The Potential of Regenerative Agriculture in Denmark

February 2024

By Peter Jameson, Lars Midtiby, Lise Walbom, Søren Skovgård Møller, and Jeppe Mikkelsen

BCG + FOOD NATION Solutions of tomorrow By Denmark + Danmarks Naturfredningsforening

Contents

02 Foreword

03 Executive Summary

04 The Case for Regenerative Agriculture
- 1.1 The Status Quo of Nature and Farmers
- 1.2 How Regenerative Agriculture Can Make Farmers Part of the Solution

10 Defining Regenerative Agriculture

13 Regenerative Practices and (Potential) Stages of Adoption

17 Addressable Agricultural Land in Denmark

20 Economic and Ecological Assessment of Regenerative Agriculture in Denmark
- 5.1 Regenerative Agriculture's Impact on Farm Economics
- 5.2 The Farmer's Path to Reaping the Impact of Regenerative Agriculture
- 5.3 Positive Impact on Nature
- 5.4 Positive Impact on Biodiversity

46 Regenerative Agriculture and the Danish Agri-Food System

50 Challenges to Widespread Adoption of Regenerative Agriculture

54 Levers to Support the Widespread Adoption of Regenerative Agriculture

58 Glossary

60 Appendix

64 Acknowledgements

65 About the Authors

Foreword

Global nature and climate are under immense pressure. We have transgressed beyond six of nine planetary boundaries,[1] the ongoing loss of biodiversity remains critical, and water pollution continues to be a major concern worldwide. National and international institutions are currently trying to tackle these challenges globally.

The EU's Fit for 55 plan aims to reduce GHG emissions by 55% by 2030 over 1990 levels, while the Danish Climate Act goes further, aiming for a 70% reduction in the same timeframe.

Despite these targets, a recent UN report concludes that the world is not on track to achieving the long-term goals outlined in the Paris Agreement, with additional emissions reductions required to keep temperature increases below 1.5°C above pre-industrial levels.[2]

Agriculture is one of the top contributors to the climate and nature crisis; however, regenerative agriculture could be the positive change that allows farmers to be part of the solution. Most recently, the critical role of regenerative agriculture in shifting global food systems toward more sustainable practices was highlighted in the COP28 Action Agenda on Regenerative Landscapes. The agenda is a flagship initiative aiming to transition large agricultural landscapes to regenerative landscapes by 2030.[3]

Given agriculture's position in both Denmark's land area and economy, a positive change can be a key improvement lever to reduce emissions, improve biodiversity, and enhance water quality. However, it is important that it be being done in a way that ensures both overall food security and continued competitiveness of the farming industry.

This report—jointly written by Boston Consulting Group (BCG), Danmarks Naturfredningsforening, and Food Nation—builds upon existing knowledge bases and uses expert experience to detail regenerative agriculture's impact and the potential path toward widespread adoption in Denmark. We aim to present regenerative agriculture as a potential part of the solution that helps overcome these different ambitions in a sustainable way and inspire different stakeholders in the food value chain to take the required steps to support the transition toward a more sustainable food system.

Peter Jameson
Managing Director and Partner
Boston Consulting Group

Lars Midtiby
Chief Executive Officer
Danmarks Naturfredningsforening

Lise Walbom
Chief Executive Officer
Food Nation

Søren Skovgård Møller
Associate Director
Boston Consulting Group

Jeppe Mikkelsen
Project Leader
Boston Consulting Group

1. Katherine Richardson et al. (2023). Earth beyond six of nine planetary boundaries. Science Advances.
2. United Nations: Technical dialogue of the first global stocktake.
3. WBCSD: COP28 Action Agenda on Regenerative Landscapes: accelerating the transition. The World Bank: CLIMATE-SMART AGRICULTURE.

Executive Summary

Agriculture is exerting an unprecedented amount of pressure on the environment; in fact, 19% to 29%[4] of the global greenhouse gas (GHG) emissions originate from world's agri-food systems, of which agriculture is a key contributor. Not only are GHG emissions highly impacted by agriculture, but so too are other key measures for a healthy planet such as soil health, biodiversity, and water quality. With a growing population, the need for food production is expected to continue increasing in the coming years, requiring agricultural food productivity to be maintained or increased. Agriculture is at the crossroad of problem and solution, where the goal is for it to become viable for the planet, people, and business.

Regenerative agriculture is as an approach that aims to create a positive impact on exactly these key challenges—GHG emissions, pressure on biodiversity, and deteriorating water quality—while potentially benefitting farmers through yield resilience. Best-practice principles are utilized to optimize for soil and crop health via practices such as minimal soil disturbing no-till systems and cover cropping. Not all regenerative practices are to be implemented at once. Rather, the proposed adoption would follow a three-staged approach:

- Stage 1: Basic implementation
- Stage 2: Intermediate implementation
- Stage 3: Advanced implementation

The adoption process is not fixed in advance and is to be tailored to each specific farm (when to use what practices depend on, for example, the soil type and climate).

Implementing regenerative agriculture provides the opportunity for farmers to be part of the climate solution. Our financial assessment indicates a potential positive impact on farmer financials with a margin uplift of up to ~40%, calculated from a non-subsidized base, effective over six years after implementing basic and intermediate regenerative farming practices.[5] This margin uplift is primarily driven by cost savings from reduced machine, diesel, and labor costs as an effect of no-till practices and fertilizer reductions resulting from cover cropping and mulch system practices. Additionally, further profit potential could occur from improved yield resilience and potential carbon dioxide equivalent (CO_2e) tax savings if the discussed CO_2e tax on agriculture materializes.

The analysis additionally shows that regenerative agriculture could potentially reduce Danish CO_2e emissions by up to ~4 megatons per year from 2035 through 2040. This corresponds to 30% of Danish agriculture's emissions in 2022.[6] Additionally, regenerative agriculture has the potential to reduce the agricultural sector's impact on biodiversity loss and water pollution.

Regenerative agriculture can be beneficial for farmer economics, the environment, and society at large, but it comes with inherent risks. In the transition period, for example, there is a risk of potential decline in yields and upfront transition costs. Practices can vary in effect due to, for example, required adjustments of regenerative practices to local factors such as soil type, climate characteristics, and farmer experience.

Financial and ecological upsides from regenerative agriculture can benefit the full food value chain, for example, through socio-ecological, financial, and reputational benefits. All stakeholders have a role to play in driving the widespread adoption of regenerative farming in Denmark and beyond.

Levers to overcome transition barriers include improving research, knowledge, and education in regenerative agriculture, for example, by incorporating regenerative agriculture as part of the curriculum at agricultural schools. The levers also include securing the supply of specialized inputs and machinery for regenerative farming; levers to overcome challenges associated with industry tradition such as cooperation between new regenerative farming associations and deeply rooted conventional farming associations; levers to reduce and redistribute regenerative transformation risk, for example, by offering lower-interest green mortgage bonds to regenerative farmers or food producers offering a short-term premium to help finance transformation; levers to improve the inclusion of regeneratively sourced inputs in the downstream food industry such as scaling regenerative pilots; those to inform and educate consumers on the benefits of regenerative food production; and finally levers to increase the financial implications of potential positive impacts on climate and nature, for example, via the discussed CO_2e tax on agriculture.

Overall, a concerted effort across stakeholders will help enable significant regenerative agriculture adoption within the next 10–15 years. Broad adoption and dedicated efforts are required to move the needle toward improving the climate and sustainability impact of the agricultural sector while maintaining the food security required by society.

4. The World Bank: CLIMATE-SMART AGRICULTURE.
5. SEGES; Annette V. Vestergard (2023). Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture (CA). FRDK; Statistics Denmark; expert interviews; BCG analysis.
6. SEGES; Annette V. Vestergard (2023). Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture (CA). FRDK; Statistics Denmark; expert interviews; BCG analysis. Katherine Richardson et al. (2023). Earth beyond six of nine planetary boundaries. Science Advances.

The Case for Regenerative Agriculture

Regenerative agriculture is a holistic and sustainable approach to farming that focuses on enhancing soil health, biodiversity, and ecosystem resilience while producing food and other agricultural products. It emphasizes practices such as minimal soil disturbance, cover cropping, crop rotation, and the use of organic matter to enrich soil nutrient levels, thus reducing the need for added fertilizer. Regenerative farming provides the option for farmers to become part of the solution to the issues both nature and themselves are facing, while also improving their own livelihoods.

With mounting pressure on nature and farmers both globally and in Denmark, it is becoming evident that the current conventional farming system is unsustainable. The negative consequences on climate, biodiversity, and water quality have grown too significant to ignore.

Nature itself has reached a critical juncture, with the latest research showing that Earth has transgressed beyond six of nine planetary boundaries.[7,8]

7. Katherine Richardson et al. (2023). Earth beyond six of nine planetary boundaries. Science Advances.
8. Stockholm Resilience Centre describes planetary boundaries as “a set of nine planetary boundaries within which humanity can continue to develop and thrive for generations to come” … “nine processes that regulate the stability and resilience of the Earth system” … “Crossing boundaries increases the risk of generating large-scale abrupt or irreversible environmental changes. Drastic changes will not necessarily happen overnight, but together the boundaries mark a critical threshold for increasing risks to people and the ecosystems we are part of.” (Stockholm Resilience Centre: Planetary boundaries).

Simultaneously, farmers are grappling with the ever-increasing challenges posed by the impacts of climate change. More uncertain and extreme weather conditions are threatening farmers' yields, leaving nature a major determinant of farmers' economic sustainability. The agricultural sector has progressed a lot, yet it is still the sector with the largest CO_2e emissions in Denmark[9] and among the largest globally. In addition, it remains a risk to Danish and global biodiversity. Thus, a solution that reduces the negative impact of agriculture on climate and nature while making agriculture more resilient to climate change would be ideal from both perspectives. Regenerative agriculture could offer exactly that.

This section outlines the status quo of nature and farmers and states the case for regenerative farming as part of the solution to challenges facing both nature and farmers.

1.1 The Status Quo of Nature and Farmers

Agriculture plays a crucial role in feeding the global population; however, its effect on the natural environment is concerning. According to the World Bank, the global agricultural sector generates 19%–29% of total global GHG emissions.[10] In addition, the conversion of natural ecosystems to agricultural land has led to significant biodiversity loss. Approximately 80% of global deforestation is driven by agricultural expansion, which threatens the habitats of many species.[11] For instance, 70% of terrestrial biodiversity loss is linked to food production.[12] Moreover, the extensive use of synthetic pesticides in agriculture has direct toxic effects on non-target species and disrupts natural ecosystems. Furthermore, agriculture is a major source of water pollution worldwide. The leaching of fertilizers from farmland into nearby water bodies leads to nutrient pollution, causing harmful algal blooms, dead zones, and loss of biodiversity in aquatic ecosystems.[13]

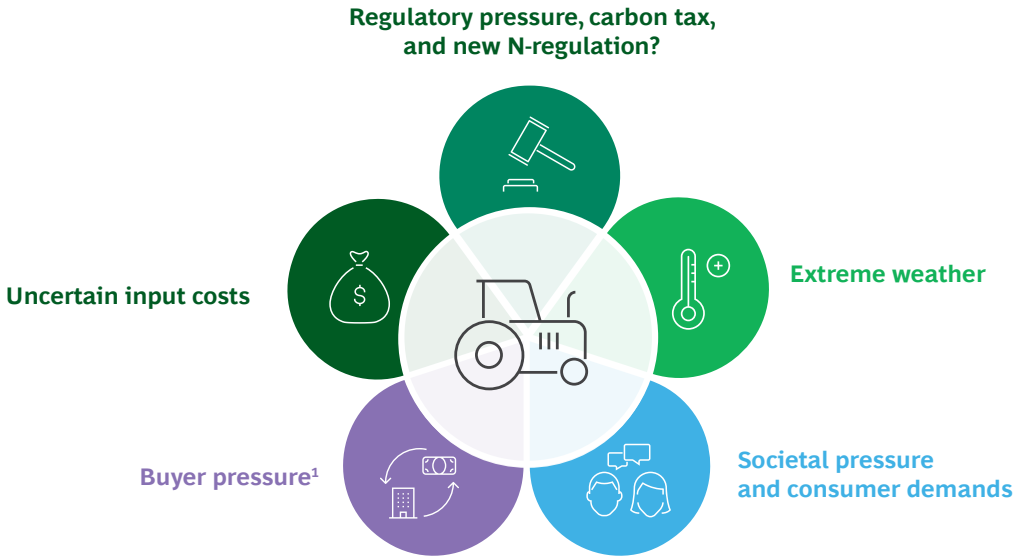
Denmark is subject to the same challenges as those faced globally. As of end of year 2022, Denmark still needed to cut CO_2e emissions by about 45% before 2030 to reach climate goals and align with the Paris Agreement,[14] 17% of Danish species populations were endangered,[15] and 43% of oxygen measurements in Danish coastal areas were classified as under extreme or moderate oxygen depletion,[16] making it the worst oxygen depletion in 20 years[17] and threatening the underwater ecosystem.

The agricultural sector was responsible for 33% of total CO_2e emission from Denmark in 2022,[18] making it the sector with the largest share of emissions in Denmark. If the agricultural sector continues to operate as it is today and emissions stay flat, this share is estimated to increase to 45% by 2030.[19] Nature is also under pressure. As for the biodiversity crisis, agriculture is among the largest drivers of Danish biodiversity loss.[20] Conventional farming practices undermine biodiversity above and below ground. In 2022, the share of Danish farmland was 61%,[21] of which a significant share was farmed using conventional practices, continuing to put pressure on Danish biodiversity. Concerning the oxygen depletion in Danish coastal areas, the agricultural sector is also a major driver. The oxygen depletion is caused by large amounts of nutrients (phosphor and nitrogen) in the water. A significant share of those nutrients stems from fertilizer use in the agricultural sector. Pesticides are leaching from farmland into rivers and further into the oceans, causing oxygen depletion and damaging the underwater ecosystem.[22]

In this context, it's essential to recognize that farmers are also under pressure to maintain high yields and minimize costs while grappling with the challenges posed by sustainability. Consequently, the sustainable development of the Danish agricultural sector must advance more rapidly and comprehensively. Doing so not only facilitates the recovery of nature but also limits, and hopefully reverses, the transgression of planetary boundaries, thereby fostering sustainable development for generations to come.[23]

9. Statistics Denmark: Klima.
10. The World Bank: CLIMATE-SMART AGRICULTURE.
11. WWF (2020). Living Planet Report 2020 - Bending the curve of biodiversity loss. Almond, R.E.A., Grooten M. and Petersen, T. (Eds). WWF, Gland, Switzerland.
12. WWF (2020). Living Planet Report 2020 - Bending the curve of biodiversity loss. Almond, R.E.A., Grooten M. and Petersen, T. (Eds). WWF, Gland, Switzerland.
13. UNESCO (2020). The United Nations world water development report 2020: water and climate change.
14. Danish Ministry of Climate, Energy and Utilities.
15. Aarhus University (2019). Rødlistestatus i Rødliste 2019. Institute for Ecoscience.; BCG analysis.
16. Environmental Protection Agency: Iltmålinger i perioden 2. - 12. oktober 2023.
17. Michael Strangholt (2023). Værste iltsvind i 20 år. DCE - Danish Centre For Environment And Energy, Aarhus University.
18. Danish Energy Agency; Statistics Denmark; BCG analysis.
19. Danish Energy Agency: Klimatstatus og – fremskrivning 2023, revised November 2023.
20. The Danish society for Nature Conservation (Danmarks Naturfredningsforening): Biodiversitet.
21. Statistics Denmark.
22. The Danish society for Nature Conservation (Danmarks Naturfredningsforening): Iltsvind i havet.
23. Stockholm Resilience Center: Planetary boundaries.

Exhibit 1 - Farmers experience increasing pressure



Source: Expert interviews; BCG analysis.

[1]Buyers include food producers and retailers.

Farmers in the Danish agricultural sector are also under immense pressure from several sides in their ecosystem. There is an increasing societal pressure for a sustainable transformation of the agricultural sector, as consumers are demanding healthy and sustainably grown food products at low prices—and regenerative agriculture could help farmers deliver on this. These demands from society and consumers feed straight into large food producers, pressuring farmers to act on the green agenda. At the same time, climate and weather conditions continue to become only more uncertain and more extreme, affecting farmers' yields and pressuring economic stability. Furthermore, uncertain weather conditions, geopolitical tensions, and supply chain uncertainty increase the volatility of input costs for farmers. Plus, the green agenda continues to take space on the political agenda, adding an increasing regulatory pressure on the agricultural sector.

Societal Pressure and Consumer Demands

Society and consumers are becoming only more focused on sustainability and how the agri-food system plays a role in it. Agriculture has historically played an important role in Danish culture; however, the image of the agricultural sector is, according to several experts, starting to fade as the green agenda continues to gain space in the public debate. There is increasing demand and public pressure for farmers to reverse their impact on climate, biodiversity, and water. Simultaneously, consumers continue to demand healthy food options at low prices—a concern that has only expanded with inflation tailwinds from 2022. Farmers are under pressure to keep high yields and costs low.

Buyer Pressure

As consumers become more concerned about the footprint of their food, so do the major food producers. Several large international and Danish food producers have set ambitious targets for sourcing regeneratively farmed input, working with farmers to transform their operations to remain competitive.

Uncertain and Extreme Weather Conditions

The rising uncertainty and number of extreme weather events are a major challenge globally. While the challenge may currently be more extreme in other parts of the world, it is also increasingly experienced in Denmark. In 2018, Denmark experienced the worst drought in 99 years,[24] and in 2023, the Danish summer was characterized by both periods of abnormal drought and long periods of heavy rains.[25] Both situations have heavily impacted farmers' yields. In 2018, yields per hectare for wheat, barley, rapeseed, and corn crops dropped by 23%, while yields per hectare in 2023 dropped by 15%[26] versus the previous year. Such unexpected circumstances put pressure on many farmers' economics and increase their concerns for the future. Projections indicate that Danish weather conditions will only become warmer, wetter, and more extreme,[27] especially in the summer period,[28] which is of most importance for farmers' yields.

Uncertain Input Costs

Increasing volatility in input costs is driven by extreme weather conditions, geopolitical tensions, and supply chain uncertainty. This volatility puts pressure on farmers' profits and is therefore one of the many concerns farmers are faced with. The war in Ukraine has triggered steep price increases in many commodities. Two examples especially relevant to the agricultural sector are fertilizer and fuel costs. The fertilizer price index (2015 = index 100) rose from index 83 on average in 2018 to index 214 on average in 2022.[29] This was an increase of 158% in just four years. Likewise, fuel costs increased from index 77 in May 2020 to index 223 in October 2022.[30] This was an increase of 190% in about two years, and illustrates how farmers largely dependent on fertilizer use and tillage practices experience increasing profit uncertainty and feel squeezed as input costs skyrocket over short periods of time.

Regulatory Pressure

The green agenda continues to gain space not only in the public debate but also on the political front, tightening regulatory pressure on sectors with a significant footprint on the Danish carbon accounts. Agriculture is no exception. With the expected CO_2e tax on the agricultural sector being introduced in the near future, many farmers will experience significant cost pressures if they continue to rely on their current operating models.[31] An analysis by SEGES[32] shows that a CO_2e tax of 750 DKK per ton CO_2e[33] will reduce Danish farmers' income by approximately 7 billion DKK per year. Consequently, the share of Danish farmers being in severe risk of bankruptcy will increase from 6% to 45%[34] if they do not adjust their current business model. The analysis shows that dairy producers will be subject to the largest negative impact, namely an estimated 1.3 million DKK reduction of operating profit per farm on average.[35] The average operating profit for a Danish dairy farm has ranged from 1 million DKK to 4.8 million DKK across the last three years.

Thus, it is not difficult to conclude that a reduction in operating profits equal to 1.3 million DKK on average will have major financial implications for farmers.[36] In addition, the biodiversity crisis is further heating up the pressure on Danish farmers. As part of the EU Biodiversity Strategy 2030 in the European Green Deal, a 50% reduction of EU pesticides use is targeted to happen before the end of 2030.[37]

Therefore, it is imperative for the agricultural sector to adapt its operations to a more environmentally sustainable and resilient approach to address the growing uncertainties within the agricultural value chain and take a leadership role in forging a sustainable future that benefits all stakeholders.

24. DMI: 2018 - Det mest tørkeramte år i Danmark i 99 år.
25. SEGES: Sommerens vejr har økonomiske konsekvenser for dansk landbrug.
26. Statistics Denmark.
27. DMI: Vejret i Danmark bliver varmere, vådere og vildere.
28. DMI: Vejret i Danmark bliver varmere, vådere og vildere.
29. Statistics Denmark.
30. Statistics Denmark.
31. Christian Brahe-Pedersen (2023). Ny analyse: Danske landmænd kan tabe op mod syv milliarder kroner i årlig indtjening ved CO2-afgift. LandbrugsAvisen.; Danish Agriculture and Food Council: Alvorlige konsekvenser af ensartet CO2e-afgift på landbruget.
32. Christian Brahe-Pedersen (2023). Ny analyse: Danske landmænd kan tabe op mod syv milliarder kroner i årlig indtjening ved CO2-afgift. LandbrugsAvisen.
33. Marie Saehl and Klaus Buster Jensen (2022). Vismænd anbefaler CO2-skat på dansk landbrug snarest muligt: Sådan kan den se ud. DR.
34. Christian Brahe-Pedersen (2023). Ny analyse: Danske landmænd kan tabe op mod syv milliarder kroner i årlig indtjening ved CO2-afgift. LandbrugsAvisen.
35. Christian Brahe-Pedersen (2023). Ny analyse: Danske landmænd kan tabe op mod syv milliarder kroner i årlig indtjening ved CO2-afgift. LandbrugsAvisen.
36. Statistics Denmark: Landbrugets regnskaber viste stor fremgang i 2022.
37. European Parliament: EU Biodiversity Strategy for 2030 in a European Green Deal.

1.2 How Regenerative Agriculture Can Make Farmers Part of the Solution

An effective approach to simultaneously dealing with the challenges of nature and farmers is regenerative agriculture. Regenerative agriculture makes farming more nature friendly and increases resilience by cooperating with nature's systems instead of fighting against them, specifically by focusing on restoring soil health and the ecosystem. The importance of regenerative agriculture in solving the challenges of the global (and local) food system was most recently highlighted in the COP28 Action Agenda on regenerative landscapes, aiming to transition large agricultural landscapes to regenerative by 2023.[38]

The regenerative approach to farming has significant positive impacts for nature. With respect to carbon and direct emissions, regenerative agriculture reduces emissions from farming machinery due to the reduced frequency of activity on farmland. Second, an important aspect in improving soil health is building the storage of carbon in soil—enabling carbon sequestering, which is a process of capturing and storing atmospheric carbon dioxide (CO_2) in soil.[39] Third, as soil health improves and the soil ecosystem restores itself, crops will require less fertilizer due to improved nutrient levels in soil and will become more efficient in absorbing added fertilizers, leading to decreased CO_2e emissions from non-absorbed added fertilizer in the air. Next, with respect to biodiversity, regenerative farming focuses on practices such as minimizing soil disturbance and optimizing soil's constant cover. Such practices will promote soil biodiversity by allowing soil to restore the natural ecosystem, of which an important part is soil biology, including soil micro-life. Fifth, regenerative agriculture could reduce farmers' consumption of water due to reduced need for irrigation, which arises due to an improved ability of soil to absorb and store water, thus staying naturally hydrated for longer periods of time. Also, regenerative agriculture may improve water quality, and in a Danish context, it is expected to partly restore oxygen levels in coastal areas—an important impact to restore the Danish underwater ecosystem. The potentially improved oxygen levels in Danish coastal areas may be partly caused by regenerative farmers using less fertilizer due to improved natural nutrient levels in soil. In addition, of the fertilizer used, a larger share can potentially be absorbed by crops, thus reducing leaching to streams and further into oceans, leading to reduced oxygen depletion in Danish coastal areas.

For farmers, regenerative agriculture also provides an effective method to cope with current pressures and challenges while maintaining a profitable business model. As stated, many experts argue that the historically good image of the agricultural sector in Denmark is starting to fade as the green agenda continues to gain space in the public debate. Regenerative agriculture is an effective method to make farming more nature friendly and sustainable while also benefitting farmer economics. A transformation will not only satisfy the demands of Danish consumers, food producers, and retailers, but also boost the value proposition of Danish agricultural output at a global scale. In addition, it will ease the increasing regulatory pressure for sustainable transformation of the Danish agricultural sector and make an important cost-cutting case for Danish farmers if the widely discussed CO_2e tax on agriculture materializes.

Furthermore, improvements in soil health and restoring the soil ecosystem can improve soil and crop resilience in extreme weather, protecting yields and farmers' economic stability. The improved resilience is explained by healthy soil and a healthy ecosystem that is significantly better at absorbing and storing water in soil for crops to use when needed. This has two implications: First, heavy rains are now absorbed by soil instead of flooding and causing soil erosion. Second, droughts that would usually dry out crops will no longer occur, as soil is better at storing water, leaving an effective source of hydration for crops in dry periods. Thus, regenerative farming can be an effective approach for farmers to adapt to climate change.

Furthermore, regenerative agriculture can reduce farmers' dependency on volatile input costs such as synthetic fertilizers, thereby enhancing the stability of their profitability. As previously mentioned, the war in Ukraine has triggered a trend of increasing volatility in costs of agricultural input, especially fertilizer and fuel. Regenerative farming can reduce the need for fertilizer by restoring the soil ecosystem and improving the natural level of nutrients in soil. Moreover, regenerative farming, by minimizing soil disturbance, reduces fuel consumption and the frequency of mechanical operations on farmland each season. This reduction in fertilizer and fuel can mitigate the impact of input cost uncertainties on farmers' profitability, thereby contributing to more stable financial outcomes for farmers in the long term.

Regenerative farming can be a key lever to the challenges faced by nature and farmers simultaneously.

38. WBCSD: COP28 Action Agenda on Regenerative Landscapes: accelerating the transition.

39. USGS: What is carbon sequestration?.

Regenerative agriculture increases resilience by cooperating with nature's systems instead of fighting against them.

