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Potentials for Danish agri- and food-tech solutions on the British market

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MINISTRY OF FOREIGN AFFAIRS OF DENMARK
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Executive summary

On behalf of the Danish Embassy in London, Deloitte Economics and Kraka Advisory have analysed the potentials for Danish agri- and food-tech solutions on the British market with a special focus on the technology used to automate and digitise the production processes in the first links of the value chain. The analysis is based on available statistics and interviews with researchers, representatives from the Danish Agriculture & Food Council and companies.

The report concludes that there is a large untapped potential for an increased use of technology and digitalisation of processes in British agriculture. On average, the British worker in the agricultural and food cluster is only 55% as productive as the Danish worker. The productivity, however, varies within the sector. The report focuses on technologies and farm types, where the return on investment for the average British farmer is expected to be particularly good.

An important explanation of the gap in labour productivity between the two countries is relatively fewer and more inferior machines and technology in British agriculture.

The total overall potential for increased productivity in British agriculture is assessed at about EUR 4 billion. The largest potential is for large farms producing milk (about EUR 667 million) and general field cropping (about EUR 527 million).

To realise this potential, Danish companies within agri- and food-tech can play a significant role building on a strong market presence and a good reputation in most European companies, China and overseas. Besides increased productivity, these technologies will also support a greener and more sustainable British agricultural and food production. This makes the market potential for Danish companies in United Kingdom even bigger, as new environmental regulation in the wake of Brexit is foreseen.

The report focuses on three overall product categories: 1) Precision technology in agricultural production, 2) automatic feeding systems, and 3) waste management equipment in relation to slurry. For precision technology, the potential is especially significant for large firms within general field cropping. Closing 10% of the productivity gap by technology-based solution will lead to an economic gain of close to EUR 53 million a year within this farm segment. For automatic feeding systems, the potential is especially pronounced within milk production on large farms, where the economic gain by closing 10% of the productivity gap is assessed at just below EUR 67 million a year. With respect to waste management – and especially slurry management – there are great environmental and climatic potentials and derived socio-economic benefits through reduced and/or targeted emissions of nitrogen substances and CO2.

Content

Introduction

Introduction

How the Danish agri- and food-tech industry can offer solutions to a more productive and sustainable British agricultural sector

Background
The Danish agricultural and food sector is an important industry in Denmark. 5.2% of the Danish gross domestic product (GDP) can be credited to the production of food and agricultural products. The Danish agricultural and food sector is among the most productive and sustainable industries in the world, and the products are in demand worldwide due to their high quality and responsible and safe production processes. 75% of the Danish agricultural and food production is exported, amounting to a total value of about EUR 23 billion, primarily to Germany, Sweden, China and the United Kingdom. In particular, the Danish food cluster's export of goods to the United Kingdom amounts to about EUR 1.6 billion a year, making the United Kingdom the fourth largest export market for agricultural and food products.

In addition to the export of agricultural and food products is the export of knowhow and equipment to support the production processes, especially in the first links of the value chain. For instance, in recent years, the demand for Danish agri- and food-tech solutions has increased rapidly, and Danish companies have a leading position within technologies focusing on optimising the production processes and the yield thereof. This applies to both land use (e.g., cultivation of crops) and animal, dairy and vegetable production.

According to the companies themselves, the Danish stronghold within agri- and food-tech solutions can largely be attributed to a broad political will to ensure a sustainable agricultural and food production in Denmark by means of both hard and soft regulation and in terms of environmental, social and economic sustainability. The increasing focus on sustainability from both a consumer and a political perspective abroad helps to ensure a continued tailwind for the industry on the world market. Currently, about 9% (or EUR 2 billion) of the Danish agricultural and food cluster's total export is agri-industrial products, but there is broad agreement between companies, researchers and decision-makers that this share is likely to increase in the years to come.

The Danish potential on the British market
British agricultural and food production covers about 50% of domestic demand. Thus, the United Kingdom heavily relies on food imports. In contrast to Danish agriculture, British agriculture in general is characterised by labour intensive production processes and a predominant focus on conventional agriculture. Where 11.3% of agricultural and food production in Denmark is organic, it is only 2.7% in the United Kingdom.

The few organic farms in the United Kingdom can to a large extent be explained by the lack of domestic demand, where the average British consumer is relatively price-sensitive and perceives organic food and beverages as high-end products that are not necessarily synonymous with sustainable agriculture and animal welfare. A transition to a greener British agricultural sector will thus require an optimisation of the production processes in order to be able to provide organic products at relatively competitive price levels.

In addition, the lapse of EU subsidies is to some extent expected to be replaced by government support, which, however, will be accompanied by regulation to support a transition to a greener, more sustainable and effective British agricultural and food production through investments. Thus, there is a clear political vision of a more sustainable British agricultural sector; for climatic and environmental reasons, but also from an economic point of view. A sustainable and productive agricultural and food production is becoming increasingly important for the competitiveness and outlets of British agricultural and food products, domestically and abroad. In this connection the Department for Environment, Food & Rural Affairs expects a new subsidy structure to be a key factor in the transition to the future of farming.

The solution to many of the challenges facing British agriculture in the years to come is to a wide extent implementation of technology and increased digitalisation in the production processes; an area in which Danish products are among the most innovative and demanded products in the world.

Objective
In continuation hereof, the overall objective of this report is to describe and quantify the concrete potentials for Danish agri- and food-tech solutions on the British market. Especially, the focus is on automation and precision technology used in the first links of the value chain, as well as equipment used to handle slurry in a more sustainable manner is touched upon.

