

By Denmark

# WHITE PAPERS

for solutions of tomorrow

# SUSTAINABILITY

SOLVING GLOBAL FOOD CHALLENGES  
- WITH SOLUTIONS OF TOMORROW

## INSIDE THIS WHITE PAPER:

- The collaborative road to sustainable food
- Efficient agriculture with a sustainable mindset
- Firm roots in the circular bioeconomy



Solutions of tomorrow  
By Denmark

## **Sustainability**

Solving global food challenges - with solutions of tomorrow

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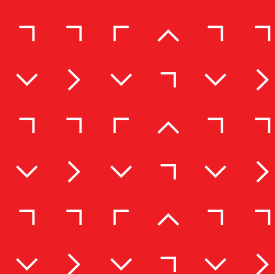
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# EXECUTIVE SUMMARY

**Denmark is a global role model for sustainable food production and innovation. Across the food value chain, collaborative efforts aim for the most efficient use of natural resources – with a strong focus on the UN Sustainable Development Goals.**

Through the steady refinement of production techniques, Danish farmers have learned to make the most of the relatively small area of agricultural land available to them. Today, they produce three times more food than the Danish population can consume, with some of the lowest greenhouse gas emissions in Europe.

Food producers follow a similar path to continuous optimisation, honing their ability to produce more with less and transform raw materials into high-value products.

Resourceful collaboration across industry, academia and authorities highlights the commitment to continuous improvement in support of the UN Sustainable Development Goals. All over the Danish food value chain, there is evidence that these endeavours are

**Resourceful collaboration across industry, academia and authorities highlights the commitment to continuous improvement in support of the UN Sustainable Development Goals**

not only beneficial to the future of the planet and its people. They are also good for business.

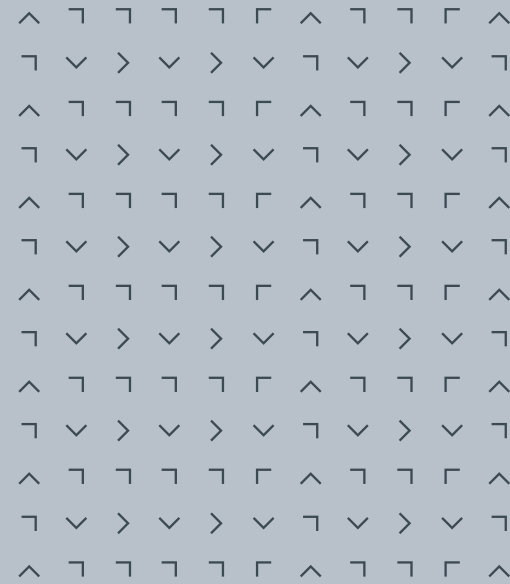
Denmark's leadership within resource efficiency sets a strong example. Primary producers invest heavily in precision farming technology to minimise their environmental footprint and maximise their yield. Food producers constantly explore new ways to

reduce their consumption of water, energy and single-use plastic packaging.

As the global need for circular bioeconomy strategies becomes increasingly apparent, the Danish food cluster is already a frontrunner. Farmers, food manufacturers, technology providers, retailers and restaurants have a strong focus on upgrading waste streams to valuable products. Raw material waste that cannot be used as food is channelled towards livestock feed, biogas production or agricultural fertilisers.

Agenda-setting consumers are demanding healthy, safe and sustainable food. Their wish is to make a difference through their purchasing choices and consumption.

The Danish food cluster is ready to deliver.



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Find out more from Food Nation

### Supporting the SDGs – how does Denmark contribute?

With the 17 sustainable development goals (SDGs), the UN has created a common framework for global challenges. The Danish agriculture and food sector has taken the SDGs on board, alongside many other stakeholders within the Danish food sector. Today, the SDGs serve as a guiding light for establishing best food production practices, prioritising research and development efforts and identifying innovation targets that will drive us towards a sustainable future.



An efficient and sustainable food sector will directly or indirectly contribute to all 17 goals. However, there are some goals where the strongholds of the Danish food sector are expected to make a particular impact. These include **Goal 2** *End hunger, achieve food security and improved nutrition, and promote sustainable agriculture* and **Goal 12** *Ensure sustainable consumption and production patterns*.