Defining Regenerative Agriculture

The key to regenerative farming is understanding that it is not a rigid and highly structured practice. Rather, the success depends heavily on the farmers' ability to understand their specific conditions with respect to for example, soil, crops, local ecosystems, climate, and their ability to apply farming practices with careful attention. The journey to regenerative agriculture necessitates ongoing on-farm learning and development. That being said, there is no broadly agreed-upon definition of "regenerative agriculture," at neither the Danish, European, nor global level. This section offers a clarification of myths and realities with respect to regenerative agriculture, our humble definition of regenerative agriculture, and key challenges of the current farming systems.

Regenerative agriculture is commonly associated with various buzzwords, initiatives, and best practices. In exhibit 2, we match some of the myths with reality.

Based on currently suggested definitions and input from experts and regenerative farmers, we have outlined the following **four key elements of regenerative farming:**

- Positive impact on carbon, biodiversity, and water
- Positive impact on yield resilience and farmers' economic stability
- Based on practically proven principles customized to local environments
- Focus on soil and crop health by restoring the soil ecosystem

These four elements are the foundation for this report's definition of "regenerative agriculture."

Exhibit 2 - Myths and reality of regenerative agriculture

Myths	Reality
Regenerative agriculture is an experimental ideology for farming	Regenerative agriculture is based on decades of best practice, but like all other fields, it relies on continuous learning and development
Regenerative agriculture is a purely organic approach to farming	Regenerative agriculture can be applied to both conventional and organic farming; however, as the soil ecosystem restores itself, the need for added fertilizer will be reduced
Danish agriculture is already fully regenerative	Many Danish farmers apply parts of some regenerative practices; however, not to a degree where the soil ecosystem can be restored
Regenerative agriculture is just another new rend that is only applicable to small-scale farming	Regenerative agriculture may be even more efficient forlarge-scale farming due to significant cost-cutting opportunities on large-scale machinery
Regenerative agriculture is an all-or-nothing, unattainable approach	Regenerative agriculture is an adaptive approach, where the farmer can tailor the implementation to their specific type of soil and crops and the local ecosystem and climate
Regenerative agriculture severely reduces farmers' profitability	It is a sustainable investment that improves farmers' profitability in the medium to long term

Source: Expert interviews; BCG analysis.

Regenerative farming aims at creating a positive impact on carbon, biodiversity, and water while benefitting farmers through improved yield resilience. Best practice principles are utilized to continuously optimize soil and crop health.

This definition illustrates that regenerative agriculture is not a standardized approach to farming, as the only standardized aspect is the goal of obtaining a positive impact on nature while benefiting farmers through improved yield resilience by continuously working to optimize soil and crop health. Specific regenerative practices should be adopted in light of current farming practices and customized to specific types of soil, crops, the local ecosystem, and the local climate. The localization aspect is especially important when considering regenerative agriculture at the global scale. There are large differences in geographical, biological, social, and cultural diversity between regions, meaning certain practices can have great upsides in one region but be less suited for other regions.[40]

Regenerative agriculture can be applied to conventional, organic, and other types of farming. It is not a separate farming approach, but rather is an add-on that allows farmers to further develop the way they work with the soil.

With that in mind, conventional farming, despite varying considerably in its methods from farm to farm, typically applies standard tilling and synthetic fertilizers in order to maximize yields. However, even though such practices may be efficient in the short run, more holistic methods, such as regenerative agriculture, may be more effective in securing long-term soil fertility and yield resilience—an aspect that only becomes more important as climate adaptability becomes more needed due to extreme weather scenarios.

On the other hand, organic farming has more strictly regulated requirements, including prohibiting all synthetic inputs, such as the use of synthetic fertilizer and pesticides, and often applies a more favorable crop rotation. However, although organic farming is more environmentally friendly than conventional farming on most parameters, farming will always have negative implications for nature. An example from organic farming is the prohibited use of synthetic pesticides sometimes leading to organic farmers relying on tilling for weed control—a practice that has negative implications for nature. Thus, even with the crucial role farming has in feeding the world's population, there is room for improvement in all types of farming.

Regenerative agriculture is a holistic approach to farming that allows both organic and conventional farmers to improve, but not eliminate, their negative impact on climate and nature by applying methods that help them rebuild and benefit from natural ecosystems.

Transforming how we use land is critical to improving food security and restoring Denmark's ecosystem. Regenerative agriculture can unlock the necessary transformation and agricultural development by providing a clear transformation path for conventional farmers to reduce their ecological impact—also modifying and developing current organic practices—while maintaining or even increasing agricultural efficiency.

40. E EASAC (2022). Regenerative agriculture in Europe. ASAC (2022). Regenerative agriculture in Europe.

Exhibit 3: Ecological challenges of conventional farming

Farming exerts pressure on nature. It disrupts natural carbon, biodiversity, water, and nitrogen cycles, and it can harm soil's key functions. Specifically, standard conventional farming contributes to an eight-stage cycle of pressure on nature:

1. Soil cover acts as a blanket to prevent evaporation. In addition, bare soil has a much lower capacity to absorb water during heavy rain compared with soil covered by vegetation, where the root system will absorb more water. This leads to lower soil moisture and thus a heightened need for irrigation.

2. Depleted and compacted soil with lower soil organic matter (SOM) cannot absorb and store as much water as soils with a higher share of SOM, thus further increasing the need for irrigation.

3. Soil biodiversity is important for both overall crop health and completing natural cycles; however, it is not a practice in standard conventional farming. Tilling and synthetic inputs affect natural soil biodiversity negatively.

4. The potential for photosynthesis to capture carbon from the atmosphere is not fully exploited when fields lie fallow without cover crops. This results in less biomass production, which reduces the soil's ability to capture carbon and nitrogen.

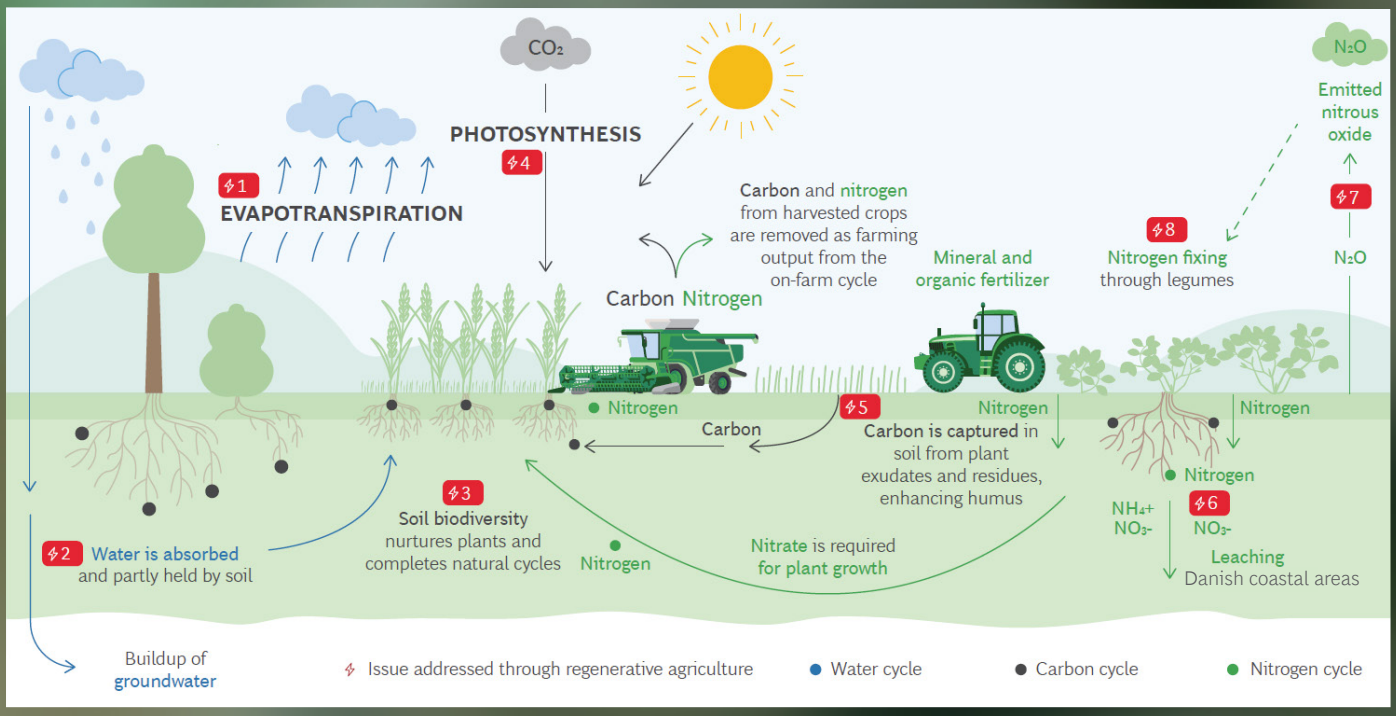
5. Depletion of soils' organic matter content causes a net increase in carbon emissions, and conventional farming practices fail to fully exploit the potential of agricultural soil to sequester carbon.

6. Nitrates from the application of animal manure and nitrogen fertilizers leach into streams and further into Danish coastal areas, causing oxygen depletion in Danish waters, affecting the underwater ecosystem.

7. Nitrification processes partially convert nitrogen fertilizer and animal manure into nitrous oxide (N_2O), a powerful GHG with a global warming potential (GWP) that is 298 times higher than that of CO_2 over a 100-year period.[41]

8. Including few or no legumes in crop mixes and rotations limits the potential for natural nitrogen fixing, a missed opportunity to complete the nitrogen cycle and reduce the need for synthetic sources of nitrogen.

Natural Resource Cycles in Agriculture



Source: Expert interviews; BCG analysis.

41. Pernille Kjeldgaard Kristensen (2018). Klimaforandringerne raser: Forstå hvorfor eksperterne altid taler om CO2. DR.

Regenerative Practices and (Potential) Stages of Adoption

The goal of this section is to explain appropriate regenerative practices allocated to three suggested stages of adoption. Although a wide range of methods may have potential for a positive impact in various places around the world, this report focuses on practices that are most relevant in a Danish context through involvement of key stakeholders across the Danish agri-food value chain.

Our description of the journey to regenerative agriculture identifies three implementation stages: basic, intermediate, and advanced. Each stage is further divided into what we call the "CIS framework," consisting of cultivation, input, and structure practices.

- **Cultivation** refers to practices that have direct effects on how crops are grown and managed, such as no-till and cover crops.
- **Inputs** are products added to the soil and crops in the field, a category most frequently associated with fertilizers and plant protection.
- **Structure** consists of changes that affect the composition of land use, including such factors as evolving crop cycles, changing aerial structures, and integrated agroforestry.

Transitioning to regenerative agriculture begins with adopting practices that are fundamental and implementable in all contexts, whereas more specialized and context-specific practices can be adopted in later stages.

However, there is no one-size-fits-all pathway to regenerative agriculture. Individual farmers may require different regenerative practices, depending on context and baseline for transformation. Basic Stage 1 practices are applicable in most contexts and together may achieve the best results; however, the adoption of intermediate and advanced practices must be customized to the context of the individual farmer. In addition, there is no final finish line with regenerative agriculture. Instead, it is a continuous process of learning and development for the individual farmer as well as other players in the agri-food system.

Before starting the implementation of regenerative practices, the individual farmer should establish and document the baseline. This includes testing drainage levels, SOM, pH levels, etc. If one finds significant issues in soil—for example, a low pH level—this can be corrected prior to adoption in order to have a strong starting point to transition to regenerative practices.[42]

The Basic Implementation Stage

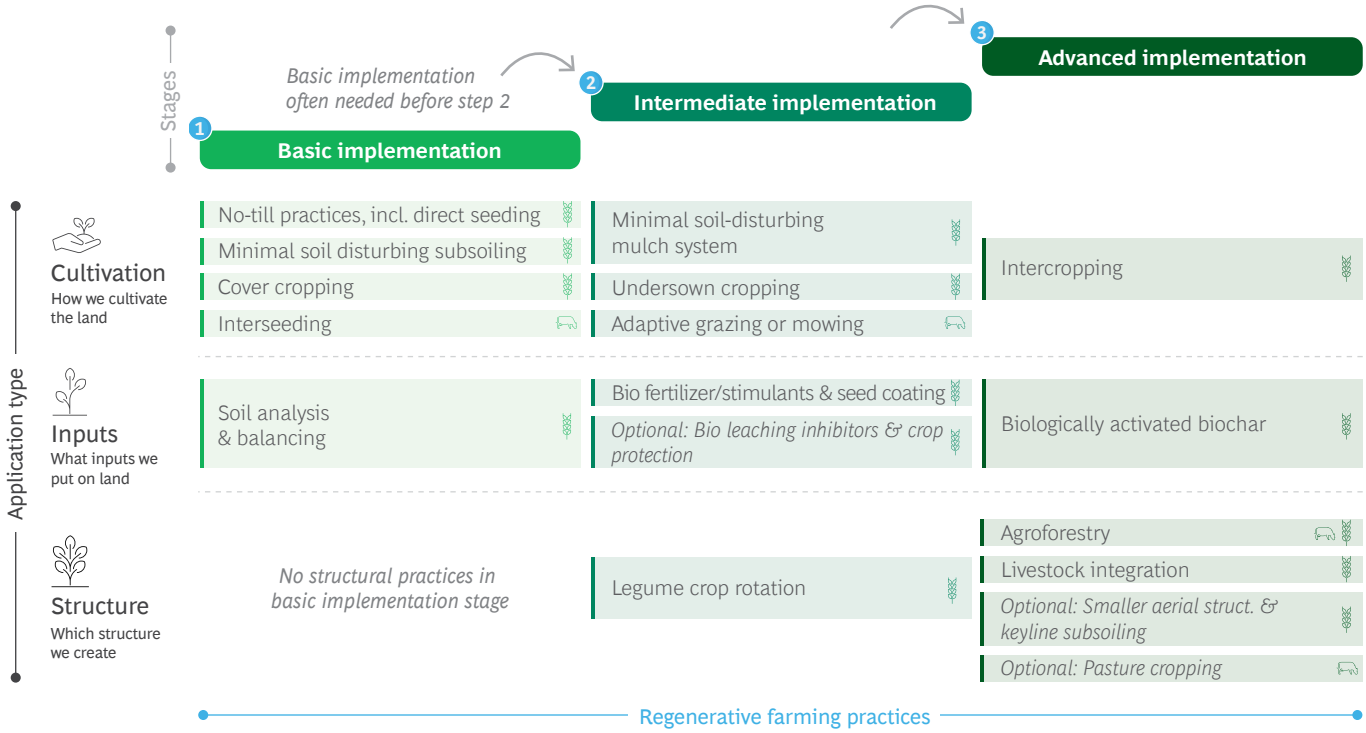
The first steps in the regenerative farming journey are an exploratory process where the farmer can either test practices on a smaller share of land or make a full basic stage adoption right away. There is no right or wrong method, and there are upsides to both. However, it is important to measure early results, focus on learning and development, and draw conclusions from which to build future efforts.

The desired outcome of the basic stage is twofold. First, cost savings in labor, machinery, and inputs such as fertilizer should be realized. Second, the farmer should experience an increased SOM, leading to improved soil health and an environment that is supportive of natural ecosystems and biodiversity.

Basic practices include the following:

- **No-Till Farming, Direct Seeding, and Minimal Soil-Disturbing Subsoiling.** The focus of these practices is on alleviating compaction and minimizing damage to the soil to establish a basis for regenerating soil health and building up organic matter. Implementation should begin with subsoiling (using minimally intrusive methods to break up subsurface soil) to get soil in shape, followed by application of controlled traffic farming (restricting machinery loads to defined permanent traffic lanes). No further intervention should be undertaken.

Exhibit 4 - Regenerative Agriculture Can Be Implemented in Three Stages



Sources: Expert interviews; BCG analysis.

42. Expert interview.

- **Soil Analysis and Balancing.** The goal of these practices is to move away from wholesale dependence on chemical nitrogen, phosphorus, and potassium fertilizers and toward a more holistic view of all necessary soil nutrients, including secondary nutrients and micronutrients.

- **Cover Crops.** Planting diverse crops after harvesting the main crop helps protect soil from erosion, builds up organic matter, encourages soil biodiversity and—in the case of legume cover crops—helps fix nitrogen in the soil, thereby reducing the need for fertilizers.

- **Interseeding on Grassland.** The aim here is to reduce the use of synthetic nitrogen fertilizers and enhance the land's productivity and soil structure by interseeding other grasses, legumes, and herbs.

The basic stage requires no specific structural changes in farming practices.

The Intermediate Implementation Stage

The intermediate stage includes advancing input practices and adopting the first structure practice by incorporating legumes as part of the crop rotation.

The desired outcome of the intermediate stage is, again, twofold. The farmer should realize cost savings associated with further fertilizer reductions as well as further improvements in soil health and biodiversity.

Intermediate practices include the following:

- **Minimal Soil-Disturbing Mulch Systems.** This practice involves shredding the cover crop and, in certain circumstances, working it into the soil while only minimally disturbing the soil surface. If possible and feasible, biostimulants or biofertilizer can be added as well.

- **Undersown Cropping.** Although conceptually similar to cover crops, undersown crops are planted to overlap with a main crop, sometimes with permanent undersowing of plants beyond a single crop cycle.

- **Biofertilizer.** Producing and using biofertilizers predominantly from farm biomass—including compost extract, compost seed coatings, ferments, and foliar sprays—increases the circularity of farming operations.

- **Legume Crop Rotation.** Integrating legumes into the main crop cycle improves soil structure and fixes nitrogen in the soil.

- **Adoptive Grazing or Mowing on Grassland.** The intermediate stage for grassland involves the use of adaptive grazing: allowing livestock to graze intermittently on defined parts of the land to foster alternating periods of trampling, grazing, and regrowing of grass. Adaptive mowing allows plants to recover faster after cutting and improves the root strength of the grass.

The Advanced Implementation Stage

The practices employed at the advanced stage—including integrating livestock, redefining areal structures, and adding hedges or agroforestry—are specific to each field and to the structure of the farm.

The upsides of the advanced stage are less defined; however, practices such as integrating biochar and agroforestry should unlock further carbon-sequestering potential. Furthermore, another key upside of agroforestry is reduced soil erosion, as trees provide shelter for wind. In addition, the implementation of advanced practices will increase the on-farm diversity, moving toward a permaculture that benefits natural ecosystems and biodiversity.

Advanced practices include the following:

- **Intercropping.** This practice involves simultaneously growing two main crops, either in strips or side-by-side; its potential benefits depend to a large extent on the types of crops to be grown.

- **Biologically Activated Biochar.** Applying carbonized biomass that has been inoculated with microbes via fermentation can improve the structure and nutrient-holding capacity of soil while also increasing soil sequestering.

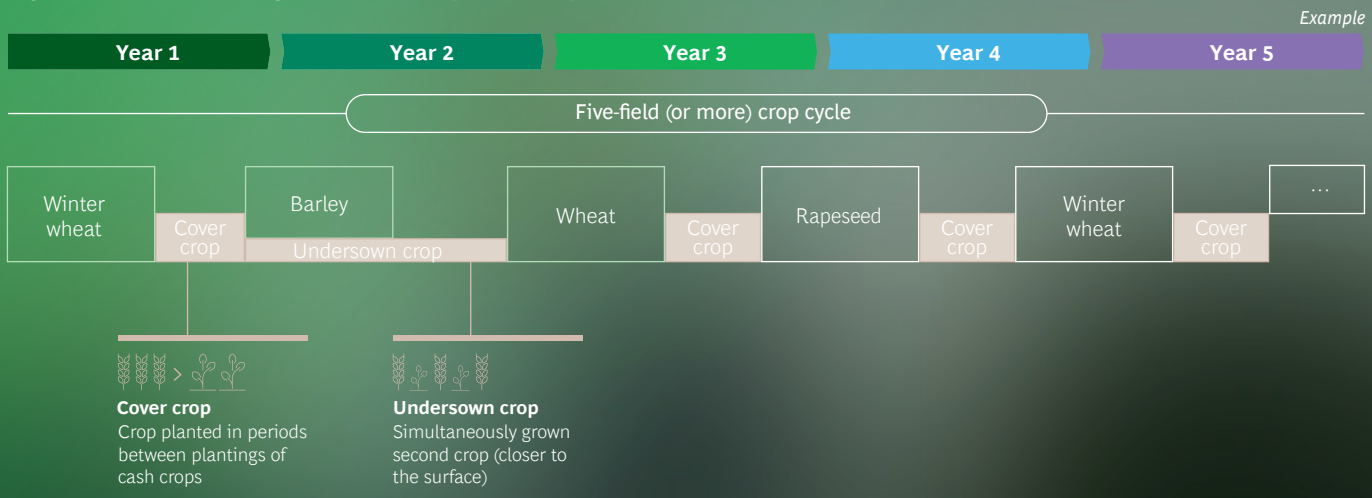
- **Agroforestry.** Here, hedges or trees are integrated into cropland or grassland to increase biodiversity, provide shade, and reduce water evaporation.

- **Livestock Integration.** This practice entails raising livestock in conjunction with growing crops—for example, allowing livestock to eat cover crops in order to increase carbon capture and directly fertilize the soil.

Exhibit 5 - The regenerative crop cycle

One way to understand how regenerative agriculture compares with, for example, conventional agriculture, is to compare crop cycles. The most central aspect of implementation of regenerative principles is how the land is cultivated. The conventional crop rotation is characterized by annual crops that are planted after ploughing and harrowing the fields nearly every year. In addition, conventional farmers often rely on large applications of either synthetic fertilizers or animal manure and intensive use of synthetic pesticides. This will typically lead to extensive periods of land lying fallow and thus to the risk of nutrient leaching into the ground or surface water systems, as described in section 1. Figure 1 illustrates crop-

Figure 1: Example of a regenerative crop cycle over 5 years



Source: Expert interviews; BCG analysis.

Figure 1 illustrates cropping principles of regenerative arable farming at the first two stages of adoption: basic and intermediate. Specifically, ways to add vegetation to the main crop cycle are illustrated. Due to the relatively cold climate in Denmark, farmers are dealing with a short growing season and colder winters. This means undersowing only takes place in spring crops due to the risk of the undersown crop dying off with the frost setting in if planted in the winter crop. Instead of undersowing in the winter crop, winter wheat, for instance, the cover crop is planted post-harvest. During some particularly wet summers, the window for planting post-harvest can be quite narrow. This means the ideal of every growing season being characterized by a main crop and an accompanying cover/undersown crop might not always materialize.

Cover cropping implies planting diverse crops after harvesting the main crop to help protect soil from erosion, build up organic matter, encourage soil biodiversity and—in the case of legume cover crops—help fix nitrogen in the soil, thereby reducing the need for fertilizers.

Undersowing implies sowing a cover crop where cover seeds or other leguminous crops are sown superficially after the main crop has been sown. These seeds will germinate, but only grow very little as long as the main crop is still there. When the main crop is harvested late July or early August, the undersown crop will start to grow. The purpose of this is twofold (at least). First and foremost, it is to prevent leaching of nutrients, particularly nitrate, into the aquatic environment, be it ground or surface water. In the late summer or early autumn, lots of free nitrogen is available in the soil. If this coincides with surplus rainfall, there is a risk that most of the available nitrogen will find its way into streams, lakes, and coastal waters. The second main purpose is to provide nutrients to the following crop. If the period provides optimal growing conditions, an undersown or post-harvest crop can deliver substantial amounts of nitrogen to the subsequent main crop, either because it collects the nutrients in the plant itself or because—as is the case with leguminous crops—it gathers nitrogen through the nodules on the roots of the plant. This again leads to a reduced need for synthetic fertilizer application in the ensuing crop.

Addressable Agricultural Land in Denmark

To understand the potential impact of regenerative practices in Denmark, one must first understand the land area that these practices can potentially be applied on.

Denmark's landscapes, spanning approximately 4.3 million hectares, dedicate 61% of their expanse to agricultural pursuits.[43] Regenerative agriculture holds potential for most of this land; however, to stay conservative and pragmatic, we only include 73% of it (about 1.9 million hectares) to have the land with the greatest potential in scope. The scoped land is equivalent to 44% of the total Danish surface area.[44]

To ensure precision and to take a pragmatic approach, our study examines the primary crops in Danish agriculture alongside permanent grassland.

The study emphasizes the most crucial crops and permanent grassland. Certain areas, such as organic farms, peatlands, and minor crops, are omitted from the study to maintain a focused and pragmatic approach to modelling the impact. However, it's important to note the specific reasons for the areas we have intentionally left out of our scope. In addition, it does not mean that many of the insights presented throughout the report are not highly relevant for these areas as well.

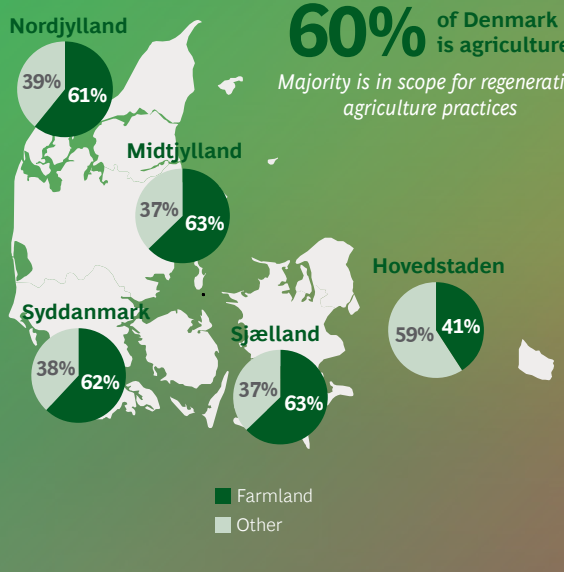
43. Statistics Denmark: Arealopgørelser.