The report is structured in five main parts. In the first two parts, the strengths of the Danish agricultural and food cluster are described followed by an introduction to the challenges and ambitions of British agriculture. In the third part, we describe the potentials for Danish agri- and food-tech solutions, in general and within three specific product categories. The fourth part focus on the realisation of the potentials based on an assessment of barriers and prerequisites. In the last part, we describe the data and methodology.

The Danish stronghold within agricultural and food production

Strengths and competencies

The Danish agricultural and food industry is among the most productive and sustainable industries in the world

Denmark is frontrunner within agri- and food-tech
Danish companies have positioned themselves as leading suppliers of technological innovations within the agricultural and food industry, with more than 80% of the processing equipment being exported to global markets, including many European countries, China and the United States. This export includes specialised processing machinery, robotics, sensors, analysis solutions and IT systems.

The reason for Denmark's innovative competencies within process equipment lies, among other things, in a tradition of collecting data from the entire value chain. This enables various big data analyses, which create the foundation for identification of efficient and innovative solutions.

Cross-sectoral collaboration
The innovative technological solutions that characterise the Danish food cluster are a result of a close collaboration between businesses, academia, research institutes and the authorities, which to a large extent can be described by a triple helix approach. Such a cross-disciplinary collaboration ensures a smooth and continuous development of the Danish agricultural and food industry, as all parties have mutual interests. By pooling knowledge and resources across the entire value chain, Danish companies have built up high standards within effective and safe production processes and continuously been able to deliver new innovative solutions to the market. The collaborative culture is thus a critical success factor for Denmark's leading role in the agri- and food-tech industry.

Growth in the sector
The agri- and food-tech sector in Denmark has experienced significant growth in recent years. Some companies are reporting yearly growth rates in turnover of 100% or above. According to the companies themselves, the increased demand for modern technology and digital solutions in agricultural and food production – and thus the strong incentives to innovation within the field – can be explained by the political goal of ensuring a green and sustainable agricultural sector through hard and soft regulation. Combined with a hard competition in the market, and a consequent focus on cost-cutting measures, the focus on less labour intensive (and costly) and more sustainable production processes has been strengthened.

In many other countries, including the United Kingdom, the political focus on a green and sustainable agricultural sector begins to reflect in an increased demand for technology to support optimisation and automation. This causes tailwind for Danish agri- and tech-solutions at existing and new export markets.

In addition, the generational transition in Danish agriculture can be mentioned as a supplementary explanation of the increase in demand for technological solutions, as the younger generations to a relatively larger extent embrace the technological possibilities and are not biased by the way the agricultural industry “used to be".

Organic demand
Denmark has focused on organic production since the late 1980s, but over the past few years, there has been an increasing demand for organic products, as consumer preferences have tilted towards greener and healthier, but also more expensive goods.

Today, Denmark has the largest share of organic food products in the retail market in the world (12.1% in 2019). The organic products in the retail market come from the organic farms, which cover over 300,000 hectares, corresponding to just above 11% of the cultivated agricultural area in Denmark. By comparison, below 3% of the British agricultural area is organic, and the average British consumer is perceived as relatively price sensitive.

The greater demand for organic food products has supported the transition from conventional agriculture to organic farming. To keep the price of the organic products relatively competitive, the need for optimisation has been – if possible – even more important, and this way also contributed to an increased demand in the agri- and food-tech solutions.

On the next page, we have given some concrete examples of Danish agri- and food-tech solutions. Please note that we focus on the overall potentials for agri- and food-tech solutions to reduce the productivity gap between British and Danish agricultural and food production, as well as the potentials for selected product categories (solutions). We do not access the potentials for specific companies, even though we may refer to companies for illustrative purposes.

Examples of agri- and food-tech solutions

Danish food- and agritech companies have strong competencies within optimisation and automation

Food- and agritech

Automation

- Washpower has developed a robot for automatic washing of pig houses.
- This automatic washing ensures a higher flexibility and increases the hygiene levels and speed in the washing process without compromising on quality of the work.
- The company offers three different models.

Feeding

- Hamlet Protein is a global supplier of specialty animal feed ingredients for young animals to improve health, welfare and performance of swine, poultry and ruminants.
- Its product offerings include protein and fibre options, which have been documented to result in a higher slaughter weight.

Quality control

- InnospeXion has developed an automatic fish bone detection system for fish factories using a specialised x-ray image technology which can detect bones down to 0.1 mm at a speed of up to 300 frames per second and with the ability to operate 24/7.
- This technology ensures a high product quality, reduces food waste and ensures a high level of hygiene.

Precision agriculture

- FieldSense provides weather stations which provide farmers with local and exact weather data at 10-minute intervals.
- The weather stations provide data which includes information on rainfall, soil temperature, air temperature, wind speed, humidity, etc.
- A more accurate monitoring of the weather conditions on the agricultural area will create a better yield and reduce the farmer's use of resources.

Quality control

- GoodProduct is a quality-screening method of milk all the way through the production chain to identify any impurities.
- This allows dairies to react quickly to any impurities and recall the milk before it is processed.
- Developed through collaboration between Foss, Arla Foods and other.

Automation

- With its special plant detecting cameras, the Robovator is an automated hoeing machine for controlling weed in row crops which can be controlled by smart phone, laptop or by its own display – even in darkness.
- Constructed by F. Poulsen Engineering ApS – an engineering company specialised in advanced technical solutions for organic/conventional farming.