Through the ambitious climate strategies of leading companies and organisations, the sector will also contribute to **Goal 13** *Take urgent action to combat climate change and its impacts*.

Achieving the ambitious goals of the 2030 agenda requires global support and partnerships. Extensive collaboration throughout the food value chain and between industry,

academia and government is an outstanding characteristic of the Danish food sector – accelerating progress with national and international initiatives and directly contributing to **Goal 17** *Strengthen the means of implementation and revitalize the global partnership for sustainable development*.

# FOREWORD



Photo: Keld Navntoft

## Denmark has a global reputation for sustainable food production and far-sighted innovation that contributes to tomorrow's food supply.

The Danish food sector is one of the most sustainable and cost-efficient in the world, characterised by an ability to produce more with less and to turn waste streams into new high-value products. Through imports of agricultural commodities and resourceful crop and livestock farming, we produce enough food to feed three times our own population.

Our innovative and knowledge-intensive food sector is built on our tradition for collaboration between companies, authorities, and research institutes. This has secured Denmark's global position as a front-runner for resource efficiency and a supplier of internationally competitive food solutions.

Environmental regulations have supported the development of our food and agriculture industry since 1971. Even before then, public institutions worked with companies to help shape and develop Danish food production.

### Advancing the 2030 agenda

Cross-disciplinary collaboration is also key to pursuing the 2030 sustainable development agenda. As global demand grows for animal and plant-based foods, Denmark is delivering proven technology to support the move towards sustainable agriculture and

food processing and to help ensure universal access to foods that are both safe to eat and nutritious.

Such technology is vital to prevent hunger, malnourishment and the lifestyle diseases that are increasingly common around the world. By drawing on our collective expertise, we are committed to making tangible progress towards the global sustainable development goals – while inspiring others to do the same.

### Climate-efficient production

In the spring of 2019, The Danish Agriculture and Food Council announced a vision to make Danish agriculture and food production completely climate neutral by 2050. For some of our biggest food producers, the aim is to be climate neutral as early as 2030. These high ambitions are, once again, based

on a belief in extensive collaboration as a means to creating innovative solutions and new technology.

The high ambitions also go hand-in-hand with the Danish government's common direction towards reducing emissions by 70 percent below the 1990 level by 2030 – and to introduce binding targets for agricultural production.

This is no pipe dream. Our food sector is already among the world's most climate-efficient. Danish milk production, for example, has some of the lowest emissions of greenhouse gas per litre in Europe.

With this white paper, we are pleased to provide some deeper insights into the Danish model for sustainable food production. We hope to inspire you.

Our innovative and knowledge-intensive food sector is built on our tradition for collaboration between companies, authorities and research institutes

A handwritten signature in black ink, appearing to read 'Mogens Jensen'.

Mogens Jensen

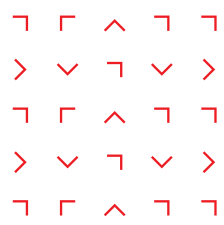
Minister for Food, Fisheries, Equal Opportunities and Nordic Cooperation of Denmark



CHAPTER 1

# THE COLLABORATIVE ROAD TO SUSTAINABLE FOOD

TARGETING GLOBAL NEEDS THROUGH  
CROSS-SECTOR INNOVATION



## Denmark is a master of fruitful collaboration. For generations, this has driven the Danish food sector to produce more with less – and ever-lower environmental impact.

The Danish agricultural and food sector has a strong track record for resource efficiency. While production has increased by almost a third since 1990, greenhouse gas emissions have declined by around 16% in the same period – food manufacturers alone achieving a 35% reduction in emissions since 2000. These results are the outcome of extensive collaboration across the food value chain, between businesses, authorities, universities and research institutions.

Having harvested the low-hanging fruit, the challenge now is to achieve even higher net reductions in emissions. Once again, col-

laboration will be necessary by extensive partnerships to find and implement the best possible solutions.