44. Statistics Denmark.

Exhibit 6 - 73% of Denmark's agricultural area is in scope for the study

Majority of all farmland in Denmark holds potential for regenerative agriculture

60% of Denmark is agriculture

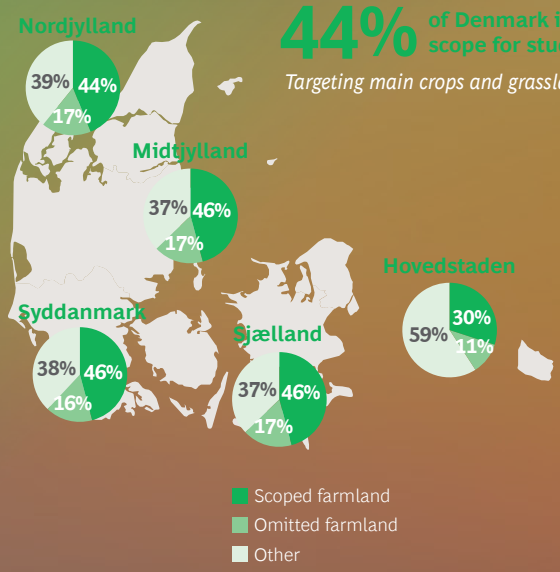


60% of Denmark is agriculture

Majority is in scope for regenerative agriculture practices

For modeling regenerative agriculture in Denmark, main crops[1] and grassland are targeted

Organic,[2] peatland,[3] and minor crops are omitted.



44% of Denmark is in scope for study

Targeting main crops and grassland

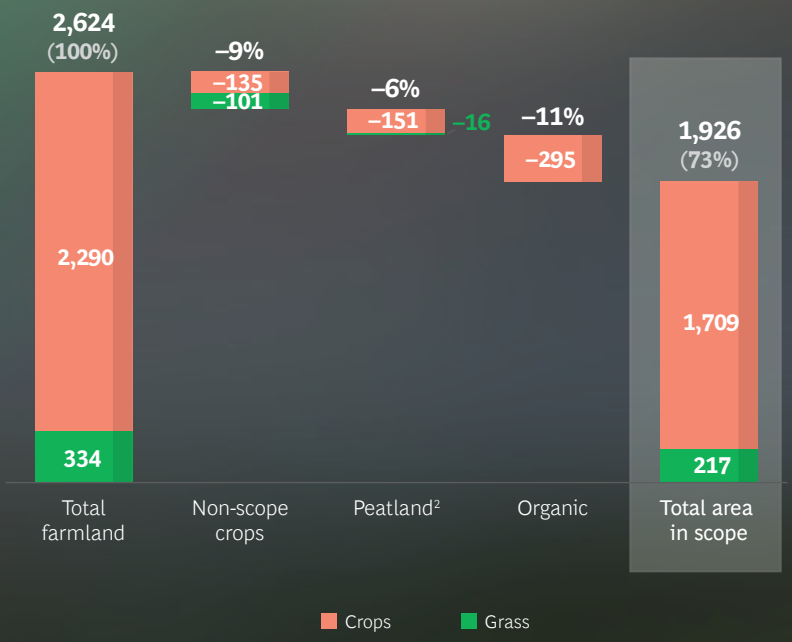
Sources: Statistics Denmark; The Danish society for Nature Conservation: Lavbundsjorde; BCG analysis.

[1]Wheat, barley, corn, rapeseed.

[2]Organic farms already uses some of the Regenerative Agriculture practices.

[3]Peatland holds greater climate value when restored.

Farmland in scope of study (K ha[1])



In scope of analysis (not application[3]):

- 1.9M ha equal to 73% of Danish farmland is in scope for the study
- This is equal to 44% of the total area of Denmark

Out of scope of analysis[3]:

- Non-scope crops include perennial crops, fallow land, and crops with <4% coverage
- Peatlands are excluded due to greater climate value when restored
- Organic areas are excluded due to many practices already being in use

Sources: Statistics Denmark; The Danish society for Nature Conservation: Lavbundsjorde; BCG analysis.

[1]'000 hectare.

[2]7% of Danish agriculture area is peatland.

[3]To be used in analysis for estimating the potential of Regenerative Agriculture. Regenerative agriculture Ag can be applied across all types of farmland and crops, but for sake of simplicity in the analysis, listed categories of farmland will be excluded.

Peatlands. While peatlands represent 7% of Denmark's terrain, they have been excluded from our study. The reason for this is their immense value in the fight against global warming. When restored, peatlands serve as significant carbon sinks, capturing and storing CO_2, thus playing a pivotal role in climate change mitigation. This is also in line with government policies on reaching the 2030 emissions goal.[45]

Organic Farms. Approximately 10% of Denmark's agricultural land is dedicated to organic farming. Organic holds a great potential for regenerative agriculture, but given that the penetration of certain regenerative practices is higher for organic land, we've chosen to exclude them. Given that organic farms typically are more advanced in sustainable methods and approach, they don't offer the same transformation potential as conventional farmland, but still hold great potential.

Minor Crops. There are certain crops in Denmark that, while part of the agricultural mix, aren't common. Examples including beets and perennial crops. The detailed impact of regenerative practices on such crops is excluded in this report, but they still hold a potential for regenerative practices.

Agricultural practices and land distribution in Denmark offer an insight into the nation's farming structure.

Small Farms. Constituting a significant 76% of all farms in Denmark, small farms, defined as less than 100 hectares in size, own only 23% of the total agricultural land. This category includes hobby farmers and accounts for 22,958 farms with an average area of 26 hectares. However, their relevance in the broader agricultural context is somewhat diminished, as many of these lands are often sub-leased to medium and large farms.

Medium Farms. These farms, ranging from 100 to 400 hectares, make up 19% of the total farms and control a substantial 44% of the agricultural land. With 5,766 farms in this category, each farm averages around 198 hectares. They represent some of the most relevant segments in the Danish agricultural sector, playing a pivotal role in production and distribution.

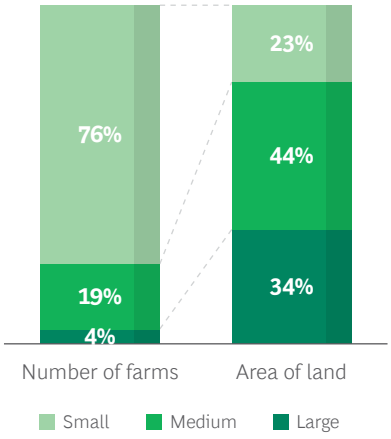
Large Farms. The largest farms, those exceeding 400 hectares, are few in number, making up just 4% of the total farms. However, their influence is undeniable, as they own a whopping 34% of the total agricultural land. There are 1,310 large farms, each with an average size of 676 hectares, forming the backbone of large-scale agricultural operations in Denmark.

The data underscores an intriguing aspect of Danish agriculture: While the majority of farms are small in size, a significant portion of the agricultural land is controlled by medium and large farms. This distribution reflects the evolving dynamics of farming in Denmark, where scalability and efficiency become paramount, especially for sustainable and regenerative agricultural practices.

Exhibit 7 - Danish farms grouped by size shows 34% of the agriculture land owned by 4% of the farms

Comparing number of farms to land owned

Grouped by size of farm



Characteristics for each farm group divided by size

Note: Data can change depending on land use and leasehold

Farm type	Size	Total number	Avg. area	Relevance
Small[1]	<100 ha	22,958	26 ha	*Less relevant, but often sub-leased to medium and large farms*
Medium	100–400 ha	5,766	198 ha	*Most relevant segments*
Large	>400 ha	1,310	676 ha	

Source: Statistics Denmark; BCG analysis.

[1]Incl. hobby farmers.

45. The Danish Agricultural Agency: Aftale om grøn omstilling af dansk landbrug 2021.

Economic and Ecological Assessment of Regenerative Agriculture in Denmark

This section assesses the impact of regenerative agriculture on farmer economics, GHG emissions, and biodiversity.

5.1 Regenerative Agriculture's Impact on Farm Economics

Contrary to conventional wisdom, regenerative agriculture could potentially not only sustain but also enhance farmers' profitability. As we examine the economics of Danish farms per hectare, an interesting insight becomes apparent. Although regenerative farming incurs initial and ongoing expenses, the medium- to long-term advantages decidedly favor farmers. We have observed a theoretical increase of farmers' profit of up to 40% from the regenerative levers, from a non-subsidized base profit, not factoring in potential upside from increased yield resilience. Looking at margin uplift from a subsidized base, the profit uplift percentage decreases to ~20%, assuming a subsidy worth 1,900 DKK/ha.[46]

In this section, we establish a baseline for farmer economics. In our analysis, the baseline excludes subsidies, even though it remains a key element in farmers' financing. The reason for excluding it in this study is to focus our quantitative analysis on direct economic impact from regenerative agriculture practices (for example, savings from diesel, labor, and fertilizer reductions). Danish farming is highly shaped by subsidies, incentivizing many current farming practices. Unpacking subsidies and their impact is not the focus of this report; however, it's further discussed qualitatively in Section 8.

46. Approximate subsidy based on expected subsidized area in 2023 is 1,900 DKK/ha (Ministry of Food, Agriculture and Fisheries of Denmark: Grundbetaling og tilskudsberettigede arealer 2023).

Building from baseline farmer economics, we analyze impact from the different practices and how it can evolve over time, building up to a steady state where farmers potentially can experience profit growth. We compute theoretical profit changes for the different regenerative agriculture practices from the basic and intermediate stages outlined in section 3, with a focus on cropland. Savings are realized from, for example, lower diesel usage, labor requirements, machine costs, use of fertilizer and upside from increased yield resistance. On the increased cost side are examples such as cover cropping seed costs, soil tests, and labor and machine costs from additional tasks.

The true potential of regenerative agriculture's economic upside, however, hinges on various factors, including the current state and utilization of the soil and market price fluctuations. It's important to acknowledge that this potential is inherently theoretical, influenced by a complex interplay of variables.

We used a two-step process to calculate the economic benefits of regenerative agriculture:

- **Step 1: Determine the Current Economic Baseline.** Establish baseline per hectare profit and loss figures for conventional farms that plant a conventional mix of crops, as well as baseline costs and revenues for the four most common crop types (wheat, barley, rapeseed, and corn) and grassland. This baseline does not include national subsidies or the EU's Common Agricultural Policy (CAP).

- **Step 2: Quantify Impact from Stage 1 and Stage 2 Practices.** After reviewing relevant Danish literature and databases, and interviewing farmers, professors, and other experts, we assessed the per-hectare impact of each of the Stage 1 and Stage 2 practices on increased costs, savings, and changes in revenue. This included a perspective on profit elevation from yield resilience as well as calculation of potential cost savings that farmers could realize if they were subject to a carbon tax.

The impacts associated with Stage 3 practices, such as agroforestry, have not been quantified due to the extended time required for these practices to show measurable effects, coupled with a limited body of research concerning their economic implications.

Our analysis excludes consideration of subsidies that may apply to farms, and it assumes that regenerative agriculture practices currently are not applied on a given hectare.

Step 1: Determine the Current Economic Baseline

Our baseline farmer contribution margins are based on SEGES farmer economics data.[47] The margin is defined as income from sales of yield (excluding subsidies, for example, CAP), minus material costs (for example, seed and fertilizer costs) and machine and labor costs (for example, diesel, machine depreciation, and interest and labor costs). Costs for land lease and insurance are also excluded. It can be argued that regenerative agriculture practices could slightly impact land use and insurance premiums, but that impact varies greatly and is not sufficiently defined in research to be included in this report.

We include the following crop categories into our analysis:

- **Barley.** A dominant crop in Denmark, barley has a contribution margin of -1,650 DKK/ha.

- **Wheat.** Another staple in Danish agriculture, wheat's contribution margin stands at -2,350 DKK/ha.

- **Rapeseed.** A smaller but significant crop in Denmark, rapeseed offers a contribution margin of -350 DKK/ha.

- **Corn.** This grain is typically used as feed for livestock and as a feedstock for biofuel. Corn in Denmark has a contribution margin of -850 DKK/ha.

Weighting the four crop types based on hectares planted, barley, wheat, rapeseed, and corn hold ~42%, ~34%, ~13%, and ~11%, respectively. This renders an average croplands contribution margin of ~1,650 DKK/ha, considering these crops.

Step 2: Quantify Stage 1 and Stage 2 Practices

This step quantifies the benefits, revenues, and costs of Stage 1 and Stage 2 regenerative practices. We present findings based on a weighted average for barley, wheat, rapeseed, and corn, reflecting their current distribution among crops. These selections are significant, as they represented key crops in Denmark and more than 63% of the Danish crop land in 2022.[48] The economic impact described applies to farms that have reached a stable state of implementation, a process typically extending over a timeframe of more than six years. Again, the size of impact is theoretical and depends on farm conditions. Also, speed of implementation depends on the initial state of the farm.

47. Based on definition used in SEGES farmer economics data (updated September 28, 2023).

48. Statistics Denmark.

Exhibit 8 - Baseline crop farming contribution margin is around ~1,650 DKK/ha, considering only sales of yields and COGS

Excluding subsidies (e.g., CAP)
Indicative

Economic breakdown (DKK/ha)	Wheat (34%)	Barley (42%)	Rapeseed (13%)	Corn (11%)	Average cropland split[1]
+ **Yield (Income)** Typical harvest weight x price	~14,300	~10,800	~12,550	~12,550	**~12,400**
- **Material Costs** E.g., seed cost, fertilizer cost, potassium, weed control, etc.	~(4,900)	~(3,150)	~(5,700)	~(5,300)	**~(4,300)**
- **Machine & labor costs** E.g., plowing, harvesting, fertilizer spreading, etc.	~(7,050)	~(6,000)	~(6,450)	~(6,350)	**~(6,450)**
= **Contribution Margin**	~2,350 ~16%	~1,650 ~15%	~350 ~3%	~850 ~7%	**~1,650 ~13%**

Sources: SEGES; BCG analysis.

[1]Based on weighing split between Wheat (34%), Barley (42%), Rapeseed (13%) and Corn (11%).

STAGE 1

Stage 1. Exhibit 9 shows the expected profit following Stage 1 basic implementation of regenerative practices in fields that grow crops. No-till practices, for example, increase margins[49] by an estimated ~18%,[50] largely by reducing the cost of tillage and seed preparation, whereas cover cropping increases margin by up to 11%. It should be noted that many factors impact the upsides of these practices. For example, cover crops' nitrogen release timing can depend on spring and autumn temperatures, which impacts nitrogen availability for the following year's cash crops, and in turn the actual upside from the practice. Adding together the practices, Stage 1 practices could increase farmer margins by up to 20%. This excludes potential increased yield resilience. It also excludes potential reduction of CO_2e tax, which will be discussed separately, as this has yet to be implemented in Denmark.

Also, it's worth noting that the exclusion of subsidies from the base margin makes the percentage of marginal uplift from the practices larger, as they are applied to a lower base margin. If including a 1,900 DKK/ha[51] subsidy, increasing baseline profits to ~3,550 DKK/ha, the marginal uplift percentage decreases to ~10%.

STAGE 2

Stage 2. Exhibit 10 shows the expected profit following Stage 2 intermediate regenerative practices in fields that grow barley, wheat, rapeseed, and corn as a main crop. Undersown cropping is not separately quantified, as the practice and benefits are closely interlinked with cover cropping, limiting upside from mixing the two practices. Moreover, the benefits of employing mulch systems can vary, as the upsides from nutrient release into the soil can fluctuate based on, for example, the temperatures in the spring and autumn. The quantified Stage 2 practices yield a theoretical maximum of up to ~15%. Calculating the upside from a base including the 1,900 DKK/ha subsidy, the uplift is ~8%. Again, this is excluding yield resilience increase and potential reduction of CO_2e tax, which will be discussed separately.

49. Definition of margin found under "Step 1: Determine the current economic Baseline."

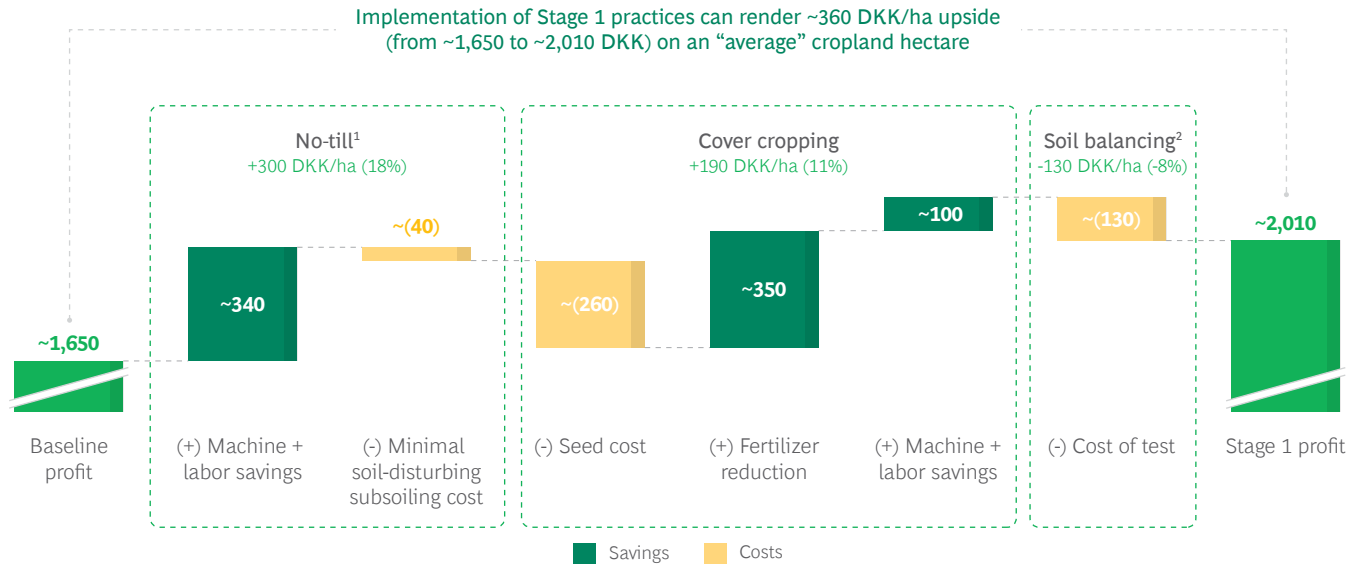
50. SEGES.

51. Approximate subsidy based on expected subsidized area in 2023 is 1,900 DKK/ha (Ministry of Food, Agriculture and Fisheries of Denmark: Grundbetaling og tilskudsberettigede arealer 2023).

Exhibit 9 - Stage One Regenerative Practices Could Increase Farmers' Direct Profits by Up to 20%

Excluding subsidies (e.g., CAP)
Indicative

Numbers show a 'weighted average hectare' with wheat (34%), barley (42%), rapeseed (13%), and corn (11%)[3]



Sources: SEGES; Statistics Denmark; expert interviews; BCG analysis.

Note: Excluding subsidiaries & only considering yield revenue + direct costs (for example, seeds, labor, machine, etc.).

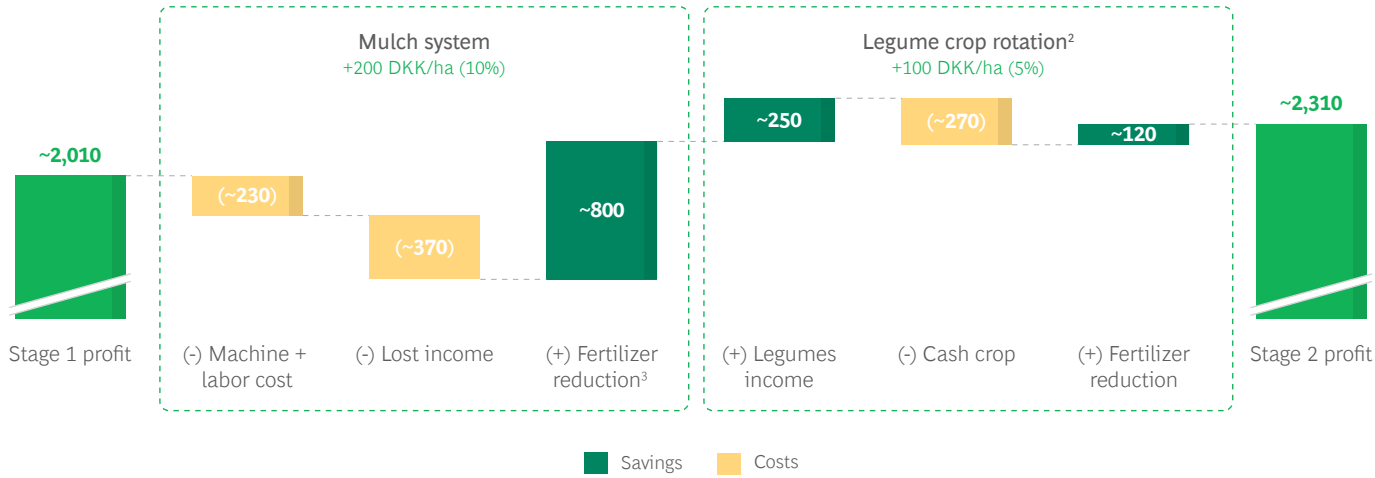
[1]Including minimally disruptive subsoiling.

[2]Test for mapping microorganisms.

[3]Based on Danish cropland distribution between the crops.

Exhibit 10 - Stage Two Practices Could Increase Profits by an Additional 15%

Impact on average crop farm hectare[1]
DKK/ha per year



Sources: SEGES; Statistics Denmark; expert interviews; BCG analysis.

Note: Excluding subsidiaries & only considering yield revenue + direct costs (for example, seeds, labor, machine, etc.).

[1]Based on Danish cropland distribution between the crops: wheat (34%), barley (42%), rapeseed (13%) and corn (11%).

[2]Legumes in crop rotation every 6th year.

[3]Fertilizer savings scaled down ~30% from peak-price savings, reflecting potentially inflated priced and outcome uncertainty.

Stage 3

Stage 3. Our analysis does not quantify the benefits from Stage 3 regenerative practices, due to a lack of available Danish research. Additionally, the benefits depend greatly on how farms are being operated. Nevertheless, farmers are likely to see the following benefits at this stage:

- **Improved Soil Structure.** Biologically activated biochar boosts carbon capture and water holding capacity while reducing nitrate leaching.
- **Reduced Water Evaporation and Heat.** Agroforests and hedges provide shade and act as windbreaks to limit evaporation and improve dew deposition, which helps cool the soil surface.
- **Reduced Erosion.** Keyline subsoiling helps mitigate the risk of soil erosion during heavy rainfall.
- **Improved Leverage of Biodiversity and Ecosystem Services.** The benefits of using improved ecosystem services include better pollination and natural pest control. Some Stage 3 practices may entail additional costs related to the structural changes needed both to implement agroforestry and intercropping and, overall, on smaller fields. Smaller fields may be challenging, as most current farm machinery is designed for large working widths. With the advent of more flexible, autonomous, and expensive farm machinery, however, this is less likely to be an issue.

Financial Impact from Avoided Yield Loss

Practicing regenerative agriculture, which emphasizes soil health and biodiversity, could enhance crop resilience and reduce yield losses in years with extreme weather. That said, research is limited, and the effects are mainly observational and experience based so the results are less certain. Thus, the financial impact from increased yield resilience should be regarded as an indicative potential further upside from regenerative agriculture practices.

Extreme weather conditions can lead to yield drops of about 20% in Denmark. This is based on observing the latest drops in yields due to extreme weather there, as seen in 2018 and 2023 with drops of 23% and 15%,[52] respectively. Some farms using regenerative methods have observed more consistent yields during extreme weather, showing the potential to mitigate yield loss. Yield resilience increase could render an annualized increase in yields of up to 4%, assuming extreme weather every fifth year and full resilience against it.

With extreme weather events expected to become more frequent due to climate change, improving yield resilience becomes increasingly important. However, predicting local impacts of climate change and crop responses to environmental changes remains uncertain, adding a degree of unpredictability to these estimates.[53]

Total Financial Impact per Hectare (Stages 1 + 2)

By deploying Stage 1 and Stage 2 practices, farmers reap financial gains. Theoretically, their margins could increase by up to 40%, from a non-subsidized base, under favorable conditions. This number has many dependents and can vary significantly for different farms. Adding the same 1,900 DKK/ha subsidy to the base margin as in our per-stage analysis, the margin increase instead becomes approximately 20%.

This excludes the financial impact from increased yield resilience leading to avoided yield loss. Quantifying this is more illustrative, but mitigating yield losses in extreme weather years could render an additional upside up to a maximum of 400–500 DKK/ha (see exhibit 11). This is assuming no yield loss in extreme weather years, thus the actual impact is likely lower.

Moreover, this projection does not factor in savings related to avoided carbon tax and subsidies. The potential financial impact depends on how policies will be designed, which is discussed further in Section 8.

The per-hectare benefits may fluctuate, influenced by, for example, farm size (including potential scale benefits for larger farmers) and other farm-specific attributes such as location and soil type. Given the extensive farm diversity, a detailed analysis of these variations has not been conducted. Instead, the presented figures represent average impacts, serving as theoretical directional guidance.

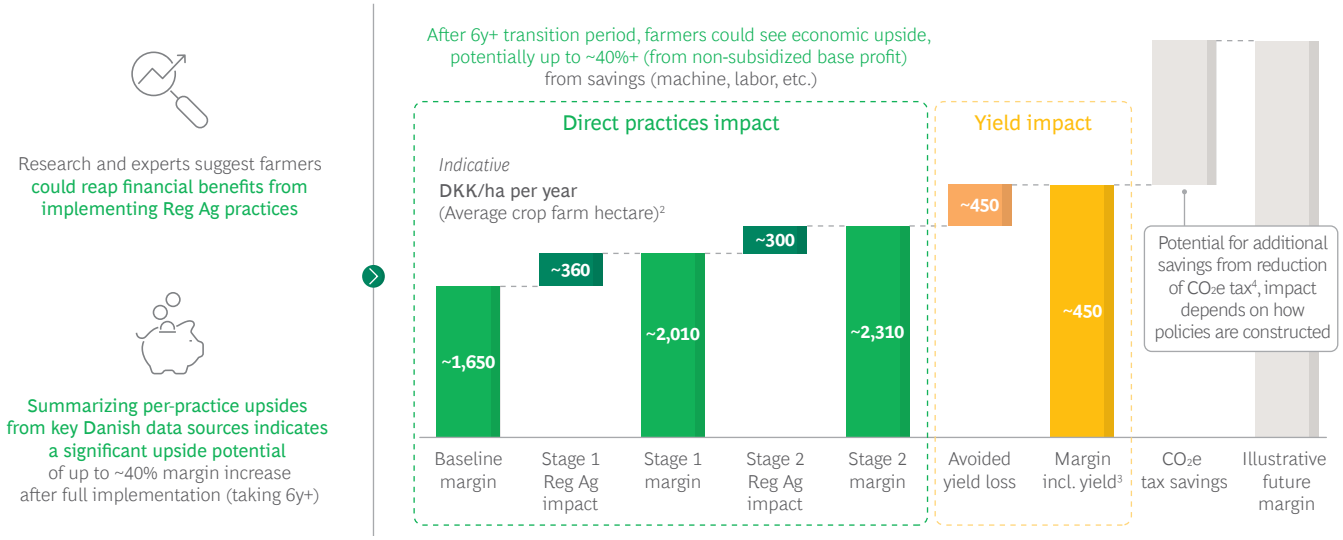
Financial Impact across Denmark

Broadening the scope to assess the direct economic impact of Stage 1 and Stage 2 practices across Denmark, we multiply the per-hectare impact by the total hectares considered. By 2035, the theoretical annual positive economic impact across farmers is estimated at around 1–2 billion DKK per year.[54,55] This projection leaves out possible impacts on other industries from the shift to regenerative agriculture. For example, transitioning to lower-power machines may affect machinery sales and price points. Moreover, enhanced farmer economics could lead to lower sales prices on yields, redistributing economic gains across the agri-value chain and to consumers.