Automation

- Ken Hygiene Systems is specialised in constructing cleaning systems for food producers which are automatic, fast and ensure a high level of hygiene to meet various requirements within the food industry.
- The company offers professional disinfection solutions for clients in for example the pharmaceutical and food industry worldwide.

Temperature control

- SKOV makes climate and farm management solutions for animal production.
- Its ventilation system and expertise regarding animal climate requirements can create an optimum livestock house climate that will ensure better yields from production.
- The company provides solutions for poultry, pigs and dairy cattle.

Challenges and opportunities in British agriculture

Challenges and opportunities

The post-Brexit and post-COVID-19 economy will drive innovation and investment in British farming

The British agricultural and food industry is facing some challenges, which to a large extent can be mitigated through the implementation of modern technology in the production processes and increased focus on digitalisation. An area, in which Danish companies have a stronghold. Thus, from a Danish perspective, the challenges in British agriculture are associated with a commercial potential, which at the same time will support the transition to a more efficient and sustainable British agricultural and food production. In reality, a win-win situation for both countries. The analysis has identified five challenges – or opportunities – depending on the perspective.

1. Low productivity and high degree of human capital in production
The average British worker in the agricultural and food industry is only producing 55% of the output of an average Danish worker. Closing just a minor part of this productivity gap by optimising production processes and reducing the dependence on manual labour is associated with large economic gains for the average British farmer.

2. Regulation to support a more sustainable British agricultural and food industry
The Department for Environment, Food & Rural Affairs has put forth a transformation of the British agriculture to become more sustainable by 2024. This is a path which will realise investment in new technologies to help farmers reduce costs and improve their profitability. For instance, as part of the plan, untargeted direct payments to farmers will gradually be reduced from 2021 to 2027 when the payments completely cease. The substitute to the untargeted direct payments will be grants made available to farmers, who want to improve productivity, animal health and welfare, reduce carbon emissions, etc. Through this change in government subsidies, the goal is to achieve a modern, sustainable and profitable food cluster.

This shift in the public subsidy scheme will create an incentive for British farmers to invest in new equipment that will increase the quality of the agricultural production through long-term investments. In addition, the Department for Environment, Food & Rural Affairs increases the focus on research and development within the industry and by creating training programmes for farmers, the British agriculture aims to develop a more competitive and sustainable food cluster.

From 2021, farmers and regulators will be working more closely together to improve the standards within the agricultural industry in the United Kingdom. This will be done by involving the farmers and other experts in the political decisions. In addition, the policy initiatives will continuously be evaluated and adapted to remain relevant and meaningful for the farmers. In this way, regulation will become more flexible and be a way to guide and improve the agricultural industry in a more sustainable direction.

3. Price sensitivity among British consumers
The average British consumer is relatively price sensitive, and it is a priority for the British government to keep the food prices down. Also, supermarket chains have a relatively strong bargaining position to farmers. However, there is an increasing awareness of sustainability in the population causing consumers to demand greener products. This cross-pressure increases incentives in the British agricultural and food industry to invest in new ways in which production processes can be optimised – both from an economic and an environmental perspective.

4. Demographics and limited continuing education
The average British farmer is relatively old and maintains a good economy, even with a low productivity. The incentives to optimise production processes in the absence of regulation – accompanied by a real risk of sanctions if not complied with – have so far been limited. Also, the tradition of continuing education and training and use of technology in British agriculture is limited causing a barrier for implementation of modern technology and digitalisation in the production processes. That said, if the business case is strong, the prospect of an economic gain may support a changed behaviour in, and thus transition of, British agriculture.

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Brexit

A technological enhancement is needed regardless of the Brexit outcome

5. Brexit

In a referendum in 2016, the United Kingdom decided to leave the European Union. Being outside the European Single Market and the Schengen area will primarily affect the flow of labour and goods to and from other EU member states. However, no matter the details of the trade agreement between the European Union and the United Kingdom, British farmers need to invest and innovate to make production more sustainable and more efficient. This conclusion is further strengthened if a number of expected consequences of Brexit occur.

Declining import

One expected consequence of Brexit is a decline in the import of goods and services from EU member states. This further implies that the United Kingdom must either import from countries outside of the European Union, lower its consumption, or increase its domestic production (or a combination). This increased dependency on domestic production will increase the need for a better and more efficient production among British farmers.

Reduction of migrant workers

Another expected consequence of Brexit is that fewer migrant workers from other EU member states will be a part of the British labour force. This is very likely to put upward pressure on the cost of labour and thereby raise the cost of production of goods. Historically, instances of increased scarcity of labour have made firms increase their investments in labour-saving technologies to produce goods most cost-effectively.

The need for investments in technology

The two primary first-order effects of Brexit – reduced flows of goods and workers from other EU countries – both leave room for increased investments in British farming and agriculture. Fewer agricultures goods from abroad and fewer workers to produce domestically call for investments in new technology that can boost labour productivity in the agricultural sector in the United Kingdom. Investment in agricultural technology is an area where the United Kingdom has been hesitant in recent years, which means that the potential for improvement is substantial.