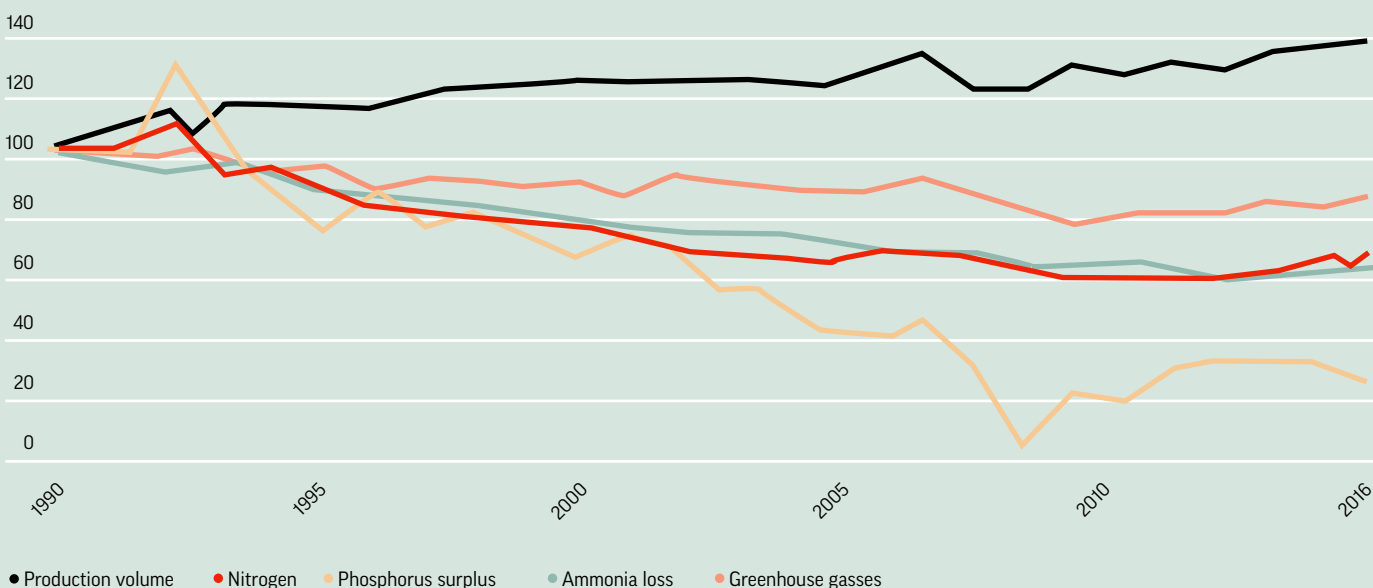
The roots of the Danish collaborative culture can be traced back to the cooperative movement. Starting in the late 19th century, the first farm cooperatives demonstrated the power of pooling resources to maximise production, optimise research and development and target new opportunities in global markets.

Today, the Danish food sector continues to invest in cross-sector partnerships that de-

liver innovative and sustainable solutions to global challenges. For international business partners, this gives access to an entire ecosystem of knowledge and innovative power.

The roots of the Danish collaborative culture can be traced back to the cooperative movement

### Since 1990, the Danish food sector has both increased production and reduced its environmental impact (1990=index 100)



Source: DCE rapporter nr. 270 og 273 (2017); DCE: Agriculture (<http://envs.au.dk>). UNFCCC: National Inventory Submissions 2016; Statistics Denmark national accounts; EIONET. Central Data Repository: A. National emission inventories (CLRTAP).



The long-term objective is to meet the world's growing protein need – produced with a minimal climate footprint and the best possible nutritional quality

#### **Early implementation of new solutions**

Denmark's leading universities have large departments that are dedicated to developing knowledge and solutions for sustainable food production. The strong ties between universities and companies enable the testing of new products from an early stage, shortening their route to market. Through its broad participation in development projects, the farmer owned agricultural knowledge centre SEGES helps to bring the latest knowledge and technology to farmers as quickly and efficiently as possible.

#### **Partnerships for protein innovation**

When it comes to developing new opportunities for sustainable food production, many research areas are in focus. One important area is the exploratory work with alternative protein sources, both for use in animal feed and for direct human consumption. For example, a project involving several Danish companies and the Technical University of Denmark is underway to find a profitable way to extract protein from grass and use it as a food ingredient.

