriculture and an embedded carbon price within asset investments. Greater transparency and better metrics can help drive the maturation of relevant technologies and the allocation of sufficient resources and investment.

3. New ways of working and green skills

The food industry should change its ways of working to accelerate the deployment of sustainable business solutions. To that end, different knowledge will be required, particularly in green tech, digital solutions, artificial intelligence and innovation. There is also a need for management skills related to ecosystem orchestration and managing complex supply chains.

In fact, all corporate functions will need "green skills" to address sustainability-related challenges. For example, the finance function needs to implement new management information and control systems, new reporting standards, and adjusted investment policies, while HR needs to reposition the food sector in the recruitment market as a "sustainability industry", recruit new profiles and embed "green skills" in training and career pathways.

In the labor market, employer reputation and employer branding are increasingly influenced by sustainability topics and purpose, as talented people gravitate from high carbon to low carbon industries.

From a societal standpoint, workforce knowledge is a long-term issue that needs to be addressed through the development of respective education paths and training (within universities and other educational institutions) at scale to build depth of knowledge.

The entire food ecosystem should transform together

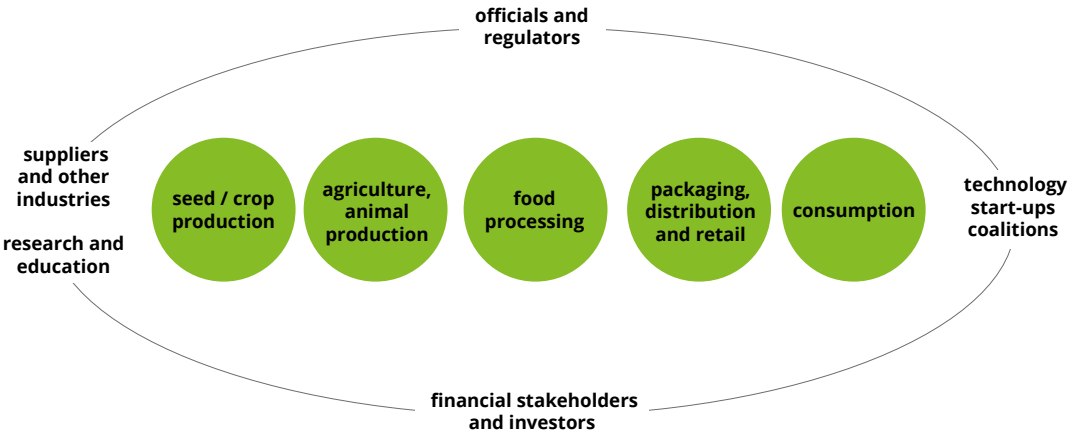
Food system should reinvent itself

not only to meet sustainability commitments and supporting regulation, but to also embrace and shift to new fast-growing sectors such as alternative protein, regenerative agriculture and plant-based materials.

Intensive **collaboration with other sectors** and suppliers to switch to renewable energy e.g. hydrogen, electrification

Regulators may set and enforce sustainability standards but should find a balance with rising consumer prices, geopolitical tensions and society disruptions (e.g. farmer protests)

There may be a massive uptake in supporting technology, digital platforms, start-ups and **coalition** forming to drive production levels in a sustainable manner meet the demand of a growing global population



Sustainability is here to stay – **consumers** globally are sensitive of climate change and the sustainability transformation need, however with a limited willingness to pay premiums

Food processing and food retail industries may set the trend and pace, driven themselves by the consumers and brand perception

New financial investments, solutions and evaluation metrics are required to help driving a sustainable system e.g. secure farmer yield for regenerative agriculture, embed carbon price within asset investments

Figure 3: A variety of value chain stakeholders will play key roles in food decarbonization

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