Identified potentials

Overall potential

British farmers are trailing Denmark in productivity, creating a need for more effective production

Potential for the British food cluster
In 2018, there were roughly four times as many full-time workers in the British food cluster compared to the Danish cluster. Yet, the value of the products produced by the average British worker is only about 55% of what the average Danish worker produces. This number shows a large gap in labour productivity between Danish and British farms. One explanation could be that the composition of farms in the United Kingdom is skewed towards the production of goods that inherently have low levels of labour productivity. Another explanation of the productivity gap could be that British farmers use fewer and inferior machines and technology compared to the Danish farmers. Our analysis investigates the potential for these explanations. We do this by mapping the farm types and farm sizes that show the biggest productivity gaps.

Where is the highest potential?
The largest economic gain is in the milk production on large farms as shown in the table opposite. If British labour productivity on large farms of milk production were to increase to the Danish level – and the United Kingdom were to keep the same amount of labour on the farms – the value of the output in the United Kingdom would increase by about EUR 667 million. In general, the potential for British farmers is largest in large and medium-large farms and in an array of farm types. Yet, the gap is most pronounced within milk production.

How can this potential be fulfilled?
British farmers cannot expect to reach the Danish standards of productivity overnight by investing in more machinery and new technology. However, a necessary condition to come closer to the Danish level of productivity is by investing in the same modern technology that Danish farmers use. These technologies include precision agriculture, automatic feeding systems, and waste management, which are described on the following pages.

Farm size*	Farm type	Most common product (In Denmark)	Yearly economic gain, EURm**	Yearly economic gain per average farm, EUR	Number of farms
Large farms	Milk production	Cows' milk products, forage crops, and beef & veal	667	153,000	4,400
Large farms	General field cropping	Cereals, potatoes, and other crop output	527	434,000	1,200
Medium-large farms	Milk production	Cows' milk products, forage crops, and beef & veal	435	62,000	7,000
Large farms	Granivores	Pig meat, cereals, and eggs	397	225,000	1,800
Medium-large farms	Cereals, oilseeds, and protein crops	Cereals, other crop output, and oil-seed crops	307	32,000	9,700
Medium-large farms	Cattle breeding	Beef & Veal, forage crops, and cereal	286	45,000	6,400

Sources: Farm Accountancy Database Network (FADN) and own calculations.
* Large farms are defined as farms with output value above EUR 0.5 million. Medium-large farms are farms with output value between EUR 0.1 million and EUR 0.5 million.
** Economic gain is calculated as the gain if British labour productivity reaches the same level as Danish workers, and the United Kingdom keeps the same amount of labour. This could also be interpreted as the economic gain from closing the productivity gap.

1) Precision agriculture

Investing in precision agriculture has great potential to improve the productivity on British farms of crop production

What is precision agriculture?
Precision agriculture is not just one single technology, but a common term for several different technological solutions. Precision agriculture increases efficiency and optimises the fertilisation process by segmenting the agricultural area allowing the farmer to target efforts towards specific areas where returns are highest. Common to the various technologies within precision agriculture is that they use satellite-/drone images, data from weather stations or sensors to monitor and/or map the condition of the agricultural area. The collected data provides the farmer with an immediate overview of the field, which in combination with for example GPS data enables identification of areas where action is needed, with an accuracy of 1-2 cm.

Danish experience from precision agriculture
The proportion of Danish farms using precision technology has increased from 23% in 2018 to 35% in 2020. This corresponds to 70% of the cultivated agricultural area in Denmark. The increased use of precision technology comes practically from the prevalence of sprinkles with section control, which can reduce the use of pesticides and thus both meet recent years' legislation on this area and reduce costs.

Another explanation of the greater use of precision technology is documented in a report written by Statistics Denmark in 2018. The report shows that 58% of the surveyed farmers – who used precision technology at that time – experienced at least one positive effect from using precision technology. The report further reveals that more than every third farmer experienced reduced cost of labour and pesticide use and that 20% of the farmers obtained a higher yield per hectare as a result of precision technology.

Precision agriculture is particularly used by the large farms in Denmark, which makes this technology relevant for British agriculture, as the United Kingdom in general has more large field cropping farms than Denmark.

What is the potential in British agriculture?
Precision agriculture in Denmark has shown a large effect in cost reduction and increased yield from crop production. The technology is mostly used on large farms in Denmark, as large farms naturally reap large benefits from investing in precision agriculture. The potential for precision agriculture only relates to plant and crop cultivation, and will not be meaningful to use on farms with horticulture or animal breeding according to experts.

The United Kingdom has many large farms producing field crops compared to Denmark. This creates a great potential for increasing production by investing in agriculture. This type of farming is also an area where labour productivity in the United Kingdom is well below Denmark.

Large British farmers of general field cropping can gain EUR 53 million by just getting 10% closer to the Danish productivity level, which accounts for about EUR 43,000 per farm per year, given a constant amount of labour input. This number implies that if the average British farmer invests EUR 150,000 in precision agriculture technology that brings productivity 10% closer to the Danish level, the investment will be paid back in less than four years. The table also shows that the potential is bigger in large farms, but also medium-large farms of crops cultivation can reap large economic benefits from investing in precision agriculture.