52. Weighted average for main crops in scope (wheat, barley, rapeseed, corn).
53. Expert interviews; BCG analysis.
54. To put a perspective on the number, it roughly equates to the annual positive economic impact from about 20% of the Danish agriculture's total subsidies from the EU in 2021.
55. See section 8.1 Quantification of CO2e-impact for description of penetration assumed.

Exhibit 11 - Regenerative agriculture could positively impact farmer profits, potentially saving them up to ~660 DKK+/ha after a 6y+ transition

Excluding impact from subsidies (e.g., CAP[1])



Sources: SEGES; Annette V. Vestergard (2023). Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture (CA). *FRDK*; Statistics Denmark; expert interviews; BCG analysis.

[1]Common Agricultural Policy, EU-wide policy partnership.

[2]Average economic impact weighting barley(42%), wheat(34%), rapeseed(13%), corn(11%).

[3]Theoretical margin.

5.1.1 Regenerative Agriculture Impact on Grassland

Permanent grassland constitutes 11% of the designated agricultural area in Denmark, encompassing approximately 217,000 hectares. This type of land is primarily utilized either for grazing livestock or harvesting as fodder. The harvested fodder is a crucial resource for feeding livestock and thereby supporting the agricultural ecosystem. An economic baseline for grassland has not been established. The regenerative agriculture levers are less researched, and the practices provide less direct impact, being more dependent on livestock. Furthermore, grassland, to a larger extent, depends on current subsidies, a topic that is not quantified in this study.

That said, grassland presents a potential for the implementation of regenerative agriculture practices. The upsides include allowing for a reduction in the use of synthetic nitrogen fertilizers and a gradual improvement in soil health through diverse approaches.

Basic Implementation

The goal of including grassland in regenerative agriculture is to reduce the use of synthetic nitrogen fertilizers while increasing land productivity and improving soil quality. This is done by interseeding a mix of multiple grasses, legumes, and herbs.

Legumes help reduce the need for nitrogen fertilizers, as they can bind nitrogen directly from the air.[56] At the same time, herbs help improve soil health with their varied root systems, which help improve soil structure, allow water to soak in better, and mitigate soil erosion.[57]

By mixing in about 20% legumes with the grassland, farmers could cut down nitrogen fertilizer use by up to a fifth, a reduction of up to about 30 kg of nitrogen per hectare.[58] The amount of monetary savings depends on the cost of fertilizers. A significant drawback of this practice is the increased expense for seeds due to the use of a diverse mix of legumes, herbs, and grasses. Furthermore, interseeding increases the carbon sequestered in grassland, resulting in an average reduction of about ~0.7 tons of carbon dioxide equivalent (tCO_2e) per hectare per year.

56. Danish Agriculture and Food Council: Fakta om kvælstof i landbruget og vandmiljøet.

57. SEGES.

58. SEGES; BCG analysis.

Case study on Christian Højgaard Weigelt

How regenerative agriculture helped Christian Højgaard Weigelt built a resilient business

Christian Højgaard Weigelt is a third-generation crop and dairy farmer just outside Aarhus. He farms 200 hectares and has 180 cows. His primary cash crops are wheat, barley, and corn. Christian is a regenerative farmer focusing on minimum tillage, including direct seeding, diverse cover crops, and crop rotations as well as continuous learning and development to improve soil fertility and resilience. He has witnessed firsthand how regenerative practices improve soil health, making his business better and more resilient.

Looking at cost savings from introducing no-till (including direct seeding) alone, Christian has saved 50% of work hours and two-thirds of diesel fuel used without experiencing any drops in yields.

Furthermore, Christian has experienced how the soil ecosystem is blooming with life. His soil has more earthworms and micro-life, increasing the share of organic matter in soil and improving the soil and crop resilience in wet and dry periods.

In 2018, Denmark experienced its worst drought in 99 years. Average yield per hectare for the four main crops, namely, wheat, barley, rapeseed, and corn, dropped by 23%. Christian, on the other hand, maintained normal yields in 2018. The same case held for 2023, which was also known to be an unusual farming season due to an unfavorable mixture of heavy rain and drought in the country. In 2023, average yields of wheat, barley, rapeseed, and corn, dropped by 15%, while Christian, again, maintained normal yields.

Christian has no doubt that regenerative farming has improved the resilience of his soil, crops, and yields. However, it has not only led to cost savings and more stable yields, but also minimized the level of concern Christian, and other farmers, are struggling with daily. “I am not panicking anymore,” Christian says. Due to regenerative farming, he is confident knowing his soil, crops, and yields are strong enough to handle whatever comes at him—and that he, his family, and his family legacy are safe.

Source: Visit at Snaastrupgård, Chriistian Højgaard Weigelt.

Intermediate Implementation

The intermediate stage for grassland involves adaptive grazing, where livestock rotate across designated land sections, fostering a cycle of trampling, grazing, and grass regrowth improving soil health and yield.[59] To implement this system, investment is needed, for example, into fencing and water supply systems, as these need to follow the more adaptive scheme and be located in multiple places or be easy to move. The success of adaptive grazing is also weather dependent, as favorable conditions promote grass regrowth, while adverse conditions such as droughts can disrupt the rotation schedule. Moreover, adaptive grazing is labor intensive due to frequent livestock movement and monitoring of grass and soil conditions. These factors highlight the need for thorough planning ahead of adoption of this practice.

For permanent grass used for cutting, adaptive mowing can be utilized. This is a practice that accelerates plant recovery after cutting and strengthens the root robustness of the grass, thereby fostering a more sturdy and resilient grassland ecosystem thanks to a reduced hay cut length.

Having a faster recovery of plants after cutting and a more resilient grassland also help in loss prevention. Furthermore, healthier soil enhances water retention and nutrient availability, which in turn supports robust grass growth, even under adverse conditions.

5.1.2 CO_2e Taxation – Additional Financial Impact

Aside from the financial impact that Stage 1 and Stage 2 practices have with regard to machine and labor expenses, a CO_2e taxation policy would also have significant implications to farmer profits and would add further differentiation between non-regenerative and regenerative agriculture farmers. This differentiation can have a widely varying magnitude of impact depending on both the price and the structure of the CO_2e taxation scheme. This has not yet been decided upon, with lawmakers planning to present a proposal for an agricultural climate tax once the assigned expert group for a green tax reform presents its conclusions.[60] To assess the magnitude of potential impact, this report considers a price range of 125 to 750 DKK per tCO_2e based on the current rates in place for different Danish industries.[61] Two potential setups could be a tax on direct CO_2e emissions or tax deductions for CO_2e sequestration.

Taxing direct CO_2e emissions is more common, with more established tracking mechanisms across at least 46 countries globally.[62] We have identified two potential scenarios should a farmer stick to conventional farming techniques. One possibility is that they limit their fertilizer and fuel consumption to reduce the associated CO_2e costs. However, reducing these inputs with no balancing action to provide crops with the needed nutrients puts them at risk of potential yield reductions. Another possible scenario is continuing operations as is, which will allow them to maintain their current yields and revenue streams while taking up an additional CO_2e cost, reducing overall profits. However, adopting regenerative agriculture practices can help farmers reduce their CO_2e tax levels compared with conventional farming, as the practices described earlier allow for reduced machine and fertilizer inputs while ideally not reducing farm yields in the long run.

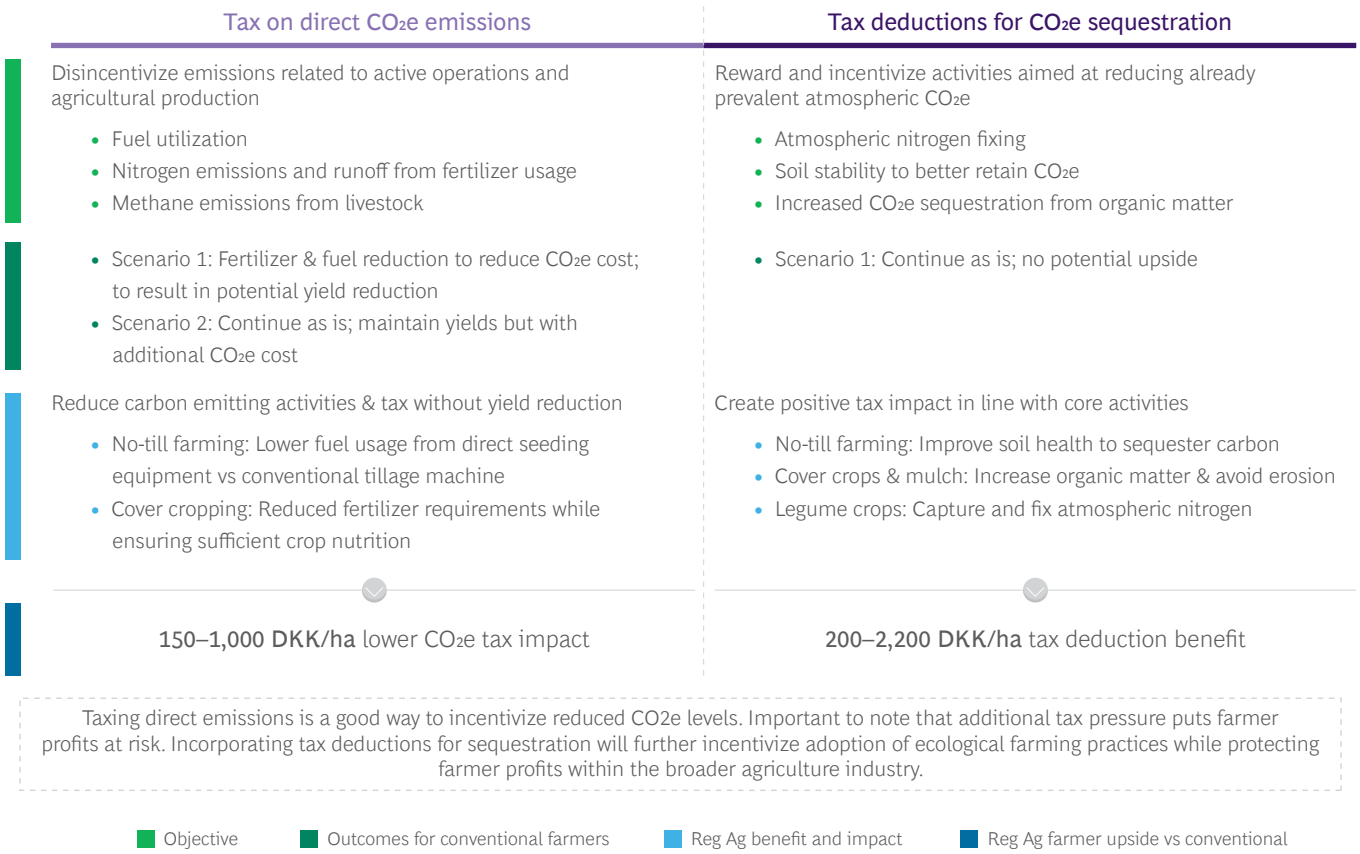
The Danish government has an ambition to maintain the competitiveness of the agricultural sector, despite the introduction of a climate tax.[63] There are several possible ways to achieve this, including to incorporate sequestration into the tax scheme as a way to stabilize farmer financials, sequester carbon, and in turn generate additional ecological benefits such as improved biodiversity and water quality. Including CO_2e sequestration could help drive adoption of activities that help reduce the already prevalent CO_2e in the atmosphere. This could again impact farmers differently depending on which practices they adhere to. Non-regenerative agriculture farmers could be able to continue as is without any positive or negative impact. On the other hand, farmers incorporating regenerative agriculture practices could be able to get additional upside of tax deductions if the sequestered CO_2e is evaluated. As this provides a potential upside to balance out the increased taxation from direct emissions, these sequestration-related deductions could ease the impact of the CO_2e tax on the agricultural sector.

It is important to note that implementing these deductions based on CO_2e sequestration introduces some additional complexity, including verifying sequestration impact, measuring baselines, and managing potential loopholes in the system that result in unintended behaviors among farmers.

Overall, incorporating a climate tax on direct emissions is a more commonly utilized method to incentivize reduced CO_2e levels. This, however, introduces an additional tax pressure that can put farmer profits at risk. Incorporating tax deductions for sequestration can help further incentivize adoption of ecological farming practices while protecting the broader competitiveness of the farming industry.

59. Organic Denmark: Holistisk afgræsning styrker jordfrugtbarheden.
60. Prime Minister's Office: Ansvar for Danmark.
61. Danish Finance Ministry: Denmark's existing Policies and Measures.
62. International Monetary Fund: More Countries Are Pricing Carbon, but Emissions Are Still Too Cheap.
63. Prime Minister's Office: Ansvar for Danmark.

Exhibit 12 - Shifting to regenerative agriculture reduces potential impact of CO_2e tax; incorporating sequestration on top of emissions can further drive adoption



Source: SEGES; Statistics Denmark; expert interviews; BCG analysis.

5.2 The Farmer's Path to Reaping the Impact of Regenerative Agriculture

Securing the financial and ecological upside of a fully implemented regenerative agriculture system does not happen overnight. Rather, it's a multi-year transition process from a farm's existing setup, with inherent risks in the initial years. Though specific timing will differ on a case-to-case basis, the transition can generally be divided into three key phases prior to achieving a steady state capturing the full benefit of the regenerative agriculture rollout.

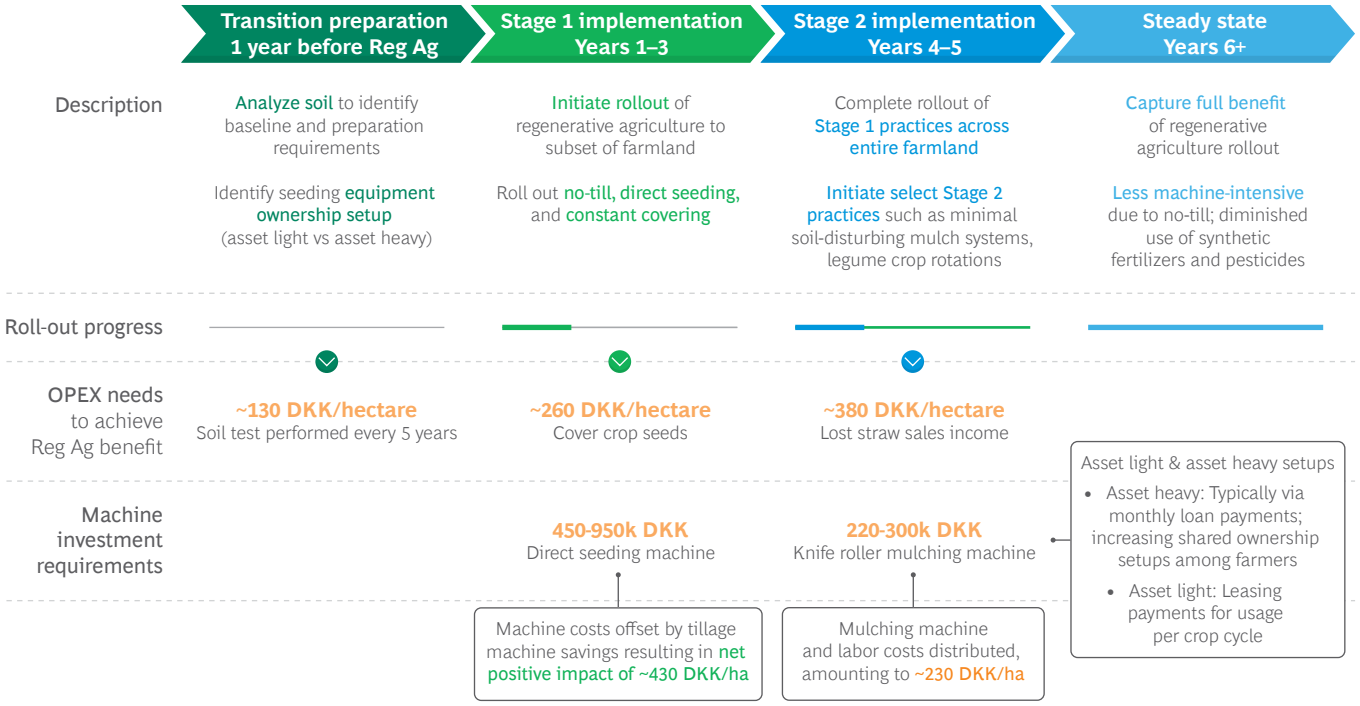
Phase 0: Transition Preparation

Kickstarting the transition process requires preparation at least a year before implementing regenerative agriculture practices. Farmers should utilize this time to build up their knowledge base and practical skills on their specific type of soil for regenerative agriculture, assess and prepare the farmland, and plan out the specific logistics of the first year of rollout.

Build Up Knowledge Base

To build up an understanding of regenerative agriculture, farmers are encouraged to utilize all resources available to them: publications and guidelines, workshops and classes, and advice from either third-party agricultural consultation providers or downstream value chain food producers with regenerative agriculture programs. Practical training and outings to other regenerative farms with similar soil and conditions are highly encouraged, as regenerative agriculture is practical and soil dependent. While availability of some of these resources is currently limited, we expect accessibility to increase as adoption picks up; it will, however, require some time prior to reaching the tipping point of a positive feedback loop between adoption and resource/service availability.

Exhibit 13 - Phased roll-out of regenerative agriculture reduces potential farmer risk and costs



Sources: SEGES; NABU; BCG analysis.

Beyond a tactical understanding of the implementation methods, one goal of this learning journey is to ensure all stakeholders in the farm have a common expectation of what outcomes will be from the change in farming methods and fully support the transition process despite potential short-term dips. This is a key consideration for generational farmers who want to ensure continuity in subsequent generations such that the long-term investment pays out, including tenant farmers who may need approval and support from landowners; cooperatives utilizing shared resources; and even sole proprietors who will need support from financial institutions and downstream players.

Assess and Prepare the Farmland

Conducting a detailed soil test is critical to understand a farm's starting point in terms of nutrient availability, carbon content, and microbial activity. Additional tests may also be developed in the future to measure additional factors such as soil structure stability.

The results of the test will inform next steps required with regard to fertilizer and herbicide usage, soil aeration, and cash and cover crop selection. Based on the level of preparatory work required, farmers can identify which portion of their land will be included in the first wave of Stage 1 practice implementation.

Depending on farm size and risk appetite, farmers typically roll out Stage 1 practices to 10%–40% of their total land to build familiarity and confidence in the new methods while mitigating costs and potential losses.

Beyond the transition preparation, regularly conducting the test every five years will help track the impact of the regenerative agriculture shift and guide the farmer on any necessary adjustments they may need to make to their operations.

Plan Out Logistics for First Year of Rollout

The two main Stage 1 practices to be implemented are no-till direct seeding and cover cropping. Securing a source of cover crop seeds should be relatively straightforward, though logistics for no-till direct seeding may require specialized machinery such as a direct seeder. As such, farmers need to identify their source of equipment and ensure availability in line with crop cycle timelines. Additionally, one key consideration for asset-heavy farmers would be the current age of their traditional tillage equipment (for example, plows, rollers, disk harrows). Since only a subset of the farmland may be initially converted to regenerative agriculture, selling this equipment off would be an unlikely choice.

Phase 1: Stage 1 Implementation

As mentioned previously, the key Stage 1 practices to be implemented in the land demarcated for regenerative agriculture are cover cropping and no-till direct seeding. It is preferred in this phase to implement them in parallel, as a staged approach will not yield optimal results. These come with associated costs, with the key item being the direct seeding machine, which can range from 450,000–950,000 DKK depending on brand and size. Farmers can opt for an asset-light model of leasing the machine on an as-needed basis per crop cycle or an asset-heavy model of purchasing the machine outright. During preparation and implementation, continuous training and knowledge sharing within the regenerative agriculture community and value chain are encouraged.

Cost Implications and Options

Though direct seeding machines are expensive, it is important to note that utilizing them will eliminate both labor and machine costs of higher-horsepower traditional tillage equipment. Overall, as discussed in the farmer economics section of this report, farmers can, on average, expect a net savings of roughly 300 DKK/ha[64] from replacing operations of higher-horsepower equipment with direct seeding options.

Both asset-heavy and asset-light models are potential options for a farmer to consider with regard to gaining access to a direct seeding machine. Asset-light farmers are familiar with renting from machine shops and will achieve the savings from lower fuel costs. Asset-heavy farmers can take out loans to cover the purchase, and, between monthly payments and fuel requirements, their total costs are expected to be lower than traditional tillage due to lower horsepower. In addition, the cooperative model has also been utilized to spread costs out among multiple farmers.[65]

Another cost to consider is the seeds for the cover crops, amounting to roughly 260 DKK/ha.[66] Though this is expected to be offset by roughly 350 DKK[67] in fertilizer savings—of course, varying with fertilizer price—it is important to acknowledge the potential risk of cover crops not providing the full nutrient requirements expected in the initial years as farmers gain experience with new plants. Should this happen, the fertilizer savings impact may not be fully realized, as farmers will have to balance this out with additional inputs.

Regenerative Agriculture Implementation

No-till direct seeding methods and cover cropping are best implemented in parallel to obtain the maximum benefit across dimensions such as, but not limited to, soil microbial activity, water retention, weed management, and input costs. Cover crops contribute organic matter nutrients to the soil while inhibiting sunlight for weeds and water evaporation, while the no-till practice helps preserve the organic matter and provides the necessary environment for soil microorganisms to preserve cover crop nutrients in the soil.

In the initial transition, risk from weeds between main crops will be at its peak, requiring focused effort from farmers to manage them. Leaving a layer of vegetation in the field at all times is a key requirement to limit sunlight reaching weeds; this can be achieved from either the cover crops or residue from the previous harvest. Additionally, herbicides can be utilized during the transition period if machines such as mulching knife rollers are not yet available to the farmers.

Soil compaction is another issue farmers should continue actively managing, with multiple options available per farm. Some measures already being practiced in Danish farms today include establishing fixed driving lanes in farms with heavy machinery to isolate compaction in predefined areas and smaller farms utilizing wider low-pressure tires and rubber tracks to spread weight and potential compaction over a wider surface area. Beyond machine-related considerations, compaction can be further managed by selecting deep-rooting cover crops to break up and aerate the soil.

As farmers gain familiarity with these techniques and reap the financial benefits, they can gradually expand these practices to a larger share of the farm.

Phase 2: Stage 2 Implementation

Upon fully rolling out Stage 1 regenerative agriculture practices throughout the farm, farmers can begin the process of implementing Stage 2 practices. The key financially beneficial practices identified are minimally soil-disturbing mulch systems between main crops and incorporating legumes in crop rotations every six years. Encouraging continuous training and knowledge sharing among the regenerative agriculture community and businesses are essential for successful implementation—as new knowledge is needed and the practice varies for different farms and soil types, thereby necessitating the knowledge sharing.

64. SEGES: Driftsøkonomi ved Conservation Agriculture i forhold til dyrkning medpløjning; BCG analysis.
65. Expert interviews; BCG analysis.
66. Land og Fritid online product catalog; BCG analysis.
67. SEGES: Driftsøkonomi ved Conservation Agriculture i forhold til dyrkning medpløjning; BCG analysis.

Cost Implications

The primary investment upon initiating Stage 2 rollout is a mulching system with minimal soil disturbance. Though equipment can cost between 220,000 and 300,000 DKK, these would likely be spread out over the course of several years, similar to what is expected of the direct seeding machine. Mulching machines such as knife rollers do not, however, directly replace any conventional machinery. As such, this would result in an annual cost per hectare of 230 DKK, driven by mulching machine, fuel, and labor costs.[68] In addition to machine costs, mulching will result in lost straw sales worth around 370 DKK per hectare,[69] as the regenerative agriculture approach is to work the plant byproduct and residue into the soil to serve as the combined mulching system and fertilizer. The lost income from straw sales will naturally vary based on price developments. These should be seen as an overall worthwhile investment, as improved soil health and increased organic matter are expected to result in fertilizer savings of up to 25 kg of nitrogen, among other nutrients. Depending on fertilizer price, this is estimated to create savings of up to 800 DKK/ha[70] should all go according to plan.

Aside from mulching, Stage 2 rollout also initiates the incorporation of legumes into the six-year crop rotation. This will have an opportunity cost, as the cash crop is replaced by legumes, but this will be offset by profits from legume sales and reduced fertilizer costs for both the legumes and the subsequent crop cycle, ending at an increase of profit up to 600 DKK/ha for the legume rotation year,[71] meaning a yearly average upside of up to 100 DKK per hectare. This upside is very dependent on prices for replaced cash crop, legumes, and fertilizer.

Regenerative Agriculture Implementation

A minimally disturbing mulch system builds on the success of the cover crop adoption in Stage 1. Its goal is to terminate the cover crops and work the residues into the soil to provide nutrients for the subsequent cash crop in a way that avoids tillage. In this way, organic matter is retained in the soil, providing the protected microorganisms for the required decomposition inputs to reduce fertilizer requirements.