Farm size*	Farm type	Yearly economic gain by realising 10% of the potential, EURm**	Yearly economic gain per farm by realising 10% of the potential, EUR	Number of farms
Large farms	General field cropping	53	43,000	1,200
Medium-large farms	Cereals, oilseeds, and protein crops	31	3,000	9,700
Medium-large farms	General field cropping	28	10,000	3,000
Large farms	Cereals, oilseeds, and protein crops	25	16,000	1,600

Sources: Farm Accountancy Database Network (FADN) and own calculations.
* Large farms are defined as farms with output value above EUR 0.5 million. Medium-large farms are farms with output value between EUR 0.1 million and EUR 0.5 million.
** Economic gain is calculated as the gain if British labour productivity reaches the same level as Danish workers, and the United Kingdom keeps the same amount of labour. This could also be interpreted as the economic gain from closing the productivity gap.

2) Automatic feeding system

Automatic feeding systems can significantly improve British cattle breeding for meat and milk production

The rationale behind automatic feeding systems
Automatic feeding systems enable feeding in small but more frequent rations. This ensures more fresh and tasty feed at the feeding fence. The increased flexibility associated with automatic feeding systems implies that feeding can be done according to segmented consumption needs of the various animals, including cattle, granivores, fish, etc. The precise and targeted feeding achieved by automatic feeding systems has a positive impact on both the health and the yield of the animals, as feeding becomes more evenly distributed throughout the day, allowing animals to eat when they need food and not at fixed time intervals. In addition to production efficiency, an automatic feeding system contributes to a reduction in working hours and in cost due to lower fuel and feed consumption.

Danish experience from automatic feeding systems
The share of Danish farms with automatic feeding systems has begun to increase in recent years. The tendency to switch to this new technological feeding solution often happens when the old feeding equipment needs to be replaced. The investment required by such a replacement has proven to be worth it for many farmers, as they experience increased yields in production and savings within time spent on feeding and fuel used in connection with mixing and distribution of the feed.

What is the potential in British agriculture?
Automated feeding systems have the largest effect on large farms with animal breeding. The United Kingdom has fewer large farms of animal breeding than Denmark. In general, animal breeding farms in the United Kingdom are smaller and based on older technology, especially cattle farms (both milk and meat production), which is where experts see the largest potential for productivity gains. However, the trend in the United Kingdom is that farms are getting larger, which increases the incentives for farmers to invest in newer technology, allowing the British sector to unleash its great potential.

Investments in automatic feeding systems can have a substantial positive effect on the output of British animal breeding. The effect is especially large on cattle breeding, as this in an area, where automation can have a significant impact (cattle eat significantly more than pigs and chickens) and, according to experts, an area where British farmers have a way to go to catch up to the technological frontier.

Large British milk producers can gain almost EUR 67 million by just getting 10% closer to the Danish productivity level, which accounts for about EUR 15,000 per farm per year. This means, that, if 1) an average British farmer is implementing automation of the feeding system to a value of EUR 75,000 in his stable, and 2) this brings the productivity 10% closer to the Danish level, the investment will be paid back in five years. The table also shows that the potential is more pronounced for large farms, but also medium-large farms of milk production and cattle breeding can reap large economic benefits from investing in automatic feeding systems.

Farm size*	Farm type	Yearly economic gain by realising 10% of the potential, EURm**	Yearly economic gain per farm by realising 10% of the potential, EUR	Number of farms
Large farms	Milk production	67	15,000	4,400
Medium-large farms	Milk production	43	6,000	7,000
Large farms	Cattle breeding	29	4,000	6,400

Sources: Farm Accountancy Database Network (FADN) and own calculations.
* Large farms are defined as farms with output value above EUR 0.5 million. Medium-large farms are farms with output value between EUR 0.1 million and EUR 0.5 million.
** Economic gain is calculated as the gain if British labour productivity reaches the same level as Danish workers, and the United Kingdom keeps the same amount of labour. This could also be interpreted as the economic gain from closing the productivity gap.

3) Waste management

Modern waste management machinery can make British production more efficient and contribute to the green transition

What is waste management technology?
Waste management in the agricultural industry consists of collecting animal waste from livestock production and distributing it to farms that produce plants. This process helps the livestock farmers get rid of the waste from animal production in a cheap and efficient way. It also benefits plant farmers, as animal waste is used as fertilizer in their production processes. In all, waste management technology can help turn waste products in some types of farms into a valuable input factor in other types of farms. As a more specific example, waste management technology has the potential of increasing the utilisation rates of nitrogen.

Danish experience from waste management
Denmark has great experience in the use of agritech machines to manage and distribute waste, especially slurry management. One explanation of why Danish farmers have adopted this technology is because of the strict legislation of nitrogen control in Danish agriculture. This legislation has forced Danish farmers to innovate and invest in the machinery that ensures that the nitrogen is used in an efficient way with minimal environmental footprint. This also means that the waste management technology in Denmark has not only focused on distributing the waste, but also on ensuring a minimal amount of the nitrogen sinks to streams and rivers.

Why is waste management important for British agriculture?
British legislation has generally not been as strict for nitrogen levels for farmers compared to Denmark. In effect, British farmers have not made the same investments in machinery and technology as Danish farmers. However, more attention has been directed towards the farmers' contribution to maintaining the environment and climate in the United Kingdom, meaning that British farmers eventually will have to invest in technology to effectively control the nitrogen emission to streams and rivers.