Additionally, incorporating legumes results in further fertilizer cost reductions, as their interaction with rhizobia bacteria serves to convert atmospheric nitrogen into ammonium for plant usage. Aside from this, their deep root system brings nitrogen closer to the surface where subsequent crops can utilize it.

While this significantly reduces fertilizer requirements, we recommend farmers regularly test the nitrogen levels in the soil to ensure fertilizer usage is adjusted in a way that the subsequent cash crop gets sufficient nutrients without negatively impacting yield. If possible, they can also utilize biostimulants and organic fertilizers.

While legumes provide significant benefits, it is critical not to overuse them to avoid monoculture risks. Excessive farming increases the likelihood of legume-targeting diseases such as powdery and downy mildews, Botrytis grey molds, and root rot, among others.[72] As such, the six-year gap between legume rotations is a key constraint to incorporate in the Stage 2 rollout.

Steady State

In the years after Stage 2 practices are fully rolled out, farmers will reap the benefits of their initial steps into regenerative agriculture. Soil health will be much improved in terms of nutrients and structure, significantly reducing fertilizer requirements and improving water retention. Carbon emission reductions and sequestration will be in a continuous process, benefiting society and also increasing profits for the farmers once an agricultural climate tax is implemented—with loss avoidance from emission reductions and potential revenue gain in the event that carbon sequestration credits are provided.

Steady state does not mean the farmer does not have to remain vigilant. Even in this phase, farmers should continue soil testing to inform their fertilizer regimens and ensure a balanced soil ecosystem. Furthermore, farmers can look to explore Stage 3 regenerative agriculture practices to further improve ecological and financial impact.

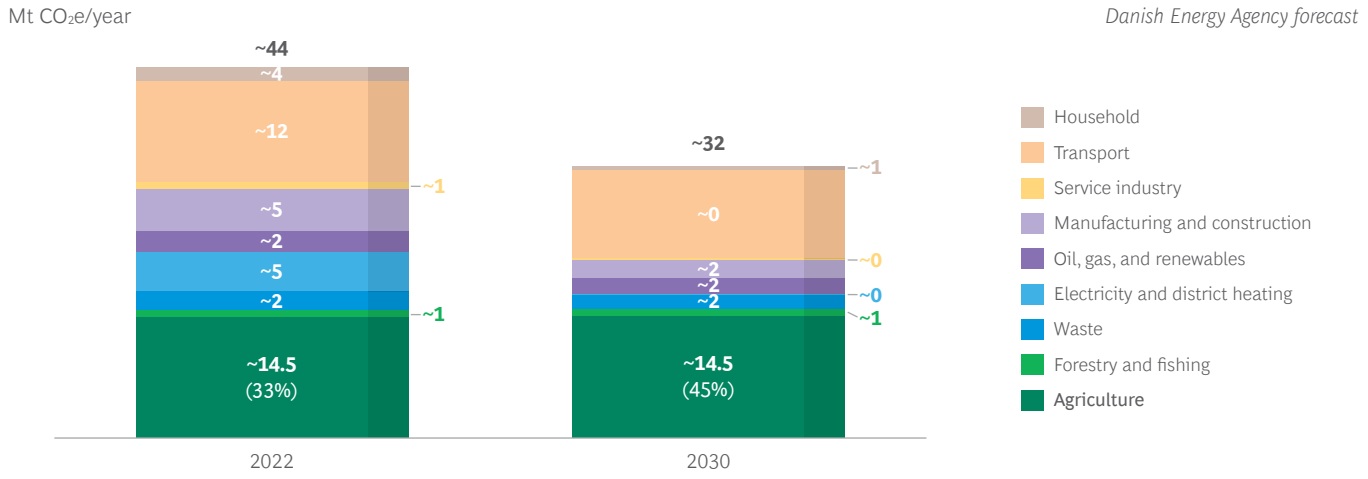
5.3 Positive Impact on Nature

The agriculture sector holds the distinction of being the largest emitter of GHGs in Denmark. Furthermore, projections indicate that without more intensive proactive intervention, emissions from this sector are likely to remain roughly flat over the next five to 10 years. This entails increasing its share of total GHG emissions from around 33% to 45%, as other sectors are projected to lower relative emissions more than agriculture will.[73] This scenario underscores the imperative for prompt and decisive action to curb emissions and foster sustainable agricultural practices.

68. SEGES.
69. Patriotisk Selskab: høje gødningspriser øger halmens værdi, overvej nedmuldning; BCG analysis.
70. Patriotisk Selskab: høje gødningspriser øger halmens værdi, overvej nedmuldning; BCG analysis.
71. SEGES; Statistics Denmark; Annette V. Vestergard (2023). Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture (CA). FRDK; BCG analysis.
72. Expert interviews.
73. Danish Energy Agency: Klimastatus og -fremskrivning 2023.

Exhibit 14 - Agriculture is the largest source of GHG emissions in Denmark; emissions are expected to stay flat, necessitating action

Danish total GHG emissions expected to drop from ~44 to ~32 $MtCO_2e$ from 2022 through 2030, but Agriculture is expected to stay flat



Sources: Danish Energy Agency: Klimatstatus og –fremskrivning 2023, revised November 2023; BCG analysis.

Shifting to regenerative agriculture has the potential to materially impact Danish GHG emissions. This section of the report explains and indicatively quantifies how regenerative agriculture could help reduce the sector's emissions in Denmark.

Our analysis suggests that by 2035, regenerative agriculture could aid in abating around 4 megatons of CO_2e per year, assuming there's a widespread implementation of regenerative practices (see exhibit 21). This projected abatement equates to approximately 10% of Denmark's total emissions in 2022, or about 30% of the emissions from the agriculture sector. This is comparable to planting almost 200 million trees, or the emissions from around 2 million internal combustion engine cars.[74] However, these figures should be approached with caution, as there are several critical factors and challenges that could hinder the realization of these outcomes. Transitioning to regenerative agriculture may encounter resistance due to factors such as lack of awareness, deficient technical knowledge, and the initial costs involved. Furthermore, accurate systems to measure carbon sequestration and GHG emissions reduction are essential to validate the benefits of regenerative agriculture; however, they can be complex and costly to implement.

5.3.1 Quantification of CO_2e Impact

Regenerative agriculture can impact Denmark's carbon footprint in three main ways. First, agricultural soil has the potential to function as a major carbon sink because the process of growing crops captures carbon and allows it to be stored in the soil. Regenerative farming practices further prevent the depletion of soil carbon. Second, regenerative agriculture can reduce direct carbon emissions caused by, for example, diesel usage. Third, it can reduce fertilizer use, which both reduces GHG emissions and mitigates leaching, thereby protecting Danish waters, such as fjords and lakes, from nitrogen pollution.

Quantification of CO_2e Impact. In quantifying the amount of carbon captured in the soil, our analysis adopts a bottom-up approach in which we consider how much carbon each regenerative practice has the potential to capture in the soil, according to the most applicable and available scientific estimates (mainly relying on Danish research). The full potential for an individual hectare depends on various factors, including the current state and utilization of the soil. It's important to acknowledge that this potential is inherently theoretical, influenced by a complex interplay of variables.

74. SEGES; Statistics Denmark; Annette V. Vestergard (2023). Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture (CA). FRDK; DCA; USDA: The Power of One Tree - The Very Air We Breathe; expert interviews; BCG analysis.

Exhibit 15 - In 10–15 years, regenerative agriculture could notably reduce Danish emissions

Indicative

Up to

~4 megatons

CO_2e p.a.

2035–2040
indicative potential yearly CO_2e impact[1] from Reg Ag practices in Denmark[2]

Considering potential only from the 73% of Danish farmland in scope[3]

... equal to:

- **~10%** of Danish 2022 emissions
- **~15%** of Danish 2030 emissions4
- **~30%** of Agriculture 2022 emissions
- **~180M** trees planted
- **~2M** internal combustion engine cars

After implementation of regenerative agriculture

Source: BCG analysis.

[1]Increased sequestration and direct reduction.

[2]Including only Stage I & II practices.

[3]Organic, minor crops, and peatland omitted.

[4]Goal to reduce emissions with 70% of 1990 emissions.

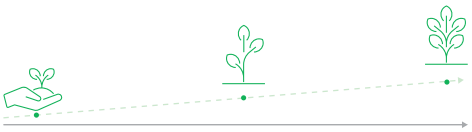
Exhibit 16 - Yearly CO_2e impact is based on ongoing impact from previously introduced practices and new land-adopting practices

CO_2e sequestration (ongoing)
"growing forest"

As a tree grows, it sequesters new carbon each year until it's fully grown and can't take in more carbon.

Similarly, some Reg Ag practices (e.g., No-Till) result in yearly sequestration for 10–20 years[1] until the soil gets saturated with carbon.

Thus, a No-Till field increases sequestration several years post implementation



Ongoing sequestration over 10–20 years

\+ Direct emission reduction **e.g., lower use of diesel**

\+ Reduction in fertilizer use **leading to reduced N_2O emissions**

= **Total yearly CO_2e impact**

Source: BCG analysis.

[1]Estimate based on SEGES report, in calculations, it is assumed that the yearly sequestration rate is consistent, and a uniform distribution over the 15-years is used.

Impact from the practices is not unanimously decided on among researchers, can be challenging to carve out from the whole system, and varies depending on, for example, soil types and weather conditions. Thus, generous ranges are frequent in research papers. We have reflected this by including ranges in our results based on the those presented in past research. Also, not all practices have been quantified in a Danish context, which we've reflected for transparency. It's also important to note that the cumulative carbon impact of these individual practices may be fully additive and will vary based on conditions.

Apart from looking at CO_2e impact in discrete years, it's relevant to view the impact over the full country-wide implementation of regenerative agriculture. This to highlight that carbon sequestration can't go on forever; at some point, the soil saturates. While it's debatable how much carbon can be sequestered in different soils, this report uses a proxy by SEGES that states that carbon sequestration can go on for 15 years after the introduction of a new practice. This means that if a farmer implements a practice that has an impact on carbon sequestration, the soil can sequester carbon for approximately 15 years. Following that point, the ongoing emission reduction will be only from direct sources (for example, diesel and fertilizer usage). Naturally, 15 years is a rough proxy and the longevity of sequestration from the introduction of new practices varies based on such factors as soil type, baseline soil health, etc.

As carbon sequestration slows down over time after adopting new practices, it's still important to continue with regenerative agriculture to prevent soil carbon loss.

No-till is a key practice for keeping sequestered carbon in the soil. The impact of no-till practices varies with the level of carbon content in the soil. In soils already high in carbon, no-till mainly helps retain existing carbon.

This report quantifies only the environmental benefits of converting tilled land to no-till. We are excluding lands where no-till is already adopted, peatlands, and organic farms when quantifying no-till impact. Thus, the carbon impact considered quantitatively is the carbon sequestered from the farms adopting new practices, for example, going from tilling to no-tilling, as well as the direct emission reduction from, for example, less diesel usage. The avoided release of carbon that would have occurred if the soil were continuously tilled is not included.

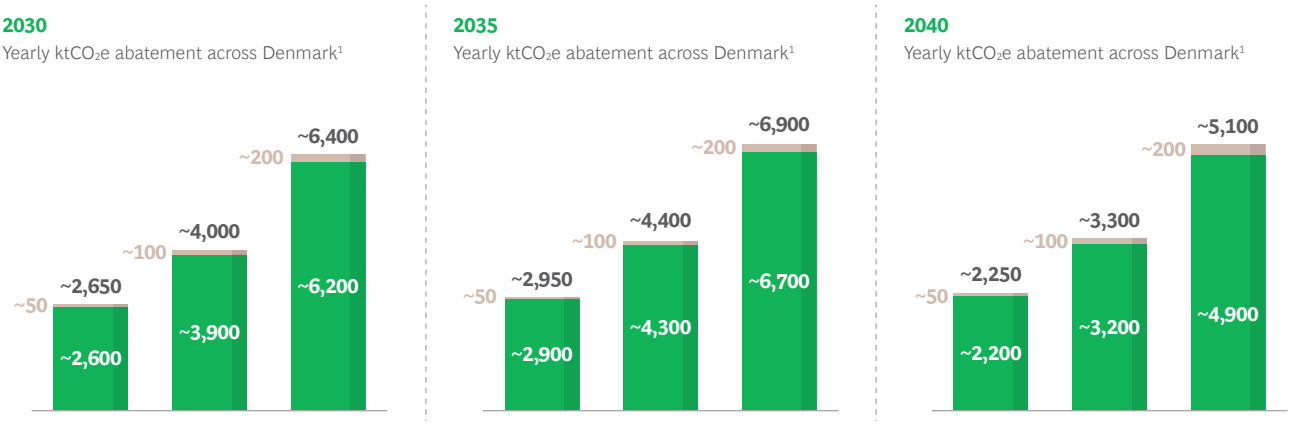
Also, in this study, we assume that penetration will continue to increases until 2035 and then stay flat, meaning the carbon-removal effect from sequestration will drop over time after 2035 as fields saturate. Some research suggests that fields can in fact sequester for much longer, but to keep our estimates conservative, the 15-year proxy is applied. To further keep our estimates conservative, this report takes several other measures. For instance, we exclude ~27% of Danish farmland (non-scope crops, peatland, and organic land) and assume no further environmental upsides from undersown cropping versus cover cropping, or a combination of the two. We include no positive environmental impact from land already doing no-till, which means we are assuming that these lands are not actively sequestering more carbon due to no-till adoption. Furthermore, we have excluded potential upsides from biofertilizers and all Stage 3 practices.

Exhibit 17 - Up to ~4 $MtCO_2e$ p.a. potential impact by 2035, where clear majority of practices have been found in Danish research

Yearly $ktCO_2e$ impact expected (split between Danish and international studies)

Per Case, Stages 1 & 2, cropland & grassland

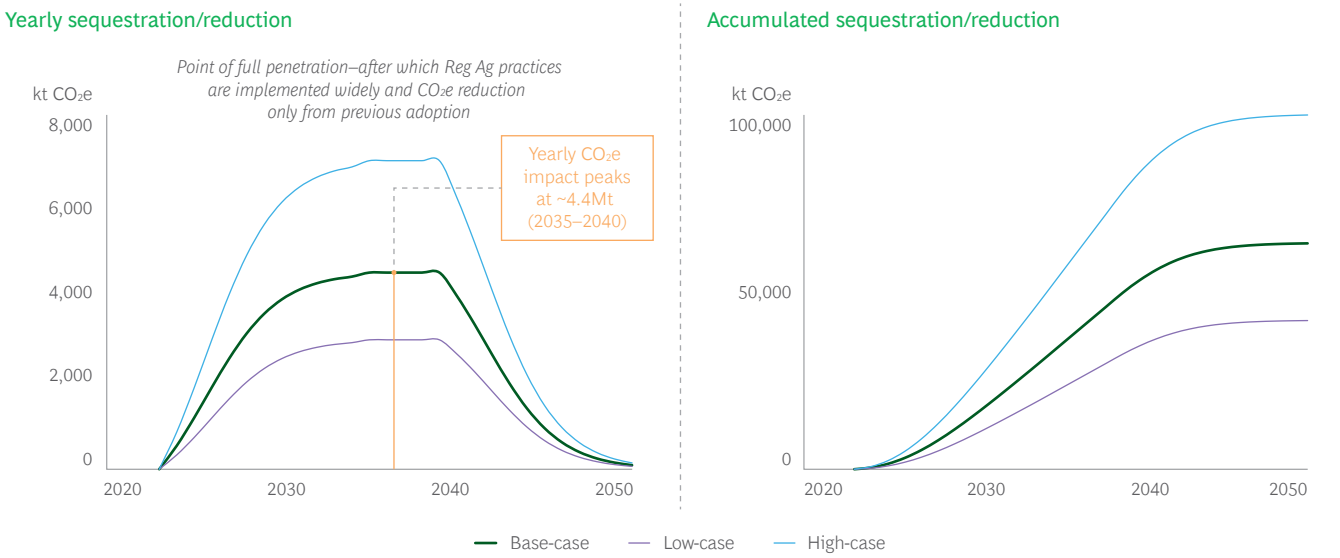
Danish sources available found for No-Till, Cover Cropping, and Legume Crop Rotation
International sources used for rest of practices



Source: BCG analysis.

[1]From Danish in-scope farmland, ~76% of farmland in-scope.

Exhibit 18 - Yearly CO_2e I mpact from regenerative agriculture practices set increase to ~4 $MtCO_2e$ by 2035, then winding down as soil sequestration saturates



Sources: SEGES; Statistics Denmark; expert interviews; BCG analysis.

Impact per Driver

As stated, the CO_2e impact was calculated by looking at impact per regenerative agriculture practice. Exhibit 19 shows the CO_2e impact per hectare and year for cropland.[75]

Like the total impact figures, the impact per individual practice is also ranged.

To go from impact per hectare and year to total Danish impact, we look at total addressable farmland and penetration per practice. Regenerative agriculture penetration's uptick forecast can't be confidently quantified. Instead, we regard future penetration as a "must-believe" to realize the environmental benefits detailed (see section 5.3). Levels are set based on discussions with experts and available literature.[76]

We have also included a potential upside from applying regenerative agriculture practices of interseeding and adaptive grazing or moving. However, grassland contributes a significantly smaller share of the potential impact. This is both because the land with permanent grass is smaller than the land with crops (217 ha compared with 1,709 ha in scope) and because regenerative agriculture practices included are predominantly for cropland (see section 4).

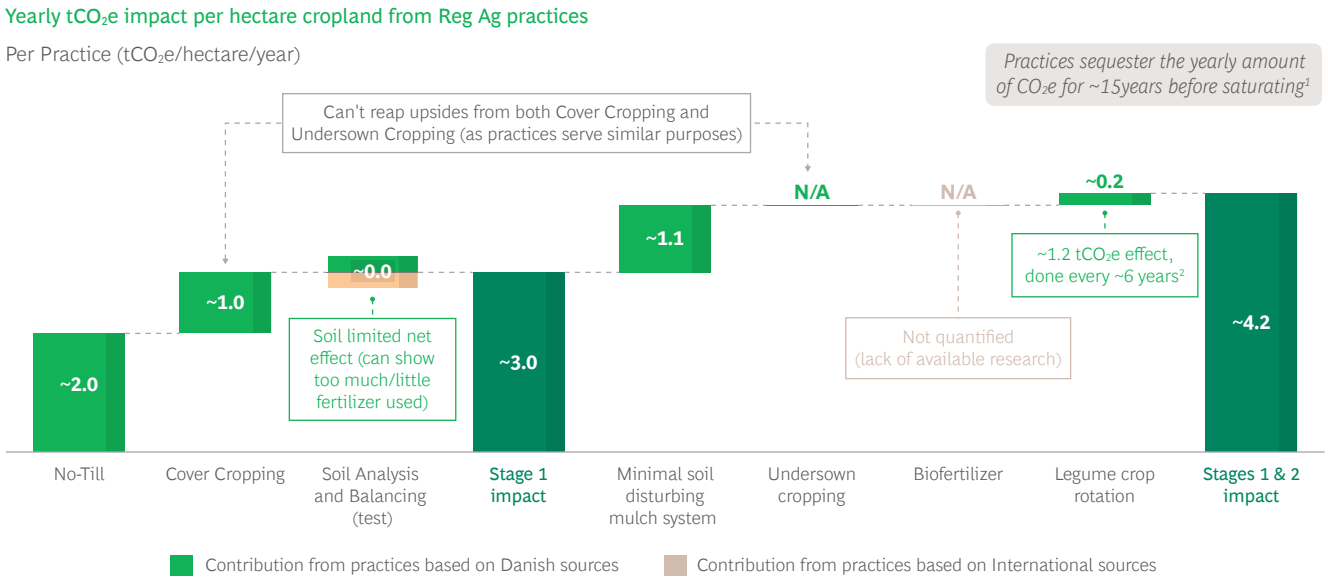
Also, less Danish research is available covering impact from grassland practice. Thus, we take a more conservative approach when quantifying potential benefits.

Data indicates that some upside potential—interseeding and adaptive grazing—could help reduce CO_2e impact by around 0.7 tCO_2e/ha and 1.3 tCO_2e/ha, respectively.[77] However, this is not based on Danish studies.

The expansion in adoption is a central determinant of the impact regenerative agriculture will potentially have. It is contingent on an array of factors, including the formulation of policies and incentives, whose design could significantly sway the extent to which regenerative agriculture is embraced and, consequently, its overall impact. The estimated adoption rates used for 2035 are "must believes" to materialize the potential upsides presented and could be realistic if the levers presented in section 8 are utilized to create the right incentives and assistance for farmers to transition. Additionally, technological advancements could have the potential to assist farmers in transitioning to regenerative agriculture and help adapt practices, further boosting adoption.

75. SEGES; Annette V. Vestergard (2023). Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture (CA). FRDK; Statistics Denmark; Land og Fritid online product catalog; Patriotisk Selskab: høje gødningspriser øger halmens værdi, overvej nedmuldning; expert interviews; BCG analysis.
76. SEGES; Annette V. Vestergard (2023). Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture (CA). FRDK; expert interviews; BCG analysis.
77. USDA-ICF 2016: Greenhouse Gas Mitigation Options and Costs for Agricultural Land and Animal Production within the United States.

Exhibit 19 - Regenerative agriculture cropland practices could abate ~4.2 tCO_2e per hectare and year, where no-till is the most impactful practice

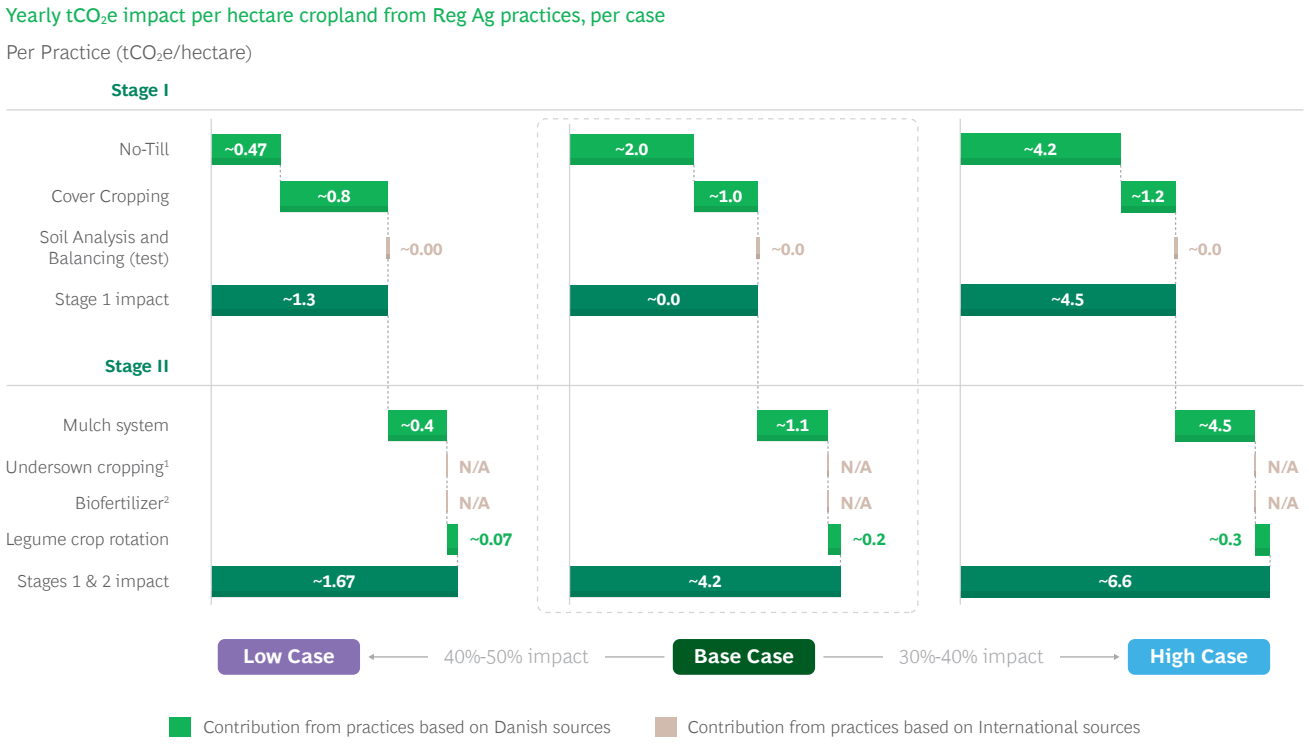


Sources: SEGES; DCU/DCA: report no 177 - videnssyntese om conservation agriculture report no 130; DCA: Virkemidler til reduktion af klimagasser i landbruget - 2023; Annette V. Vestergard (2023). Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture (CA). *FRDK*; expert interviews; BCG analysis.

[1]SEGES estimate on feasible frequency.

[2]Due to cost-consideration with not seeding cash-crops & diseases due to pathogen build-up.

Exhibit 20 - Impact from Stages 1 & 2 cropland practices range between ~2-6 tCO_2e per hectare

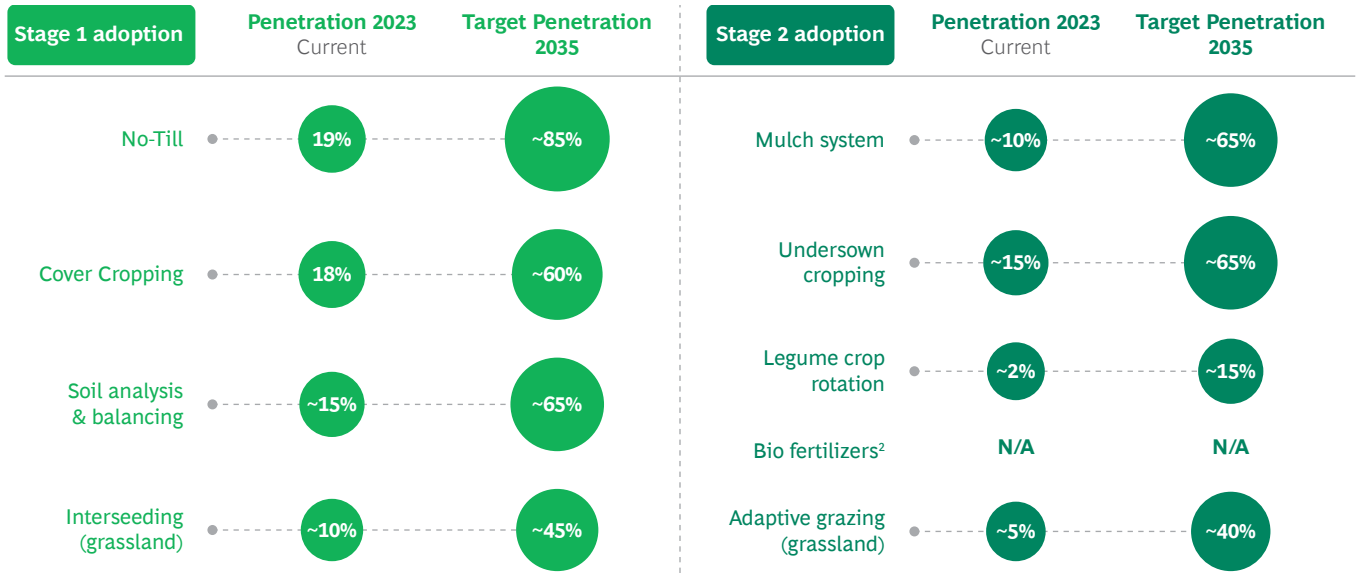


Sources: SEGES; Annette V. Vestergard (2023). Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture (CA). *FRDK*; DCU/DCA: report no 177 - videnssyntese om conservation agriculture report no 130; DCA: Virkemidler til reduktion af klimagasser i landbruget - 2023; expert interviews; BCG analysis.

[1]Assuming no further upside from bundling cover cropping and under sown cropping.

[2]Practice not quantified.

Exhibit 21 - To materialize environmental upsides, penetration of practices must see a rapid uptick in the next 10–15 years



Sources: SEGES; expert interviews; BCG analysis.

Note: Advanced implementation not quantified.

[1]Due to cost-consideration with not seeding cash-crops & diseases due to pathogen build-up.

[2]Penetration not considered as practice is not quantified.

5.3.1.1 Enhancing Water Retention and Soil Organic Matter

Regenerative agriculture practices have multifaceted benefits that are not just limited to carbon sequestration and reduction. The regenerative agriculture approach has showcased promising results in improving soil's water retention capacity and enhancing the resilience of crop yields.

Increased Soil Water Holding Capacity

One of the significant advantages of regenerative agriculture is its ability to enhance soil's water holding capacity. With every ton of carbon organic mass sequestered in the soil, the water holding capacity increases by approximately 2.6 m^3.[78] This not only reduces the need for irrigation but also combats the adverse effects of droughts. Denmark's soils have shown the potential to sequester approximately 1.3 tons of carbon mass per hectare under regenerative farming practices.[79] For Denmark's agricultural land, this translates to a potential water holding increase of 3.4 m^3/ha. Such an increase in water retention can lead to substantial savings in water resources.

Yield Resilience and Soil Health

Beyond water savings, the soil's improved water holding capacity directly impacts the resilience of crop yields. With the soil retaining more moisture, crops become more resistant to periods of water stress, ensuring consistent and potentially increased yields even under unfavorable weather conditions. Furthermore, enhanced water retention reduces the chances of surface water puddling, minimizing the risk of crop damage and soil erosion.

Carbon Sequestration and Soil Organic Matter

Denmark's soil has shown a great potential to sequester carbon. This sequestration not only aids in countering CO_2e emissions but also contributes to the increase in SOM. Higher SOM levels enrich the soil, making it more fertile and productive. This, in turn, supports healthier plant growth and further carbon sequestration, creating a positive feedback loop.

Adoption of regenerative agriculture in Denmark presents a holistic solution to water management and soil health.

78. Libohova et al (2018). Reevaluating the effects of soil organic matter and other properties on available water holding capacity using the National Cooperative Soil Survey Characterization Database. Journal of Soil and Water Conservation.

79. From Carbon-sequestering impact from No-till, Cover Cropping, Minimal soil disturbing mulch systems, legumes in crop rotation every sixth year.

Exhibit 22 - Positive Impact on Leaching and Fertilizer Usage

Fertilization is a fundamental practice in agriculture, involving the addition of essential nutrients to the soil to enhance plant growth and optimize crop production. However, this practice can have unintended consequences, particularly in the case of nitrogen, a critical nutrient for plant growth. Nitrogen leaching is a phenomenon where water moves through the soil, carrying with it dissolved nitrogen compounds. This process can deplete the soil of essential nutrients and transport excess nitrogen to streams, lakes, and other inner coastal areas, leading to significant environmental issues.

The consequences of nitrogen leaching on water quality are profound. Excess nitrogen in fjords, for instance, can result in oxygen depletion, leading to what is known as hypoxia. This oxygen depletion can have devastating effects on aquatic ecosystems, causing the fleeing and death of marine life such as fish and shellfish. In essence, nitrogen leaching poses a serious threat to aquatic biodiversity and the overall health of water bodies.

In response to these challenges, regenerative farming practices can potentially be part of the solution. The adoption of regenerative agriculture practices strives for more sustainable fertilizer usage, particularly concerning nitrogen, which is crucial for plant growth.

Under ideal settings, regenerative farming practices have the potential to significantly reduce nitrogen usage. The data indicates a maximum potential savings of up to approximately 50 kg of nitrogen per hectare.[80] The average nitrogen usage for conventional croplands is approximately 220 kg per hectare.[81] This indicates that the potential reduction could be as high as 20%–25% of cropland nitrogen usage, underlining the potential benefits of regenerative farming practices in optimizing fertilizer to secure yield, while concurrently supporting ecological balance.

One key aspect of regenerative farming that contributes to this reduction in nitrogen leaching is the use of cover crops.

80. Patriotisk Selskab: høje gødningspriser øger halmens værdi, overvej nedmuldning; SEGES; DCA: Virkemidler til reduktion af klimagasser i landbruget - 2023; Annette V. Vestergard (2023). Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture (CA). FRDK; The Danish society for Nature Conservation: Sådan ligger landet 2022; BCG analysis.
81. The Danish society for Nature Conservation: Sådan ligger landet 2022.

Cover Crops

Cover crops, sown in the intervals between the cultivation of main cash crops, possess the capability to retain nitrogen within the soil, thereby preventing its leaching into nearby water bodies. This conserved nitrogen can then be utilized by the subsequent cash crops, diminishing the need for supplemental synthetic fertilizers. A potential drawback of cover crops is that, in certain conditions, they could retain nitrogen for extended periods and release them too late for the main crop. This nitrogen retention varies based on, for example, temperatures during spring and autumn, resulting in a wide fan of potential outcomes. Under optimal conditions, the practice of cover cropping alone holds the theoretical potential to conserve up to approximately 20 kg of nitrogen per hectare annually.[82]

Mulch Systems

Another effective regenerative farming practice is the use of mulch systems. These systems have a theoretical potential to help save up to around 25 kg of nitrogen per hectare per year. This potential upside can vary depending on many things, including spring and autumn temperatures, which effect the release timing of nutrients and thereby the potential savings. Mulch acts as a slow-release source of nutrients for the next-up cash crop, reducing the need for synthetic fertilizers and minimizing the risk of nitrogen leaching into the environment.[83]

Legume Crop Rotation

Incorporating legume crop rotations into farming cycles can save up to an additional 5 kg of nitrogen per hectare per year. This practice diminishes the demand for synthetic fertilizers both during the legume crop rotation year and the subsequent year, owing to the legumes' unique capability to fix atmospheric nitrogen into the soil. Typically implemented every six years, this rotation offers enduring benefits for soil health and nitrogen management.[84]

Nitrogen leaching in agriculture poses a significant threat to water quality and aquatic ecosystems. Regenerative farming practices offer a sustainable and effective solution by significantly reducing nitrogen usage and preventing the leaching of this vital nutrient into water bodies.

82. SEGES; BCG analysis.
83. Patriotisk Selskab: høje gødningspriser øger halmens værdi, overvej nedmuldning; BCG analysis.
84. Annette V. Vestergard (2023). Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture (CA). FRDK; Danish Agricultural Agency: Vejledning om gødsknings- og harmoniregler - Planperioden 1. august 2022 til 31. juli 2023; BCG analysis.

SOM and Soil Structure

Cover crops enrich SOM by introducing plant residues that gradually decompose, providing a continuous source of organic carbon for soil microorganisms. This, in turn, promotes microbial activity, enhancing SOM levels. Additionally, cover crop root systems play a vital role in improving soil structure. They help bind soil particles together, reducing erosion and enhancing soil stability. The complex root networks of cover crops create channels in the soil, improving water infiltration and air exchange, preventing compaction, and, overall, promoting better soil structure. Cover crops contribute to SOM by introducing plant residues that decompose over time, providing organic carbon for soil microorganisms and promoting soil structure through their root systems.[85]

Mulch systems protect the soil from erosion and gradually decompose, adding organic matter to the topsoil. The breakdown of mulch provides a continuous source of organic carbon, nourishing soil microorganisms and supporting SOM. Furthermore, by shielding the soil from erosive forces, mulch preserves topsoil integrity and reduces surface crusting, favoring healthy root growth and maintaining good soil structure.[86]

Legume crop rotations increase SOM through nitrogen-rich residues, enhance root growth, and stabilize soil mass, thereby promoting improved soil structure.

Enhanced soil structure prevents compaction, facilitates water infiltration, and encourages robust root development.[87]

These practices foster the accumulation of organic matter, mitigate erosion, support nutrient cycling, and create a more hospitable environment for beneficial soil organisms, leading to healthier and more productive soils. Additionally, they help in retaining nutrients in the soil, preventing them from being washed away.

85. Organic Denmark: Efterafgrøder.
86. Patriotisk Selskab: høje gødningspriser øger halmens værdi, overvej nedmuldning.
87. United States Department of Agriculture: Legumes and Soil Quality.

Situation Today in Denmark

The effects of nitrogen leaching extend into the Danish fjords, where excessive nutrients in surface waters are leading to high levels of oxygen depletion. In the autumn of 2023, Denmark experienced the worst oxygen depletion in 20 years, according to Aarhus University.[88] The situation is detrimental to marine life, as excessive algae growth, fueled by nutrient overloads, including nitrogen, leads to oxygen depletion, thereby killing plant and animal life on the seabed.

Despite concerted efforts to reduce nitrogen leaching in the agricultural sector in Denmark, there has been no significant decline in nitrate leaching levels since the early 2000s.[89] As of 2021, Danish agricultural land still faced a notable nitrogen surplus of 83 kg of nitrogen per hectare, the surplus being nitrogen added but not fixed or used as intended. This signifies an ongoing challenge in effectively managing nitrogen levels, adding up to a total of 215,000 tons of nitrogen surplus for agriculture in Denmark in 2021.[90] The savings in nitrogen fertilizer from regenerative agriculture for the scoped area alone could amount to about 50,000 tons of reduced nitrogen usage per annum by 2035, about 20% of the nitrogen deficit in 2021.[91] Introducing regenerative agriculture practices to areas outside the scoped areas (for example, organic farmland and minor crops) would increase it further.

It is essential to understand that while nitrogen surplus in agriculture provides an indication of potential nutrient leaching, it does not directly represent the actual leaching that occurs. Model-based assessments for specific regions in Denmark estimate nitrogen leaching to be around 50 kg of nitrogen per hectare. However, it is crucial to acknowledge that there is no fixed relationship between nitrogen surplus and nitrogen leaching. The extent of leaching is heavily influenced by weather conditions, with dry years resulting in minimal nitrogen leaching due to the lack of nutrient runoff caused by rainfall.[92]

88. Aarhus University, Hovedet i Havet: Iltsvind I Danmark
89. Ministry of Environment of Denmark: Landbrugets udvaskning af kvælstof fra marken.
90. Aarhus University: Landovervågningsoplande NOVANA.
91. Aarhus University: Landovervågningsoplande NOVANA; BCG analysis.
92. Ministry of Environment of Denmark: Landbrugets udvaskning af kvælstof fra marken.

Multiple regenerative practices can help prevent leaching by, for example, having a slower release of nutrients. This is the case for leaving root systems and crops that slowly release nutrients in the field. Their slow-release nature allows plants to take up the nutrients as they become available, reducing the risk of nutrient surpluses that can lead to leaching. In contrast, synthetic chemical fertilizers often release nutrients quickly, increasing the likelihood of excess nutrients leaching into the soil and potentially reaching water bodies.[93]

Furthermore, biofertilizers have some of the same traits, as they decompose and release nutrients slowly, and biofertilizers based on organic material contribute to increasing SOM, adding to the microbiological life that improves soil structure water retention and nutrient holding capacity.

Nitrogen leaching has a crucial effect on ecosystems and water quality

Indicative

Reg Ag practices could potentially help reduce synthetic fertilizer usage on cropland with **up to ~20% per hectare by 2035**

This by saving up to ~50 kg of nitrogen per hectare of cropland (out of ~220 kg N/ha average usage), directly reducing leaching

Additionally, Reg Ag practices could reduce soil erosion and nutrient loss by retaining moisture and increasing SOM[1]

Sources: Patriotisk Selskab: høje gødningspriser øger halm ens værdi, overvej nedmuldning; SEGES; DCA: Virkemidler til reduktion af klimagasser i landbruget - 2023; Annette V. Vestergard (2023). Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture (CA). *FRDK*; The Danish society for Nature Conservation: Sådan ligger landet 2022; BCG analysis.

[1]Soil Organic Matter.

Regenerative agriculture practices have the potential to reduce the need for added fertilizer, mitigating current leaching issues in Denmark

Indicative

Direct nitrogen use reduction, in turn impacting leaching

Potential to reduce
up to ~50 kg N/ha,
compared with ~220 kg N/ha average cropland use

~20%
reduced nitrogen usage

Summarizing impact, up to ~45 kt N[1] could potentially be reduced p.a. in 2035, compared with ~215 kt N surplus on all agriculture land in 2021

Main nitrogen reducing practices

Cover Cropping
Up to ~20 kg nitrogen reduced per hectare and year
Cover crops storing nitrogen in the soil, instead of e.g., leaching, which can be absorbed again by cash-crops the following season

Minimally disturbing mulch systems
Up to ~25 kg nitrogen reduced per hectare and year
Fertilizer reduction from slow release of nutrients from mulch used by following cash crop

Legume Crop Rotation
Up to ~5 kg nitrogen reduced per hectare and year
Reduced fertilizer need in the year following the legume crop rotation, no fertilizer needed during the year with legumes. Can be done every ~sixth year

Sources: Patriotisk Selskab: høje gødningspriser øger halm ens værdi, overvej nedmuldning; SEGES; DCA: Virkemidler til reduktion af klimagasser i landbruget - 2023; Annette V. Vestergard (2023). Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture (CA). *FRDK*; The Danish society for Nature Conservation: Sådan ligger landet 2022; BCG analysis.

[1]Reduction is only for scoped crop land, i.e., 65% of all crop land in Denmark.

93. Milorganite: What is the Difference between Fertilizer Derived from Organic and Synthetic Sources?

5.3.2 Positive Impact on Leaching and Fertilizer

5.4 Positive Impact on Biodiversity

More than half of all the habitable land in the world—and close to two thirds of Denmark's land—is devoted to agriculture.[94] Just as we are responsible for ensuring that our food system can feed the planet's growing population fairly and affordably, we must also strive toward an agri-food system that limits the harm on biodiversity and helps combat global warming.

Biodiversity encompasses multiple dimensions, including genetic variation, diverse species, and the intricate ecosystems they form. To grasp the biodiversity of a region, it's not just about acknowledging the evident species, such as mammals or plants. It's also about understanding the genetic nuances within species and plants and soil, and the intricate web of interactions across ecosystems, such as the biodiversity of croplands, rivers, and forests. Croplands offer value not only through food production, but also through economic, soil development and fertility, and educational value. Yet, agriculture is the leading stressor on biodiversity in Denmark,[95] and the global food system is the primary driver of biodiversity loss globally.[96] This stress results from transforming lands for agricultural needs and the ensuing environmental pollution. This is alarming, as the worldwide agri-food industry relies heavily on biodiversity.[97] Regenerative agriculture aims to shield biodiversity by curbing the adverse effects of traditional farming and bolstering the biodiversity of croplands and pastures, thereby enhancing their ecosystem contributions.

Measuring Biodiversity's Worth. Placing a monetary value on biodiversity is challenging, primarily because there is no universally accepted metric, except for the value of the ecosystem services.

We've detailed the effects of specific regenerative agriculture methods on biodiversity, focusing on above-ground species richness and improved soil biodiversity. The primary influencers of these advantages are minimizing soil disruption and reducing the dependency on synthetic crop protectants and fertilizers.

- Cover, intercropping, undersown crops, and legume crop rotation help expand habitat and the provision of diverse food supply for animals and organisms.[98,99,100] These practices also reduce crop protection and fertilizer input. Furthermore, it should be noted that cover, intersown, and undersown cropping also positively impact the life below ground, as the mixture of crops provides a great variety of nutrients (food) to the micro life in the soil. This creates a positive cycle with the feeding of micro life, which increases the nutrient level in the field.[101]

- Livestock integration improves ecosystem services such as pollination and pest control.[102]

- Agroforestry, especially hedges, provides habitat and ecosystems for species to thrive in.[103]

Prime examples of the regenerative approach below ground include the following:

- **No-Till Practices.** Evidence strongly suggests that practices that minimally disturb the soil amplify microbial biomass and boost populations of invertebrates such as earthworms.[104] Earthworms can lead to a surge in underground biomass and a potential hike in crop yields.[105] The burrows they create enhance the soil's water absorption and conductivity.

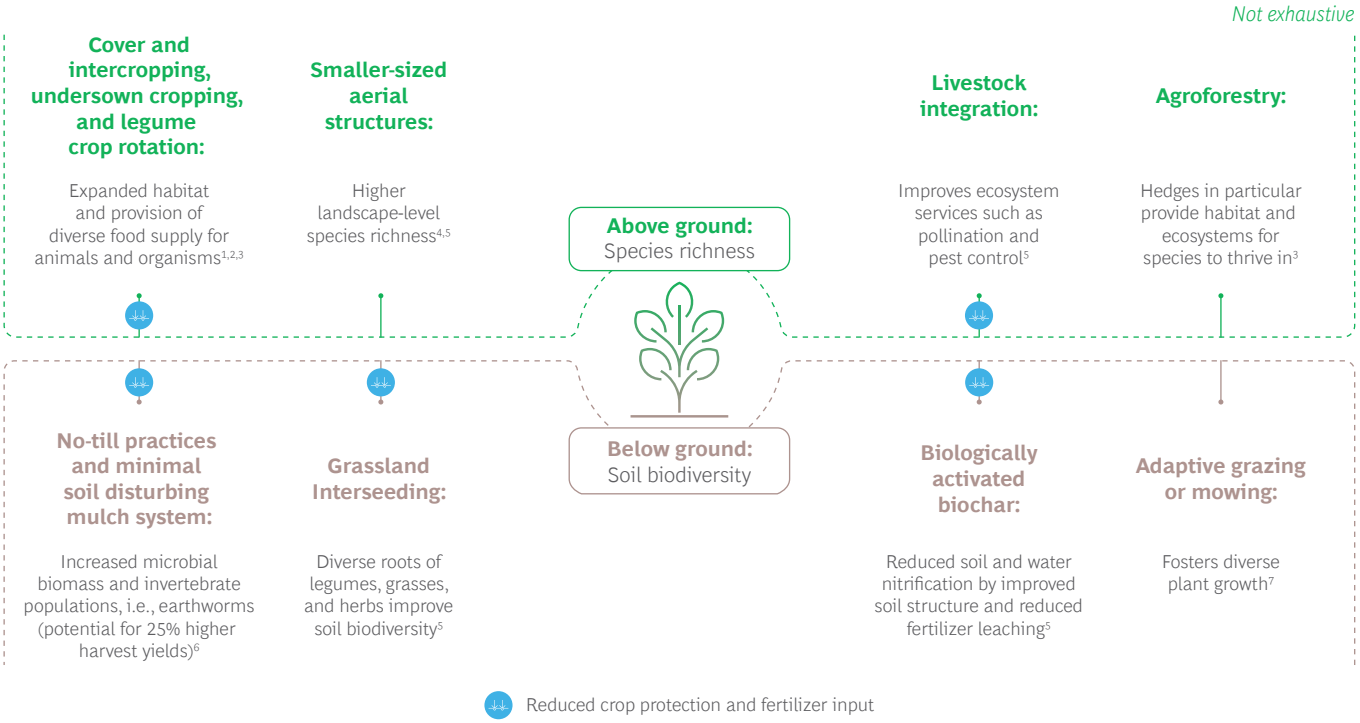
- **Grassland Interseeding.** This produces diverse roots of legumes, grasses, and herbs, which improves soil biodiversity.[106]

94. Oxford Martin School, Oxford University: Oxford Martin Programme on the Future of Food.
95. Ministry of Environment of Denmark: Hvad truer biodiversiteten?
96. UN Environment Programme: Our global food system is the primary driver of biodiversity loss.
97. FoodPrint; Biodiversity and Agriculture.
98. Beillouin et al. (2021). Positive but variable effects of crop diversification on biodiversity and ecosystem services. Wiley.
99. Triquet et al. (2023). Undestroyed winter cover crop strips support wild bee abundance and diversity in intensive cropping systems. Biodiversity and Conservation.
100. Triquet et al. (2023). Undestroyed winter cover crop strips support wild bee abundance and diversity in intensive cropping systems. Biodiversity and Conservation.
101. Expert interview.
102. Kremen and Merenlender (2018). Landscapes that work for biodiversity and people. Science.
103. Jones et al. (2021). Farmers' attitudes towards, and intentions to adopt, agroforestry on farms in lowland South-East and East England. Science Direct.
104. Food and Agriculture Organization of the United Nations (2020). Advances in Conservation Agriculture: Volume 2: Practice and Benefits, Burleigh Dodds Science Publishing.; Wittwer et al., 2021: Organic and conservation agriculture promote ecosystem multifunctionality. Science Advances.
105. Van Groenigen et al. (2014). Earthworms increase plant production: a meta-analysis. Scientific Reports.
106. Kremen and Merenlender (2018). Landscapes that work for biodiversity and people. Science.

The systems below ground are important, and are often neglected in relation to the visible above-ground systems. The sub-soil life is complex and filled with microbiological activity. A teaspoon of fertile agriculture soil can contain over 10 kg of fungal hyphae and tens of millions of bacterial cells.[107] The microbial activity is doing several ecosystem services, such as enabling the transportation of nutrients and water in the soil and the breakdown of organic matter, each of which improves plant growth.[108]

As stated, practices such as no-till have the potential to strengthen the micro-life in the soil. It's critical to care for the life below the soil, and regenerative agricultural practices have the potential to do so. That said, more research is needed to increase the understanding of these systems and how to work with them.

Exhibit 23 - Regenerative agriculture helps promote the increase of biodiversity, microorganisms, and carbon in soil through many practices



Source: BCG analysis.

[1]Beillouin et al. (2021). Positive but variable effects of crop diversification on biodiversity and ecosystem services. *Wiley.*

[2]Triquet et al. (2023). Undestroyed winter cover crop strips support wild bee abundance and diversity in intensive cropping systems. *Biodiversity and Conservation.*

[3]Jones et al. (2021). Farmers' attitudes towards, and intentions to adopt, agroforestry on farms in lowland South-East and East England. *Science Direct.*

[4]Tscharntke et al. (2021). Beyond organic farming – harnessing biodiversity-friendly landscapes. *Trends in Ecology & Evolution*. 5 Kremen and Merenlender (2018). Landscapes that work for biodiversity and people. *Science*.

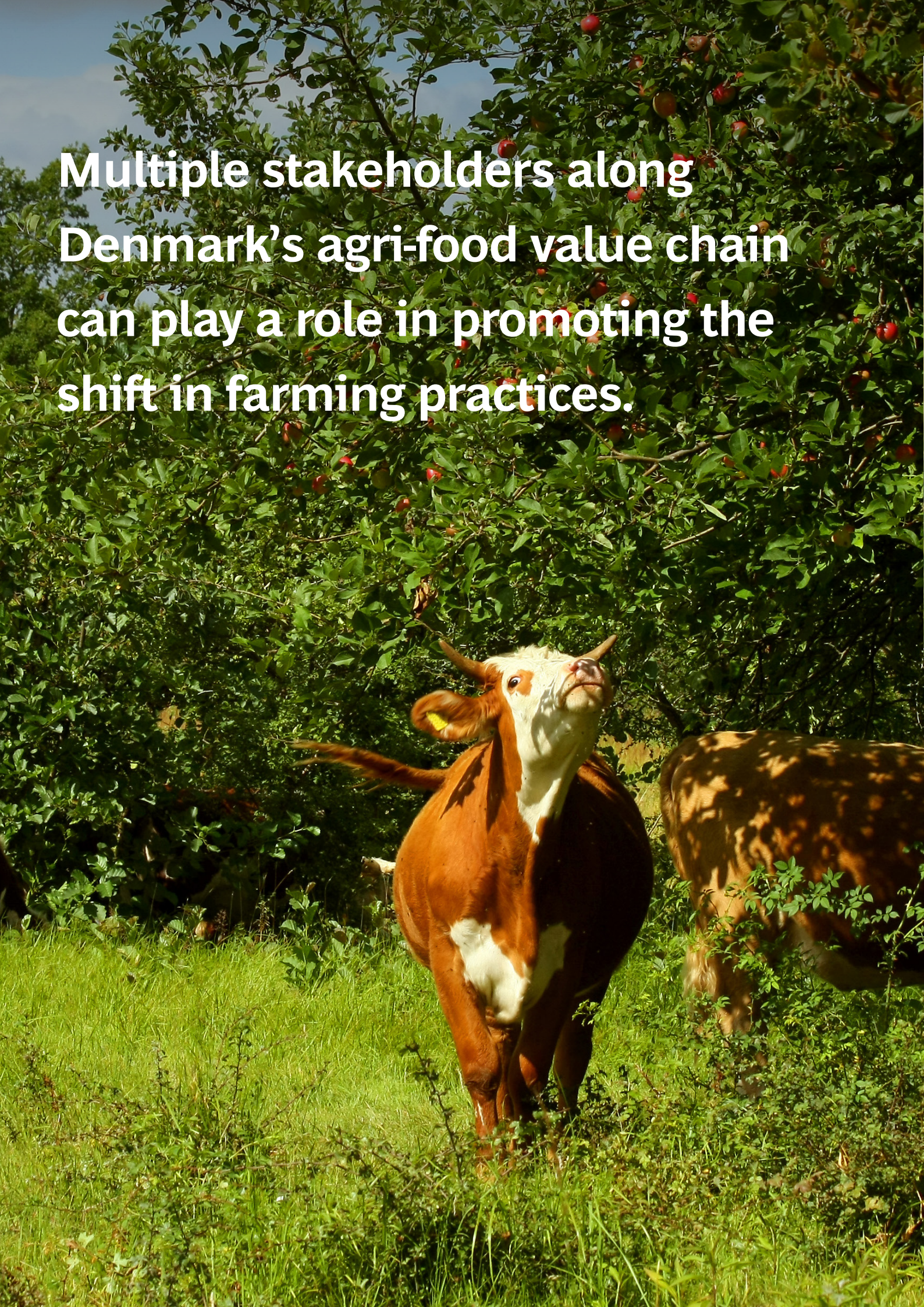
[5]Expert interviews.