Source: Dansk Agroindustri

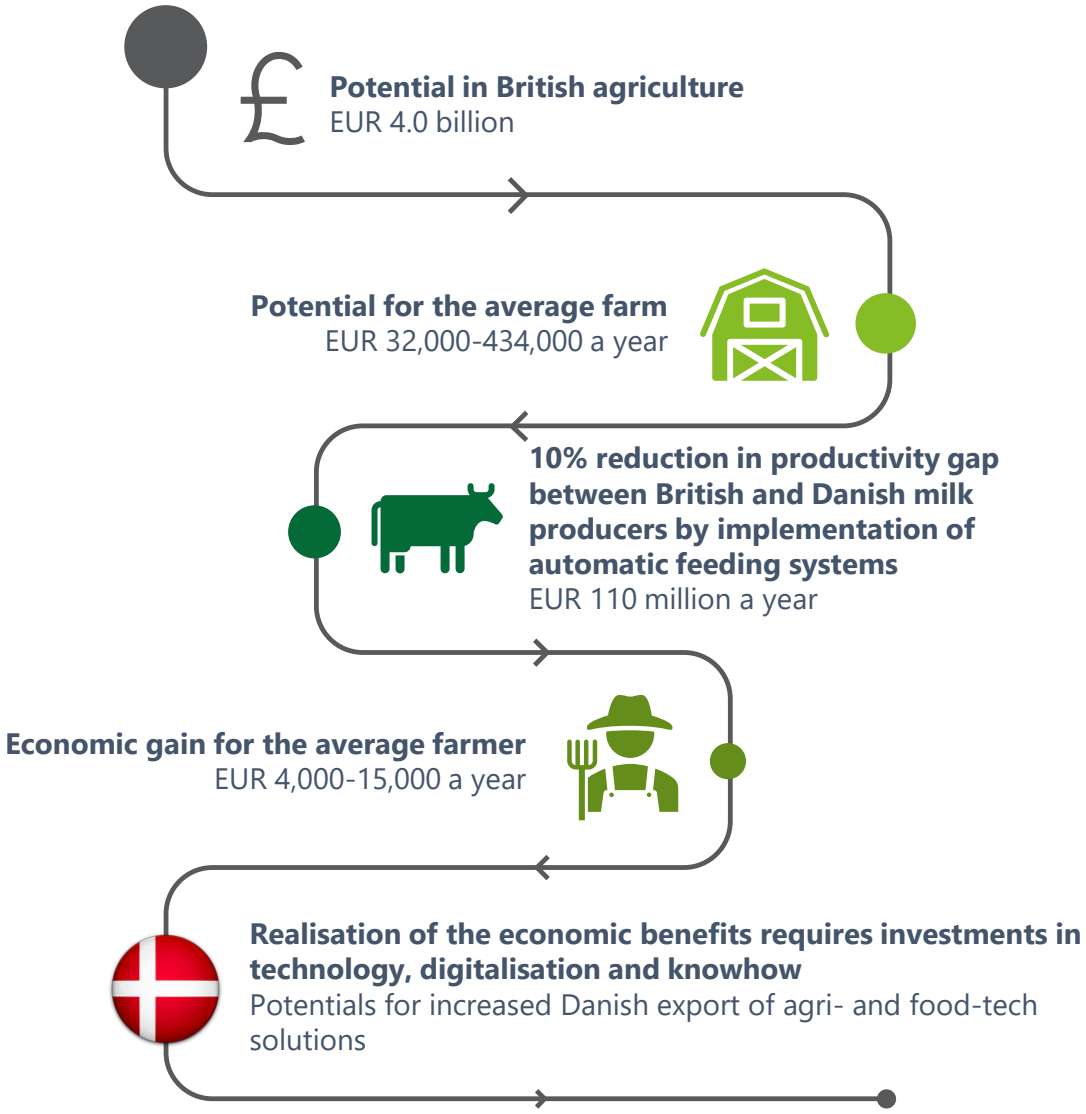
Opportunities for Danish agritech businesses in the United Kingdom

Past British underinvestments open great potential for a big market for agritech businesses

Export from the Danish agricultural and food cluster
The Danish agricultural and food cluster is a cornerstone in the Danish economy. According to the Danish Agriculture & Food Council, this cluster exported for roughly EUR 23 billion in 2019, accounting for 23% of the overall Danish export of goods. Food production accounts for most of the export from the agricultural and food cluster, but according to the Danish Agriculture & Food Council agro-technology is responsible for about 9%, which is EUR 2.1 billion of the cluster's export. The group agro-technology is a broad group of products that includes fertilizer and insect protection, but also machinery and agritech. Due to the structure of the database, it is not possible to group agritech into more specific categories than the agro-technology group, which the Danish Agriculture & Food Council has defined.

Danish export to the United Kingdom
About 7% of the export from the Danish agricultural and food cluster went to the United Kingdom in 2019, which amounts to EUR 1.6 billion. This makes the United Kingdom number four on the list of the largest export markets for Danish food and agricultural export. Danish export of agro-technology to the United Kingdom was about EUR 80 million, which is only about 5% of the total export to the United Kingdom from the Danish agriculture and food cluster. Thus, the data shows that the United Kingdom is currently not a large market for Danish agro-industrial producer, which is confirmed by both experts and Danish exporting agritech firms themselves.

How will Danish export of agri- and food-tech be affected?
British farmers need to invest in new technologies to obtain a more efficient process of production of food and agricultural products. Brexit has made this need even more urgent. For a long time, the United Kingdom has been a small market for Danish agritech firms due to its lack of interest in investing in new and better technology. However, this also means that British farmers are lagging behind and that the potential is big. Their need for investments may open a window of opportunity for Danish agritech firms to enter the market in the United Kingdom. Danish farmers have been pioneers in adopting new technology, also in farm type, where the United Kingdom has fallen behind. If British farmers increase their investments as expected, Danish agritech firms have a great opportunity to step in and supply the needed technology.