[6]Amir Kassam et al. (2019). Advances in Conservation Agriculture Volume 2. Burleigh dodds science publishing.

[7]Enri et al. (2017). A biodiversity-friendly rotational grazing system enhancing flower-visiting insect assemblages while maintaining animal and grassland productivity. *Agriculture, Ecosystems & Environment.*

107. Australian Government: Grains Research and Development Corporation.

108. DCE: Microorganisms as indicators of soil health.



Multiple stakeholders along Denmark's agri-food value chain can play a role in promoting the shift in farming practices.

Regenerative Agriculture and the Danish Agri-Food System

While farmers are the most involved stakeholders in the adoption of regenerative agricultural practices, the transition may not happen in a vacuum. Multiple other stakeholders along the value chain can play a key role, each having different motivations to promote and aid a shift in farming practices. However, it is important to keep in mind that, even though different demands throughout the value chain may drive part of the agenda, the solution is the farmers themselves. They are the key to succeeding with the widespread transformation.

Call to Action

In general, motivations to act or reasons to change can be segmented into socio-ecological, financial, and reputational drivers. While socio-ecological and financial drivers impact the broader value chain, midstream players such as producers and retailers, given their consumer-facing natures, have the key incentive to build up a responsible sourcing reputation.

Socio-ecological and Financial Pressures

Socio-ecological and financial pressures go hand in hand. Data shows that crop yields in extreme weather years such as 2018 and 2023 dropped by 15%–23%.[109] This not only threatened farmer profits but also put pressure further downstream in the value chain. In line with the 23% yield drop, rye and barley prices increased by roughly 28% year-on-year from 2017 to Q4 2018.[110]

This increased both total costs for consumers as well as profit margins for the different food-related businesses. Furthermore, a drop in yields goes beyond impacting financials and also threatens business continuity and overall production capacity.

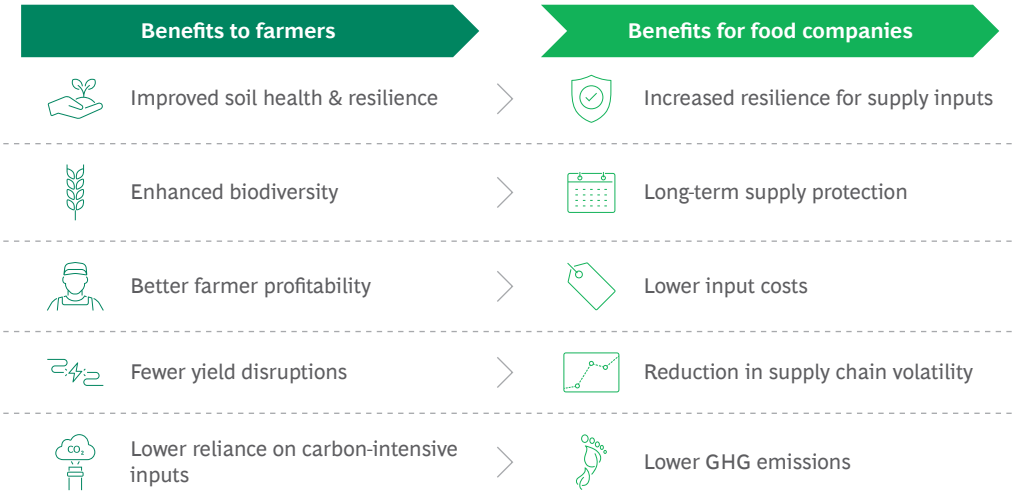
Beyond extreme weather events, food producers also have a long-term incentive to promote ecological practices. As monocropping and aggressive conventional farming reduce soil health and deplete nutrients, yields could gradually decrease, requiring sourcing from new locations with associated establishing and logistics costs. Promoting regenerative agriculture could help improve the overall supply chain resilience.

Aside from crop yields, a growing climate consciousness among consumers and regulators may reverberate upward in the value chain. If consumers select more sustainable products, goods utilizing traditionally farmed produce may be at risk of experiencing declining sales volumes. Additionally, the Danish government has indicated its intention to institute a climate tax on agricultural products,[111] resulting in additional costs for goods with a higher CO_2e footprint, which will potentially be passed through, at least in part, to consumers. As a result, food producers down to consumers may be incentivized to purchase their products from sources with a lower CO_2e footprint and thus lower associated costs.

Overall, benefits experienced by farmers cascade down the value chain to food producers, wholesalers, distributors, and retailers.

Inputs and machinery providers, situated upstream of farmers, may face another pressure: the risk of losing competitive position.

Exhibit 24 - Benefits to farmers cascade down the value chain to food companies



Source: Expert interviews; BCG analysis.

109. Statistics Denmark: Economics of Agricultural Activities.

110. Statistics Denmark.

111. Prime Minister's Office (2022). Ansvar for Danmark – Det politiske grundland for Danmarks regering.

In the medium term, a scenario exists in which an input offering may be delayed and machinery for regenerative agriculture may put suppliers at risk of farmers sourcing the required inputs from other providers.

In the long run, the same scenario could, in more extreme cases, lead to farmers being unable to shift to more ecological practices such as regenerative agriculture. Consequently, such a scenario could add risk to both farmers' and suppliers' operations due to these financial pressures.

This may, in an extreme scenario, reduce the competitiveness of the Danish agricultural industry and potentially shift part of Danish farming outside the country, thereby reducing the business for local machine providers. It is, however, highly unlikely that a scenario in which all input providers hold back from supporting the transition will materialize. There will be some who will take the opportunity to tap into a new value pool and capture the growing demand among farmers.

Reputational Motivation
As public interest for sustainable products increases, large corporations have the opportunity to position themselves at the forefront of change, as they have the scale to support farmers in being part of the solution. This may, of course, positively impact how customers and potential partners perceive them. Furthermore, it may also be a key differentiator to attract talent to a company—an element that is becoming increasingly important.

Role in Driving Regenerative Agriculture Adoption

The swift adoption of more sustainable practices such as regenerative agriculture necessitates a unified effort among all stakeholders within the value chain. Initially, the transition may proceed at a gradual pace, but is anticipated to gain momentum as regulatory pressure keeps increasing and demand potentially reaches a critical mass. This growing demand and the benefits seen across different parts of the industry, such as for farmers, food companies, and stores, could create a shared positive trend, with each part supporting the others in making this shift toward regenerative agriculture.

Suppliers and Inputs of Machinery
There are two main new input categories a conventional farmer will have to source in order to transition to regenerative agriculture: no-till machinery and seeds for cover crops and legumes. Seeds are already offered locally, and supply companies have to ensure sufficient supply to cater to potentially increased demand.

The bigger consideration would be no-till machines to support direct seeding and mulching. While no-till are not as widely available as conventional machines, distributors and equipment providers are starting to stock up on them. As regenerative agriculture grows in popularity, the need to establish sufficient procurement availability for asset heavy farmers while also having enough inventory and manpower to support asset-light farmers potentially requiring equipment and manpower services simultaneously within a crop cycle becomes more apparent.

Food Producers and Wholesalers
Major food companies have a significant role to play in driving adoption of regenerative agriculture. Given their large networks of associated farmers, they have the capability to influence different players and support their transition, accelerating the transformation across the supply chain. This support can range from upskilling farmers with the required know-how, reducing investment risk, establishing product demand, and incentivizing the new practices.

Compared with farmers, large companies have better access to research as well as the scale necessary to experiment with innovative ideas. Some have already started down this path, with Arla, for example, launching a pilot partnership with 24 farmers across five countries, helping train and coach the farmers on regenerative agriculture methods and assisted in data tracking to better substantiate future rollouts.[112]

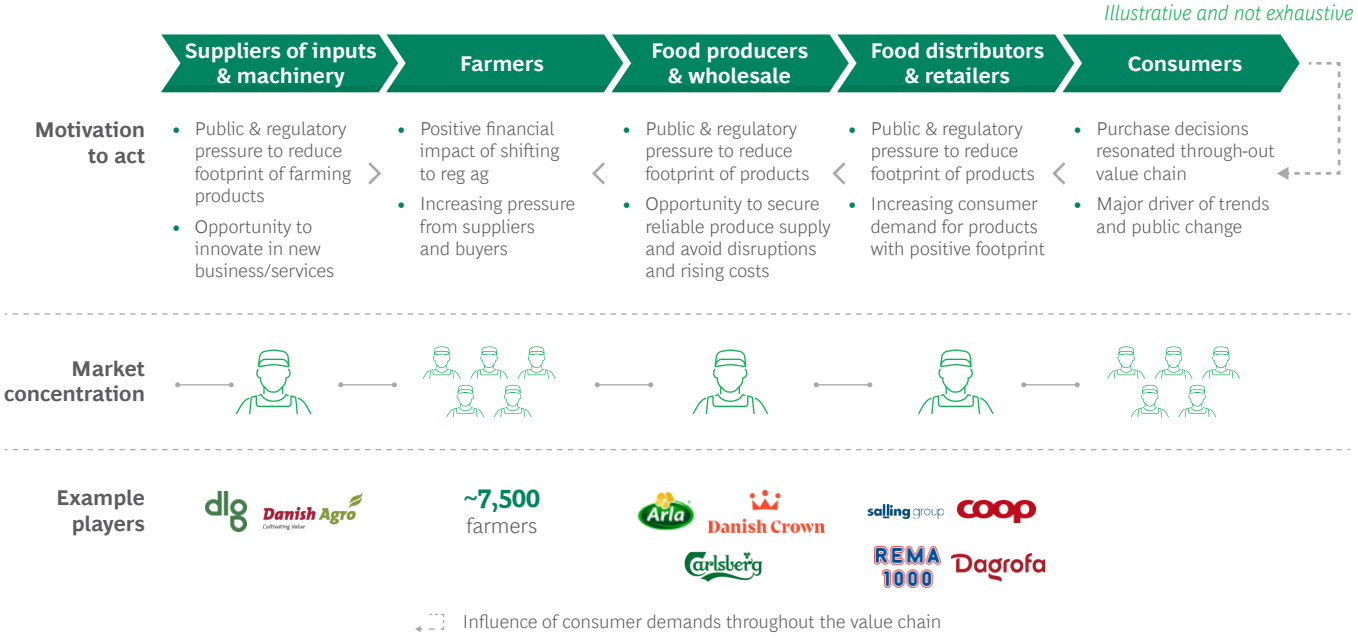
112. Arla: Arla digs into Potential of Regenerative Dairy Farming.

Beyond fast-tracking the knowledge gaining journey, food producers can also help financially. This can go beyond investment support and also revolve around supply chain and sales. For example, establishing long-term purchase agreements can help give farmers the necessary comfort that their harvests will be sold at a certain price. In the short term, producers can even consider slight price premiums to accelerate the transition so they can help meet their own carbon reduction goals. Carlsberg is one company that has shown support for regenerative agriculture, pledging to source 30% of all its agricultural inputs from regenerative practices and sustainable sources by 2030 and eventually scaling up to 100% of inputs by 2040.[113]

Food Distributors and Retailers

Aside from food producers, retailers are the main point of contact consumers have with the food industry. The key role they play is to ensure availability of responsibly sourced products. Furthermore, should a share of CO_2e tax imposed on non-regenerative agriculture products get distributed throughout the value chain, this highly price competitive sector may be incentivized to increase both availability and end-consumer awareness of regenerative-agriculture-produced goods.

Exhibit 25 - Food producers are key change agents in the food value chain, with both significant motivation to act and concentrated bargaining power



Source: Statistics Denmark; BCG analysis.

113. Carlsberg: Carlsberg Group plans expanded regenerative barley usage across brands in the UK, Finland, and France.

Challenges to Widespread Adoption of Regenerative Agriculture

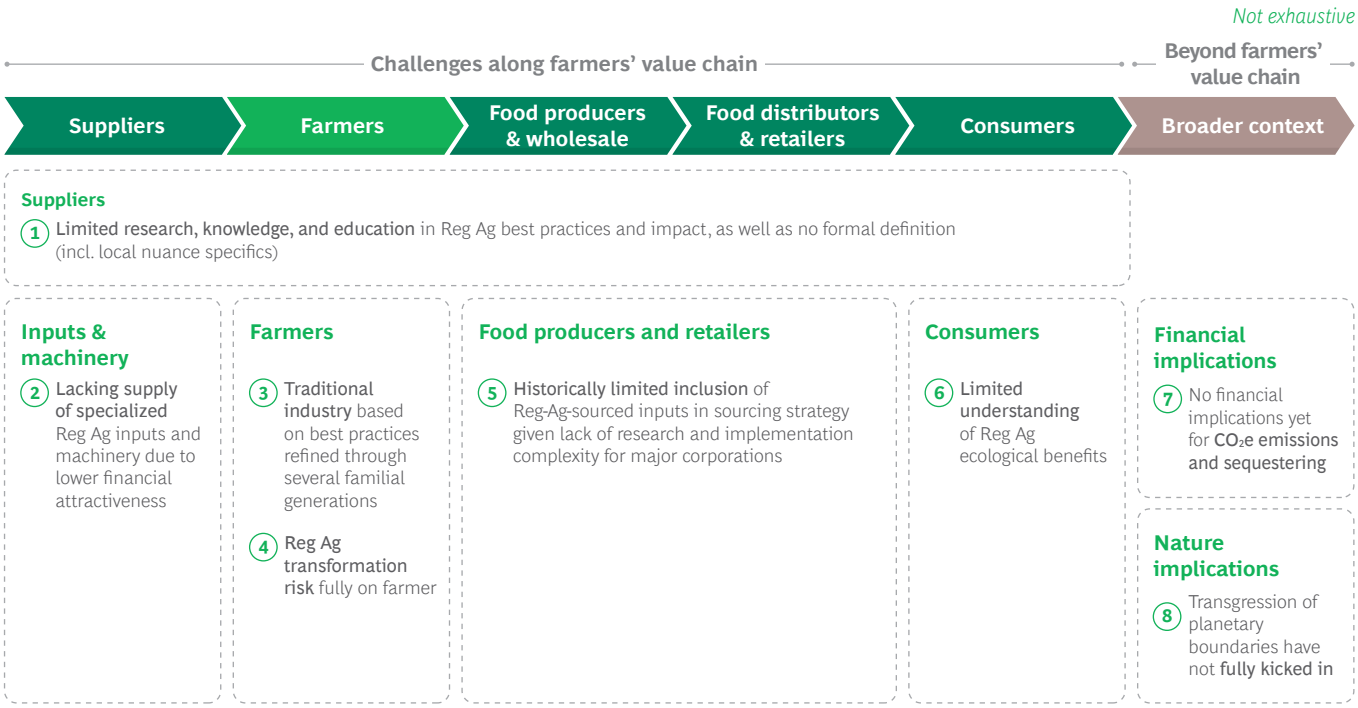
Regenerative agriculture may appear to be the ideal solution for all stakeholders within the agri-food system. However, if this is the case, why has it not been adopted more extensively by the Danish agricultural sector?

We have outlined key transition challenges currently hindering the regenerative transformation of both individual Danish farmers and the Danish agricultural sector as a whole.

Challenge 1: Limited Research, Knowledge, and Education in Regenerative Agriculture Best Practices and Impact, as Well as No Formal Definition

Regenerative agriculture draws on practically tested solutions. However, data on the combination and impact generation of practices, including research on the impact regenerative practices have on nature and on farmer economics, is limited. Thus, there is a limited foundation for documenting the effectiveness of regenerative farming practices, both for farmers and for other stakeholders in the agri-food system. This has two major implications. First, farmers have no research to lean on when first making the transformation decision, causing many to "play it safe."

Exhibit 26 - Challenges along the Agri value chain ultimately impact farmers, hindering the widespread adoption of regenerative agriculture in Denmark



Source: Expert interviews; BCG analysis.

Furthermore, regenerative agriculture is still not part of the curriculum at standard Danish agricultural schools, meaning even new farmers are not educated in regenerative best practices or taught the pros and cons of regenerative agriculture. Second, large corporations often being measured on different ESG (environmental, social, and corporate governance) parameters throughout the supply chain do not have a foundation for documenting the regenerative impact, thus eliminating what could be a key incentive for sourcing regenerative agriculture inputs.

In addition, there is no formal definition of what regenerative agriculture, as an umbrella term, is—or, for that matter, what it is not. This also makes it difficult for farmers to lift regenerative output to a higher standard and increases the risk of it being utilized as a greenwashing tool, thus also increasing the risk of corporations being suspected of greenwashing if using it as part in their ESG strategy.

Aside from a broader formal definition, additional local research is also required, as the scaling of regenerative agriculture practices also needs to be tailored to the specific crops and geographies the farmers currently operate in.

Challenge 2: Lacking Supply of Specialized Regenerative Agriculture Inputs and Machinery Due to Lower Financial Attractiveness for Suppliers

Supply entails inputs in terms of, for example, cover crop seeds and biostimulants[114] as well as specialized machinery such as no-till equipment and cover crop rollers. Lack of specialized inputs and machinery hinders farmers' ability to implement regenerative practices, slowing down the widespread adoption of regenerative agriculture in the Danish agricultural sector.

A core element of regenerative agriculture is minimizing tilling and general soil disturbance. All else equal, this implies regenerative farmers' demand for large-scale machinery will be significantly lower than their conventional peers'. For that reason, widespread adoption of regenerative agriculture may not be in the interest of machine producers and distributors. Such counteracting incentives are a key challenge hindering the Danish, European, and global adoption of regenerative agriculture.

114. Biostimulants are natural substances that can be applied to seeds, plants, and soil. These substances cause changes in vital and structural processes in order to influence plant growth through improved tolerance to abiotic stresses and increased seed and/or grain yield and quality (BCG analysis).

Challenge 3: Traditional Industry Based on Best Practices Refined through Several Familial Generations

The agricultural industry is a conservative one that is heavy on tradition. Many farms have been in families for generations, and farmers have grown up learning from their fathers who grew up learning from their fathers, making the barrier for standing out and risking the family farm a lot higher. In a sense, what they do is not "just a job" but rather a family legacy that has been built and refined through many generations. This implies that the caution associated with change is rather high among farmers.

In addition, farmers and the agricultural industry are practitioners as opposed to theorists. This is great because it means they are experts in understanding and farming their specific farmland; however, it also implies that they often learn and develop their skills in enclosed agricultural networks and by watching and learning from their peers in practice—and not by reading academic journals.

Challenge 4: The Regenerative Agriculture Transformation Risk Is Fully on Farmers

The transformation to regenerative agriculture, like all other transformations, comes with risks. First, to allow for transformation, a smaller or larger initial investment for inputs and machinery is required. The size of the investment depends on whether the individual farmer has an asset-light or asset-heavy model—that is, the degree to which the farmer rents versus owns machinery. Second, the regenerative transformation entails a change in farming practices. During this process, there is a risk that the farmer will experience a drop in yields in the short to medium run. At present, the risks associated with undertaking an initial investment as well as those associated with a potential yield drop during the transformation period fall almost entirely on the shoulders of the farmers themselves.

There are several underlying drivers of this challenge, one being that the landscape around agricultural subsidies, financing, and legislation in Denmark is focused on common conventional and organic farming practices. The lack of targeted subsidies, financing, and legislative instruments that support and incentivize regenerative adoption hinders the distribution of transformation risk to other parties than the farmer alone. Consequently, this leads to a failing attempt to optimize the perceived risk-adjusted return for individual farmers. The failing risk-return argument has several implications further challenging widespread regenerative adoption, including that farmers are often subject to significant mortgages, making banks a large shareholder in many Danish farms. This essentially implies that banks also have a say in the investments and risks taken on by farmers.[115] Therefore, the limited research on the impact of regenerative farming can also challenge adoption decisions due to the uncertainty associated with the risk-adjusted return.

Thus, the absence of financial incentives and regulatory support distributing the transformation risk and optimizing the risk-adjusted return can discourage farmers from transitioning to regenerative agriculture, despite the potential climate and nature upside. Going forward, such challenges should be solved to promote the widespread adoption of regenerative agriculture in the Danish agricultural sector.

Challenge 5: Historically Limited Inclusion of Reg-Ag-Sourced Inputs in Sourcing Strategies Given the Lack of Research and Implementation Complexity for Major Corporations

The role of food producers in shaping the agricultural landscape is pivotal. Their decisions regarding sourcing, production methods, and market strategies have ripple effects throughout the supply chain. In addition, they are a key stakeholder in distributing the transformation risk from being solely on the farmer to being more evenly distributed along the supply chain. Therefore, a key challenge to the widespread adoption of regenerative agriculture is food producers' historical lack of support for a regenerative transformation of the agricultural sector.

115. Expert call.

Certain large Danish food producers are starting to introduce regenerative initiatives. For example, Arla is partnering with 24 pilot farms (six in Denmark) over four years to test regenerative farming practices.[116] Furthermore, Carlsberg is partnering with suppliers, experts, and farmers across Europe, committing thousands of hectares to farm barley malt regeneratively.[117]

However, while pilots are a step in the right direction, they are not enough to drive widespread industry transformation. Thus, food producers must scale their reach to realize the full potential of regenerative agriculture in Denmark. Yet, the insufficient research and no formal definition challenge how food producers can embrace regenerative agriculture. The limited research on the climate and nature impact of regenerative agriculture implies there is a limited foundation for documenting the positive impact on ESG accounts. Also, that there is no formal definition of what regenerative agriculture is and is not implies that food producers must be extra cautious in how they frame it within their ESG strategies to avoid being accused of greenwashing.

Food producers looking to incorporate regenerative agriculture into their operations also typically encounter other barriers as a result of this lack of research. Integrating a new operating model in terms of practices, stakeholders, and data collection systems will take time to design, as relatively few companies have done this. Additionally, the lack of research poses challenges for companies to understand the business case behind supporting the transition as well as providing farmers the required support to shift practices.

Challenge 6: Consumers Have Limited Understanding of the Regenerative Agriculture Ecological Benefits

The general knowledge of and understanding about the ecological benefits of regenerative agriculture among consumers and the greater society is rather limited. In addition, some consumers may have misperceptions about what regenerative agriculture is. This implies that the opportunities for differentiating regeneratively produced food products are limited without first educating consumers about the upsides regenerative agriculture may have on climate and nature.

Challenge 7: No Financial Implications for CO_2e Emissions and Sequestering

A CO_2e tax on the Danish agricultural sector is currently under consideration politically. A tax could either pose a challenge or be an opportunity, depending on whether it includes deductions for reduced direct emissions and carbon sequestration. However, there are many challenges and complexities associated with including such challenges or opportunities. First, accurately measuring and verifying carbon sequestration and potentially deducting them from carbon emissions is a complex and costly process. Second, market mechanisms and regulations would have to be well thought through to avoid unintended behaviors, such as tilling the field only once carbon storage reaches its steady state level and farmers are able to start over benefitting from carbon sequestering again.

Challenge 8: Consequences of Transgressing Planetary Boundaries Have Not Fully Kicked In

While it is a positive that the Danish climate is not yet as affected by climate change as many other countries are, regenerative agriculture provides an effective strategy to adapt farming practices to climate change. The less extreme weather conditions in Denmark imply that Danish farmers, unlike those in, for example, South or North America, are not yet "forced" to think differently with respect to safeguarding crops and yields. However, as the number of extreme weather events in Denmark is expected to increase in the future, there is an increasing pressure for climate adoption among Danish farmers.

Addressing these challenges is crucial for the successful widespread adoption of regenerative farming in Denmark. Each challenge represents a unique barrier that requires a combination of public awareness, policy support, commitment from farmers, and industry collaboration to overcome. By addressing these challenges effectively, Denmark can move closer to attaining a more sustainable and regenerative agricultural system.

116. FAI: Arla's regenerative farming pilot farm network; Arla: Arla tester potentiale for regenerativ mælkeproduktion.

117. Carlsberg: Carlsberg Group plans expanded regenerative barley usage across brands in the UK, Finland, and France.

Levers to Support the Widespread Adoption of Regenerative Agriculture

As we have shown, regenerative agriculture has the potential to provide a win-win situation for Denmark, offering significant benefits for both nature and farmers. However, transformation is not straightforward. In the previous section, we outlined eight key challenges currently hindering the widespread adoption of regenerative agriculture in Denmark.

The key to success lies in minimizing those challenges by supporting farmers in their efforts to begin their regenerative journey and throughout the transition by distributing the risks of transformation along the food value chain. Efforts to support farmers can be built upon a three-pronged framework: direct farmer support, support from downstream food industry, and targeted government support and regulation.

Exhibit 27 - Transition levers cover the main transition challenges

#	Transition challenges	Transition levers	*Not exhaustive*
1	Limited research, knowledge, and education in Reg Ag	Coordinate and accelerate research on Reg Ag practices' impact on nature (CO_2e, biodiversity, water), farmer economics, and greater society	All
		Incorporate Reg Ag practices in education and consultation (e.g., in agricultural school curriculum)	 Farmer support
2	Lacking supply of specialized Reg Ag inputs and machinery	Increase awareness and accessibility of specialized input and machinery (e.g., cover crop seeds, bio-stimulants, direct seeding equipment)	
3	Traditional industry	Foster Reg Ag knowledge sharing among farmers by leveraging established agricultural networks and farming media	
4	Reg Ag transformation risk only on farmers	Develop targeted financing products to support, incentivize, and mitigate risks (e.g., green mortgage bonds, yield insurance policies)	
		Offer short-term premiums on Reg Ag output to take share in farmers' initial investment cost and distribute transformation risk	 Support from downstream food industry
		Support farmers' Reg Ag transformation by providing advisory services	
5	Historically limited inclusion of Reg-Ag-sourced inputs in downstream food industry	Establish long-term purchase agreements on Reg Ag outputs to ensure demand for farmer production	
		Evolve from pilots to Reg Ag at scale	
6	Limited understanding of Reg Ag ecological benefits among consumers	Educate consumers in the ecological upsides of Reg Ag	
7	No financial implications for CO_2e emissions and sequestering and nature impact	Consider incorporating Reg Ag practices as a prerequisite for receiving Common Agriculture Policy (CAP) subsidies	 Targeted government support & regulation
		Consider including sequestration in upcoming CO_2e ag taxation when sequestration impact has been more investigated	
		Consider using regulatory measures to raise the bar and promote regenerative agriculture	
8	Transition challenges	Provide upsides for ecosystem contributions (e.g., biodiversity credits)	

Source: Expert interviews; BCG analysis.

Levers to Improve Research, Knowledge, and Education in Regenerative Agriculture

First, the allocation of funds to dedicated research on the nature and economic impact of regenerative agriculture is key to promoting widespread adoption of regenerative agriculture in Denmark. The investment in dedicated research is crucial to solve other challenges, as it provides a foundation for impact documentation and optimizing the perceived risk-adjusted return, as described in section 7.

Research and knowledge generation are the responsibility of both farmers, up- and downstream players in the food industry, and public research centers and universities, governments, and ministries; however, in order to succeed, efforts must be coordinated. Establishing formal research provides a foundation for documenting the impact of regenerative agriculture on nature and farmer economics. This will incentivize farmers to transform to regenerative agriculture, as the risk of not knowing what to expect will be reduced, thereby optimizing the risk-return argument. It will also incentive food producers and other significant value chain players to source regeneratively farmed products, the reason being that they will be able to document the carbon impact of regenerative agriculture in their Scope 2 and Scope 3 emissions, which will positively impact their ESG accounting.

Second, to increase the knowledge and awareness level regarding regenerative agriculture among farmers, regenerative practices could be included as a core part of the curriculum in standard Danish agricultural education. Future farmers would benefit from being educated early in the pros and cons and challenges and opportunities associated with regenerative practices.

In addition, it would be highly beneficial for farmers if the possibility to further study and improve their skills within regenerative agriculture were made widely available and promoted to both conventional and organic farmers. This includes hosting and promoting courses and agricultural consultancies that may educate themselves and their customers about regenerative agriculture. Improving the knowledge and awareness of regenerative agriculture among Danish farmers will provide a key element crucial for widespread regenerative adoption in the Danish agricultural sector.

Levers to Secure Supply of Specialized Inputs and Machinery for Regenerative Farming

Suppliers of agricultural inputs and machinery may ensure the development, awareness, and accessibility of specialized inputs and machinery for regenerative agriculture. Such development entails investing in R&D to produce high-quality and innovative inputs and machinery for optimizing the yield/impact ratio of regenerative agriculture. In addition, suppliers may widely distribute and promote the benefits of adopting regenerative agriculture, utilizing specialized inputs and machinery to farmers to support widespread adoption of regenerative agriculture. Specialized inputs and machinery entail inputs in terms of, for example, cover crop seeds and biostimulants, services such as soil testing and balancing, and machinery such as direct seeders and cover crop rollers.

Levers to Overcome Challenges Associated with Industry Traditions

To boost knowledge, awareness, and a general willingness to transition to regenerative agriculture among Danish farmers, knowledge sharing networks in which curious, new, or experienced regenerative farmers can connect and learn from each other may be promoted by established agricultural networks and media. In Denmark, we have regenerative associations such as Foreningen for Regenerativt Jordbrug and Foreningen for Reduceret Jordbearbejdning I Danmark, and as of November 2023, we have the European Alliance for Regenerative Agriculture at the European level. Currently well-established agricultural networks and media embracing and potentially promoting regenerative networks may support regenerative agriculture to gain space in the Danish agricultural sector. Cooperation between established and newer regenerative networks plays an important role in maximizing the knowledge, awareness, and general willingness to transition.

Levers to Reduce and Redistribute Regenerative Transformation Risks

To reduce and distribute the transformation risks that are currently borne mainly by individual farmers, one may optimize the risk-return argument for the regenerative business model. One way to do so is by offering favorable financial products to regenerative farmers. An option could be to introduce and promote green mortgage bonds to the agricultural sector.

Farmers often have significant mortgages. For that reason, the interest rate they pay is a key determinant in their finances. This means many farmers may be incentivized to adjust their operations substantially if it means they can reduce their interest payments. On the other side is the investor. Institutional investors are no longer only being measured on their financial returns, but rather are also increasingly being measured on their ESG impact. Many investors are therefore willing to accept a lower return if the financial product has a better ESG score. For that reason, green mortgage bonds with higher ESG ratings and lower interest payments are becoming increasingly popular among institutional investors in particular.[118]

The potential to gain from this has not yet been realized and integrated into the Danish agricultural sector. However, if the opportunity for financing regenerative farmers with lower-interest green mortgage bonds were offered to farmers, it could incentivize and promote widespread adoption of regenerative agriculture in Denmark. At the same time, it would reduce the transformation risk solely on the farmer, as it would provide a certain future financial gain by reducing financing costs, as part of the transformation risk is re-allocated from the farmer to the investor.

Also, to re-distribute part of the transformation risk from the farmer to players in the downstream food industry, food producers that purchase agricultural output can pay a short-term premium for regenerative output to help farmers finance the initial investment cost. This will make a great incentive for farmers and support them in being confident the return is worth the risk.

To reduce the transformation risk for the individual farmer, players in the food value chain may support farmers in their regenerative journey by providing advisory support. This would ensure that farmers have access to the knowledge required to succeed in the transformation to regenerative farming, consequently reducing the risk of transformation by ensuring a high-quality foundation of knowledge.

118. Katie Gilbert (2013). Green Bonds Gain Investors and Climate-Friendly Credentials. Institutional Investor; Chiyoung Cheong, Jaewon Choi (2020). Green bonds: a survey. Journal of Derivatives and Quantitative Studies.

Certain Danish food producers have started to provide such advisory support; however, for a widespread adoption of regenerative agriculture in the Danish agriculture sector, the support should be scaled.

Levers to Improve the Inclusion of Regeneratively Sourced Inputs Downstream in the Food Industry

To further reduce the transformation risk for the individual farmer and ensure the inclusion of regeneratively sourced agricultural output in the downstream food industry, buyers may make long-term purchase agreements with regenerative farmers, ensuring a stable market and predictable income for farmers. This would give farmers the confidence to transition, knowing they have a secure market for their output, reducing the risk associated with transformation. In addition, it would ensure the inclusion of regenerative-sourced outputs in the downstream food industry in the medium to long term.

Certain Danish food producers have started to engage in such initiatives; however, for a widespread adoption of regenerative agriculture in the Danish agriculture sector, the agreements should be scaled and the full food value chain must participate.

Several Danish food producers are running regenerative pilots in collaboration with farmers; however, to gain the full potential, food producers may evolve from selected pilots and invest in application at scale. If the food value chain enforces a push for regeneratively sourced agricultural output, this will have the power to transform the agricultural landscape in Denmark, while positioning Denmark as a front runner in regenerative agriculture.

Levers to Inform and Educate Consumers on the Benefits of Regenerative Food Production

The downstream food industry may educate consumers on the ecological benefits of regeneratively sourced food products. Individual food brands and retailers are the ones interacting with the consumers, thus the education and promotion of regeneratively sourced food products to consumers could be their responsibility. However, at the end of the day, the food value chain will produce what consumers will demand, meaning we all have a responsibility.

Levers to Increase the Financial Implications of Positive Impacts on Climate and Nature

Central government-implemented measures have the ability to further accelerate free market shifts. The following measures are example levers that can be implemented should regenerative agriculture be deemed a priority by the Danish government.

One of the key levers that would significantly impact farmers is the allocation of the EU's CAP subsidies. Even though this study excludes CAP from the quantitative analysis, it remains a key aspect in the agricultural financing landscape.

Farmers in Denmark rely heavily on subsidies. Denmark's CAP strategic plan already highlights sustainability as a key goal,[119] and incorporating regenerative agriculture practices into the local prerequisites to receiving CAP can be an effective lever to drive further adoption among conventional farmers. The CAP plan also highlights habitat biodiversity and climate-friendly grass as targets.[120] Showcasing regenerative agriculture as a path to improve soil microbiology and thus receive these subsidies targeting biodiversity can also serve to drive adoption among non-regenerative agriculture farmers.

As mentioned in the farm economics section, a climate tax on CO_2e is an option to promote the adoption of regenerative agriculture. Disincentivizing emissions would drive farmers to look for less-CO_2e-emmissions-heavy activities while still maintaining their current yields. Adopting regenerative agriculture practices can be a potential solution to achieve these two goals. Furthermore, incorporating carbon sequestration into a tax measure can further drive adoption given the significant financial upside CO_2e sequestration can achieve. This, however, would likely require further time for implementation guidelines and tracking to mature before being a feasible option.

A final approach to pushing the widespread adoption of regenerative agriculture is regulation. The Danish agricultural sector is already heavily regulated on matters regarding the environment. Targeted regulatory measures could be a way to raise the bar further and make it increasingly beneficial and/or necessary for farmers to transition to regenerative agriculture.

We believe that these measures together will provide a good foundation for promoting and sustaining widespread adoption of regenerative agriculture in the Danish agricultural sector. The levers could enable Denmark to reach the 2035 assumed adoption rates (see exhibit 21) and hence reap the resulting benefits for the economy, climate, biodiversity, and water quality. The longer-term business case for the farmers is sound both in terms of cost savings and climate adoption, while the impact on nature is positive, being a key selling point of regenerative farming.

119. European Commission: Denmark's CAP Strategic Plan.

120. Ministry of Food, Agriculture, and Fisheries of Denmark: The EU's Common Agricultural Policy in Denmark – green transition (Fact Sheet 6).

Glossary

TERM	DEFINITION
biodiversity	The variability of genes; the number, distinctiveness, and spatial distribution of species; and the diversity of ecosystems. The interplay of all these elements—from the molecular level to the macroenvironmental level—enables ecosystem services through nature's regulating, provisioning, habitat providing, and cultural functions. Altering even a single element inside an ecosystem may curtail those functions.
biological seed coating	Covering the surface of seeds with low amounts of biologically active ingredients to improve seed performance and plant establishment (through the alleviation of biotic and abiotic stresses) while reducing production costs.
biostimulants	Natural substances that can be applied to seeds, plants, and soil. These substances cause changes in vital and structural processes in order to influence plant growth through improved tolerance to abiotic stresses and increase seed and/or grain yield and quality.
carbon credits	Financial products expressed in tons of CO_2e that are generated by reducing or removing GHG emissions and are traded in the voluntary, industry, and geographic compliance market by individuals, companies, and countries to offset (or neutralize) emissions; one credit equals one ton of reduced GHG emissions.
carbon sink	Storing carbon in soil, oceans, and forests to avoid discharging it into surface water and groundwater and the atmosphere; a sink is a process or activity that removes GHGs from the atmosphere.
compost solutions	Application of composted organic materials such as crop residues in the form of compost tea or extract to increase the amount and diversity of microbes in the soil and in crops.
cropland	Land on which agricultural crops, including all annual and perennial crops, are grown.
ecosystem	A system of interacting living organisms and their physical environment. The definition of the boundaries of an ecosystem varies depending on the focus of the study. Therefore, the scale of an ecosystem can range from very small to global.
grassland	Area with permanent grass that can be used for grazing.
greenhouse gas (GHG) emissions	Gaseous constituents of the atmosphere, produced both naturally and anthropogenically, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself, and clouds.
keyline subsoiling	Transverse or vertical planting intended to interrupt the flow of water and impede soil erosion. Also referred to as contour farming or bunting.
leaching	Washout of surplus nutrients that are not absorbed by plants but instead are discharged into air, soil, and water.
legume	The fruit or seed of plants of the legume family (such as peas and beans) used for food.

TERM	DEFINITION
microbial biomass	Microbial biomass is a measure of the mass of the living component of soil organic matter. The microbial biomass decomposes plant and animal residues and soil organic matter to release carbon dioxide and plant-available nutrients.
nitrate	An ion formed from nitrogen and oxygen that can leach from animal manure and nitrogen fertilizers into groundwater, polluting water and leading to algae blooms.
nitrous oxide	A very potent GHG with more than 250 times the impact of CO_2.
perennial crops	Crops that grow for longer than one year.
plowing	A cultivation method that involves digging deep into the soil and turning it over before seeding.
regenerative agriculture	Regenerative farming aims to create a positive impact on carbon, biodiversity, and water while benefitting farmers through improved yield resilience. Best practice principles are utilized to continuously optimize soil and crop health.
Scope 1 emissions	Direct GHG emissions that occur at sources owned or controlled by a company—including, for example, emissions from combustion in owned or controlled boilers, furnaces, and vehicles, or emissions from chemical production in owned or controlled process equipment.
Scope 2 emissions	All GHG emissions that physically occur at a facility where electricity a company purchases and consumes is generated. Depending on regional circumstances, emissions associated with heat, cooling, or water purchased from third parties may also qualify as Scope 2 emissions.
Scope 3 emissions	Emissions that arise as a consequence of a company's activities but occur at sources the company neither owns nor controls. Examples include emissions from extracting and producing purchased materials, transporting purchased fuels, and using sold products and services.
soil carbon sequestration	The amount of carbon stored in soil per unit of area to a given depth of soil within a specific timeframe.
soil microbiome	The vast array of microorganisms in soil that contribute to such essential ecosystem services as carbon and nitrogen recycling, soil structure protection, and pathogen suppression.
soil organic matter (SOM)	Plant or animal matter in soil at various stages of decomposition.
subsoiling	A minimally soil-disturbing technique for breaking up soil below the surface to reduce soil compaction.
tillage	Preparing soil for seeding by intensively agitating the upper soil horizons (through cutting, stirring, or digging) for weed control and soil loosening.

Appendix

TABLE 1 DETAILS THE POSITIVE AND NEGATIVE FINANCIAL IMPACTS OF STAGE 1 REGENERATIVE PRACTICES.

PRACTICES	POSITIVE IMPACT	NEGATIVE IMPACT
No-till practices and minimal disturbance of the subsoil	• Substantial savings from tillage and seed preparation, as traditional plowing requires high-powered machinery and consumes large amounts of fuel • Key contributor to increased yield resilience	• Additional machine costs for direct seeding (may be bought and depreciated, or rented) • Machine cost for subsoiler operation, if required; this operation is important to loosen machinery lanes when practicing no-till in combination with controlled traffic farming
Cover cropping (Implementation of species-rich cover crops)	• Cover crops considerably reduce fertilizer needs by binding relevant nutrients in the soil for the next cash crop up to a theoretical ~20 kg of nitrogen per hectare per year, while improving nitrogen use efficiency • Cover crops sequester carbon and contribute to increased yield resilience by improving SOM	• Machine operating cost for cover crop seeding after cash crop harvest, as well as for simple mulching before the start of the next cash crop cycle • Seed costs for cover crops, which may vary significantly depending on the species mix; for best results, multiple species should be used
Soil analysis and balancing (via soil testing)	• Potential to better balance the soil, for example, fertilizing more/less or adding minerals; not quantified separately as it's an enabler for other practices (and tests can prompt farmers to, for example, either increase or decrease fertilizer usage) • Increase soil health by optimizing bacteria and fungus ratio	• Cost of soil test mapping out the micro-organisms and nutrients in the soil. Cost of test is 130 DKK/ha per year, as the test is performed every fifth year • Input after test is individual depending on the soil and might be a cost or a saving and therefore is not estimated in the report
Additional impact of Stage 1 practices on cropland	• Avoided yield loss, due to increased drought resistance; one out of five years are typically drought or extreme weather years in Denmark (considering 2018 drought and 2023 extreme weather), and climate change is likely to produce even worse droughts in the next five to 10 years); the 2018 drought reduced spring barley yields in Denmark by an average of more than 25% • Stage 1 practices, which help bind water in soil and limit evaporation through better soil coverage, should mitigate the yield loss in drought and extreme weather years • Practices contribute to water holding capacity	
Grassland: **Interseeding**	• Grassland interseeding with different types of grass, herbs, and legumes can reduce fertilizer need by a fifth, having ~20% legumes in seed mix. Fertilizer savings of up to 30 kg nitrogen/ha; cost savings depend on fertilizer price	• Seed costs for interseeding mixes, including legumes and herbs

TABLE 2 DETAILS THE POSITIVE AND NEGATIVE IMPACTS OF STAGE 2 REGENERATIVE PRACTICES.

PRACTICES	POSITIVE IMPACT	NEGATIVE IMPACT
Undersown cropping	• There is no assumed additional benefit to combining undersown cropping with cover cropping, as these practices are somewhat similar. Undersown cropping involves planting a secondary crop alongside the main crop rather than after the main crop's harvest, making it somewhat akin to cover cropping. As a result, the advantages of the two practices are not typically additive, but rather the undersown crop is an alternative	• Seed costs for undersown crops; however, limited additional machinery, as seeding occurs alongside main crop seeding runs
Minimal soil disturbing mulch system (advanced use of harvest and cover crop scraps)	• Drastically reduced crop protection costs—especially for herbicides—by adopting the mulch system • Theoretical savings of up to ~25 kg of nitrogen fertilizer per hectare • Reduction of herbicide and fertilizer machine runs, reducing overall machine costs • Mulch adds to the baseline with up to ~200 DKK/ha	• Machine costs for mulching and a cultivator to work the mulched cover crops into the first centimeters of the soil, depending on local context • Lost income from straw sales
Biofertilizer (Improving manure)	• Reduction in synthetic fertilizer use attainable (however, not quantified here due to being highly situation-specific)	• Biostimulant costs mixed into manure • Biological seed coating costs and compost extract costs, including, for example, micronutrient foliar spraying
Additional impact of Stage 2 practices on cropland	• Additional avoided yield loss from all Stage 2 practices concerning crop farmland	
Grassland: **Adaptive grazing or mowing**	• Reducing the amount of grass that gets trampled can be beneficial for maintaining a healthy and productive pasture • Having a faster recovery of plants after cutting and more resilient grassland result in loss prevention	

TABLE 3 DETAILS THE POTENTIAL POSITIVE IMPACTS FROM AVOIDED YIELD LOSS, FROM REGENERATIVE PRACTICES.

PRACTICES	POSITIVE IMPACT	NEGATIVE IMPACT
Avoided yield loss	• Avoided yield loss is overarched for both Stage 1 and Stage 2. Due to increased drought resistance, one out of five years are typically drought or extreme weather years in Denmark (considering 2018 drought and 2023 extreme weather) • Practices contribute to water holding capacity. • Avoided yield loss is estimated to ~20% every fifth year. Results in ~4% avoided yield loss per year, with indicative estimated value up to 450 DKK/ha	

TABLE 4 DETAILS REFERENCES USED FOR ECONOMIC & ECONOMICAL IMPACT, RESPECTIVELY.

PRACTICES	POSITIVE IMPACT	NEGATIVE IMPACT
No-till practices	• SEGES (Driftsøkonomi ved Conservation Agriculture i forhold til dyrkning medpløjning) • Triangulated in expert interviews and with BCG study "The Case for Regenerative Agriculture in Germany – and Beyond"	• FRDK: Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture • DCA: Virkemidler til reduktion af klimagasser i landbruget - 2023
Cover Cropping	• SEGES (Driftsøkonomi ved Conservation Agriculturei forhold til dyrkning medpløjning) • Land og Fritid (crop prices) • Triangulated in expert interviews and with BCG study "The Case for Regenerative Agriculture in Germany – and Beyond"	• FRDK: Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture • DCA: report no. 130
Soil analysis and balancing	• Test prices from GPS Agri, Eurofins, VKST, and LandboNord • Discussions with Arla Pilot Farms • BCG study "The Case for Regenerative Agriculture in Germany – and Beyond"	• Experts (including BCG expert Benjamin Subei); no direct impact from practice
Grassland: **Interseeding**	• SEGES Budgetkalkuler September 2023 • BCG analysis	• USDA 2016 (US Department of Agriculture)

TABLE 4 DETAILS REFERENCES USED FOR ECONOMIC & ECONOMICAL IMPACT, RESPECTIVELY.

PRACTICES	POSITIVE IMPACT	NEGATIVE IMPACT
Minimally disturbing mulch system	• SEGES Budgetkalkuler September 2023 • Patriotisk Selskab (high fertilizer prices increase the value of the straw, consider mulching)	• FRDK: Beskrivelse af klimaeffekter ved dyrkningssystemet conservation agriculture • DCA: Virkemidler til reduktion af klimagasser i landbruget - 2023
Undersown cropping	• SEGES • Interviews with Arla regenerative agriculture pilot farmers • Land og Fritid (crop prices)	• Impact from practice not feasible to add on top of cover cropping (confirmed across interviews with professors) • Inland Norway University of Applied Sciences, Institute of Agriculture: Poudel et al., 2022
Adaptive grazing or mowing	*Not quantified*	• USDA-ICF 2016 (US Department of Agriculture)
Biofertilizer	*Not quantified*	*Not quantified*
Legume crop rotation	• SEGES Budgetkalkuler September 2023 • Statistics Denmark	• DCA: Virkemidler til reduktion af klimagasser i landbruget – 2023 • Ministry of Food, Agriculture and Fisheries of Denmark: Vejledning om gødsknings- og harmoniregler • Yara: It's crops I want, not CO_2 • FRDK: Dyrk dit eget kvælstof og spar gødning • SEGES Budgetkalkuler September 2023

Acknowledgements

Boston Consulting Group (BCG), Danmarks Naturfredningsforening, and Food Nation would like to thank the following individuals who shared their time, expertise, and insights during the research process for this analysis, which draws on a broad spectrum of stakeholders and for that reason does not represent any individual view. Please note that participation does not imply endorsement of the report.

Thank you to Annette Vibeke Vestergaard (Foreningen for Reduceret jordbearbejdning i Danmark, FRDK), Christian Højgaard Weigelt (Snaastrupgård), Hanne Gundersen (Jordkontakt), Henrik Hauggaard-Nielsen (Roskilde Universitet, RUC), Janne Aalborg Nielsen (SEGES), Jim Terp (Den Gode Gård), Joanna Lawrence (Arla), Jon Aagaard Enni (Innovationscenter for Økologisk Landbrug), Jørgen Eivind Olesen (Aarhus University), Klaus Kristensen (Hovergaarde), Mads Veng (Veng Agro), Martin Hvarregaard Thorsøe (Aarhus University), Michael Højholdt (SEGES), Nanna Sommer (SEGES), Niels Hedermann Pedersen (Lykkegård), Rasmus Emil Jensen (SEGES), Sandra Villumsen (Foreningen Regenerativt Jordbrug), Simon Boas Hoffmeyer (Carlsberg Group), Sybille Kyed (Økologisk Landsforening), Søren Ilsøe (Agrovi), Tavs Nyord (CONCITO), Thomas Roland (Coop), and many others.

In addition, the authors would like to give special thanks to the working team behind the analysis.

Thank you to Frederik Rasmussen (BCG), Oscar Jakobsson (BCG), Ronald Abundo (BCG), Louise Gram Andersen (BCG), Ellen Marie Gaunby (BCG), Rikke Lundsgaard (Danmarks Naturfredningsforening), Mie Ole Lauritzen (Food Nation), and Jens Renner Christensen (Food Nation).

About the Authors

Peter Jameson is a managing director and partner in the Copenhagen office of Boston Consulting Group. You may contact him by email at jameson.peter@bcg.com.

Lars Midtiby is the chief executive officer of the Danish Society for Nature Conservation (Danmarks Naturfredningsforening), the largest nature conservation and environmental organization in Denmark.

Lise Walbom is the chief executive officer of Food Nation, a public-private partnership that creates awareness of Denmark as a front-runner in innovative and sustainable food solutions.

Søren Skovgård Møller is an associate director in BCG's Copenhagen office. You may contact him by email at moller.soren@bcg.com.

Jeppe Mikkelsen is a project leader in BCG's Copenhagen office. You may contact him by email at mikkelsen.jeppe@bcg.com.

For Further Contact

If you would like to discuss this report, please contact the authors.

Boston Consulting Group

Boston Consulting Group partners with leaders in business and society to tackle their most important challenges and capture their greatest opportunities. BCG was the pioneer in business strategy when it was founded in 1963. Today, we work closely with clients to embrace a transformational approach aimed at benefiting all stakeholders—empowering organizations to grow, build sustainable competitive advantage, and drive positive societal impact.

Our diverse, global teams bring deep industry and functional expertise and a range of perspectives that question the status quo and spark change. BCG delivers solutions through leading-edge management consulting, technology and design, and corporate and digital ventures. We work in a uniquely collaborative model across the firm and throughout all levels of the client organization, fueled by the goal of helping our clients thrive and enabling them to make the world a better place.

Danmarks Naturfredningsforening

The Danish Society for Nature Conservation (Danmarks Naturfredningsforening) is the largest nature conservation and environmental organisation in Denmark. It is a membership organisation that works to conserve nature and the environment in Denmark through local work, conservation, lobbying and specific projects. We have more than 130,000 members, 95 local divisions, 60 employees and 1,500 volunteers.

We are committed to conserve and protect the natural environment in Denmark in order to secure a future, where natural forests and meadows rich in biological diversity still exist and clean drinking water is still obtainable.

Food Nation

Food Nation is a non-profit public-private partnership established by the Danish government and leading private organisations and companies. We are your gateway to information about the Danish agriculture and food sector and know-how that can accelerate the growth of international business through better solutions, innovative products and trusting cooperation. Food Nation creates awareness of Denmark as a frontrunner in innovative, sustainable and effective food production and works as a gateway for international stakeholders seeking information about Danish food solutions.


BCG
FOOD NATION
Solutions of tomorrow By Denmark
Danmarks Naturfredningsforening