Future implications

Future implications

The United Kingdom faces short-term barriers driven by uncertainty, but with a great long-term potential for investing in agri- and food-tech

The current situation in the United Kingdom is characterised by a high degree of uncertainty caused by Brexit, covid-19 and general economic challenges. However, there are good perspectives for increased export of Danish agri- and food-tech solutions to the British market – even with a hard Brexit. This is due to the importance of stable and affordable food supply combined with requirements for increased productivity and sustainable production processes facing British agriculture. Requirements that to a large extent can be explained by the political as well as market driven focus on sustainable production – also from an economically perspective, where there need for optimisation and being able to produce more for less is a key determinant.

That said, there are still a few barriers and uncertainties to overcome.

British farmers need to invest in agri- and food-tech
British farmers have great potential for improving productivity and making production more efficient. The best way to fulfil this great productivity potential in the British food cluster is for British farmers to invest in modern agricultural technologies. Many British farmers have neglected these investments for several reasons, for example access to cheap labour making automation unnecessary and laissez-faire environmental legislation (compared to Denmark), reducing the need for investments in for example waste management.

Political will to change
Since Brexit, British politicians have had a focus on increased domestic production. To increase the domestic production, farmers must produce their goods more efficiently than they are doing now. Increased automation and efficiency have along with a more sustainable agricultural production been high on the agenda in British politics. The political will to focus on a greener and more efficient agriculture could lay a foundation for British investments in Danish agri- and food-tech solutions.

Barriers to fulfilling the potential
Brexit and the COVID-19 pandemic have created a lot of uncertainty for the British economy, which is usually harmful for the companies' incentive to invest. Brexit may be a barrier for British investments in products from the European Union, including investments in Danish agritech.

The final conditions of Brexit are yet to be finalised, so the terms of trade between Denmark and the United Kingdom are not known. However, Brexit may have negative consequences for Danish export to the United Kingdom in general. Danish agritech firms may meet restrictions that are worse than what they currently are facing. Trade barriers in terms of customs, bureaucracy and tougher legislation are just some of the barriers that Danish firms can be met with due to Brexit.

A requirement for fulfilling the potential
The platform for Danish agritech firms to enter the British market is there. The technology level among farmers in the United Kingdom is low and they need investments to catch up with Denmark and stay competitive. Brexit has made this need even more pronounced. Brexit also has the potential of changing the composition of Danish export to the United Kingdom to the benefit of agritech firms. If the United Kingdom reduces its import of food from Denmark, and instead focuses on domestic production, Danish agritech exporters could benefit at the expense of Danish food exporters.

An essential requirement for increased export of agritech to the United Kingdom is that British farmers have a motivation for investing in new technology. Two things may be blocking that motivation. First, a relatively large fraction of the British farms is leased, creating more uncertainty about the future and less motivation to invest in new technologies that benefit in future. Second, British farmers are relatively old. The motivation to invest in technology may increase, as the younger generations take the reigns in British farms. Younger farmers will be more likely to see the benefits of the new technology and are more prone to invest in it. British farmers will not invest in new technology until they have realised that the benefits exceed the cost of the investment. A younger generation will help this realisation.

The United Kingdom has some short-term barriers to investing in agritech, primarily driven by uncertainty about the near future. However, the long-term challenges that they face require investments, so there is no reason why the United Kingdom would not be a valuable market for Danish agritech firms.

Data and methodology

Our approach

1) Data collection
This analysis is based on a broad range of data comprised of Deloitte's internal industry knowledge, an expert panel with in-depth insights into the Danish food cluster, Danish companies offering various food- and agritech solutions, as well as quantitative and qualitative material collected via desk research.

The recommendations of the analysis are thus based on a data consisting of various reports from for example Food Nation Denmark, Statistics Denmark, the Danish Agriculture & Food Council etc., quantitative data from Statistics Denmark, various news articles, case studies, etc., as well as interviews with Dansk Agroindustri & Agromek, the Danish Agriculture & Food Council.

3) Analysis of potentials
The potential is analysed using the European Commissions database called Farm Accountancy Data Network (FADN), which includes an extensive selection of data of farm value added, value of output, labour input, number of farms, etc.

We have used this database to calculate the average labour productivity based on value added per person employed on a farm. This is done for both Danish and British farms depending on farm size and type. We have used the average labour productivity and the number of workers to calculate the potential for British farmers, if they increase the labour productivity to the Danish level but keep the same number of workers.

We have used data for 2016 to 2018, as this was the latest available data. The values are calculated as the average of 2016, 2017 and 2018 to reduce the sensibility from yearly outliers.

2) Mapping
Based on the collected data material, the first task in the mapping process was to sort/group our data to get an overview of the depth of the data. This process gave us an indication of where Denmark has its competitive advantages in the form of technological solutions and knowhow.

From here, we created several hypotheses for where the Danish food cluster could have its comparative advantages over the British agricultural industry. We presented these hypotheses to our expert panel, and based on a joint discussion, we were able to target our further mapping of potentials. With something more concrete at hand, the data collection was intensified, and the challenges and opportunities of the British food cluster became part of our mapping too.

As the mapping progressed, and we incorporated the perspectives and knowledge from Danish food- and agritech companies as well as our expert panel, it became more and more clear which potentials we should continue to pursue. The next step for us was to begin the analysis of these potentials to further elaborate on their size and nature.

Data sources

Interviews
- 3 qualitative interviews with Danish agri- and food-tech companies
- Minutes from interviews with CLA (CLA.org.uk), Danish Crown, Department for Environment, Food and Rural Affairs, Kinston Hill Farm and National Farmers Union conducted by the Danish Embassy in London

Data bases
- Statistics Denmark

Expert assessments from:
- Brian H. Jacobsen, Section for Environment and Natural Resources, Copenhagen University
- Christian Friis Børsting, Department of Animal Science, Aarhus University
- Søren Marcus Pedersen, Section for Production, Markets and Policy, Copenhagen University

Documents and analyses from:
- Agriculture and Horticulture Development Board
- Copenhagen Economics
- Danish Agricultural and Food Council
- Department for Environment, Food and Rural Affairs
- Food Nation Denmark
- Journal of Political Economy
- Organic Denmark
- Statistics Denmark
- The Danish Agricultural Agency

Appendix

Productivity potential - overall

Potential if British farmers get to the same productivity level as Denmark

Farm size*	Farm type	Most common product (In Denmark)	Yearly economic gain, € million**	Yearly economic gain per average farm, €	Number of farms
Large farms	Milk production	Cows milk products, forage crops, and beef & veal	667	153,000	4,400
Large farms	General field cropping	Cereals, potatoes and other crop output	527	434,000	1,200
Medium-large farms	Milk production	Cows milk products, forage crops, and beef & veal	435	62,000	7,000
Large farms	Granivores	Pigmeat, cereals, and eggs	397	225,000	1,800
Medium-large farms	Cereals, oilseeds, and protein crops	Cereals, other crop output, and oil-seed crops	307	32,000	9,700
Medium-large farms	Cattle production	Beef & Veal, forage crops and cereal	286	45,000	6,400
Medium-large farms	General field cropping	Cereals, potatoes and other crop output	285	96,000	3,000
Large farms	Horticulture	Vegetables & flowers, other field crops, adn fruit	269	715,000	400

Farm size*	Farm type	Most common product (In Denmark)	Yearly economic gain, € million**	Yearly economic gain per average farm, €	Number of farms
Large farms	Cereals, oilseeds, and protein crops	Cereals, other crop output, and oil-seed crops	246	158,000	1,600
Medium-large farms	Combined crops and livestock	Pigmeat, cereals, beef & veal	147	41,000	3,600
Large farms	Combined crops and livestock	Pigmeat, cereals, beef & veal	128	185,000	700
Medium-large farms	Horticulture	Vegetables & flowers, other field crops, adn fruit	109	153,000	700
Medium-large farms	Granivores	Pigmeat, cereals, and eggs	106	55,000	1,900
Medium-sized farms	Cereals, oilseeds, and protein crops	Cereals, other crop output, and oil-seed crops	38	7,000	5,800
Medium-large farms	Mixed crops	Vegetables & flowers, cereals and other crops	25	57,000	400
Small farms	Cereals, oilseeds, and protein crops	Cereals, other crop output, and oil-seed crops	9	3,000	2,900

Source: Farm Accountancy Database Network (FADN) and own calculations.
* Large farms are defined as farms with output value of above € 0.5 million. Medium-large farms are farms with output value between € 0.1 and € 0.5 million.
** The economic gain is calculated as the gain if British labour productivity reaches the same level as Danish workers, and the UK keeps the same amount of labour. This could also be interpreted as the economic gain from closing the productivity gap.

Productivity potential – selected technologies

Potential if British farmers get 10 per cent closer to the Danish productivity level.

Automatic feeding system

Farm size*	Farm type	Yearly economic gain by realising 10 pct. of the potential, € million**	Yearly economic gain per farm by realising 10 pct. of the potential, €	Number of farms
Large farms	Milk production	67	15,000	4,400
Large farms	General field cropping	53	43,000	1,200
Medium-large farms	Milk production	43	6,000	7,000
Large farms	Granivores	40	23,000	1,800
Medium-large farms	Cereals, oilseeds, and protein crops	31	3,000	9,700
Medium-large farms	Cattle production	29	4,000	6,400
Medium-large farms	General field cropping	28	10,000	3,000
Large farms	Horticulture	27	72,000	400

Precision agriculture

Farm size*	Farm type	Yearly economic gain by realising 10 pct. of the potential, € million**	Yearly economic gain per farm by realising 10 pct. of the potential, €	Number of farms
Large farms	Cereals, oilseeds, and protein crops	25	16,000	1,600
Medium-large farms	Combined crops and livestock	15	4,000	3,600
Large farms	Combined crops and livestock	13	19,000	700
Medium-large farms	Horticulture	11	15,000	700
Medium-large farms	Granivores	11	6,000	1,900
Medium-large farms	Cereals, oilseeds, and protein crops	4	1,000	5,800
Medium-large farms	Mixed crops	2	6,000	400
Small farms	Cereals, oilseeds, and protein crops	1	<1,000	2,900

Source: Farm Accountancy Database Network (FADN) and own calculations.
* Large farms are defined as farms with output value of above € 0.5 million. Medium-large farms are farms with output value between € 0.1 and € 0.5 million.
** The economic gain is calculated as the gain if British labour productivity reaches the same level as Danish workers, and the UK keeps the same amount of labour. This could also be interpreted as the economic gain from closing the productivity gap.

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