A new advanced biorefinery has also been inaugurated at Aarhus University, with the support of several Danish food and agricultural companies and public investment. The focus is feed production - a grass concentrate for pigs and a fibre fraction for cows.

The long-term objective is to meet the world's growing protein need – produced with a minimal climate footprint and the best possible nutritional quality.

This transition is supported by a new partnership – Danish Protein Innovation - consisting of organisations, companies and knowledge institutions. Here, the aim is to strengthen research and development in support of sustainable protein production for feed, food and high-value products.

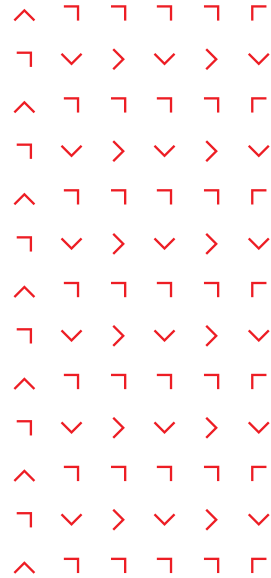
At the same time, Denmark has a strong focus on importing raw materials for sustainable livestock and food production. Close collaboration between the Danish government and the food and agriculture sector promotes the procurement of certified sustainable soya and palm oil. Sustainability certification ensures production is socially fair, economically viable and environmentally sound - with no deforestation.

#### **Ambitious food research and innovation strategy**

In 2017, the Danish Food and Drink Federation, the Danish Agriculture & Food Council and private companies drew up a new food research and innovation strategy that sets out Denmark's vision up to 2030 and beyond. The objective is to convert future research and innovation challenges into opportunities that will both benefit global society and keep the Danish food sector at the forefront when producing foods, ingredients, process equipment and services, and developing the industry per se.



# EFFICIENT SPREADING TECHNOLOGY MAKES MANURE A SAFE CHOICE



Livestock manure ought to be the most natural fertiliser in the world. Yet, concerns about nutrient runoff into sensitive waterways and greenhouse gas emissions have often made it a controversial issue.

Spreading technology enables farmers to use livestock manure as a highly efficient fertiliser with low environmental impact

For Denmark-based supplier of agricultural solutions SAMSON AGRO, it was a high priority to turn the problem around. The company was sure the right spreading strategy was the solution – enabling farmers to cut their use of chemical fertilisers.

That was a few years ago. Today, SAMSON AGRO has a well-established cooperation with farmer consultants and researchers from Danish agricultural advisory DLBR, the Danish Technological Institute and Danish universities. Together, they have developed new spreading technology and expertise that enable farmers to make the very best use of livestock manure as a natural and highly efficient fertiliser with low environmental impact.



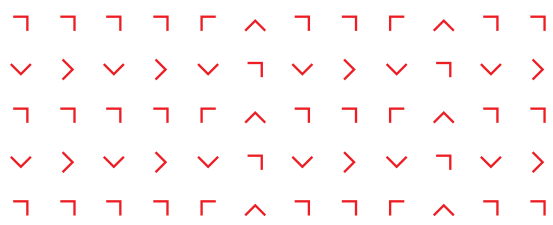
Photo: Samson Agro

The basic advice boils down to a few simple points: analyse the nutrient content of the manure; control the flow for even spreading; and apply the nutrients as close to the roots as possible.

It means that, used in the right way, farmers can rely almost entirely on manure to return vital nutrients to their fields, minimising or even eliminating their need for expensive chemical fertilisers.

SAMSON AGRO has not stopped here. The collaboration continues to develop ever-better technology for responsible and efficient use of the world's most natural fertiliser.

## Case by SAMSON AGRO



# NEW METHOD REVEALS BUSINESS POTENTIAL IN WASTE

What happens to the leftovers when potatoes and seaweed are used as raw materials for food ingredients such as starch, alginate and carrageenan? Until recently, such side streams have either been sold off cheaply for animal feed or been disposed of as waste.

But now scientists from the Technical University of Denmark (DTU) and Aalborg University are working with five Danish companies on a new method that can scan side streams for valuable proteins with functional potential.

Based on modern bioinformatics, the method has already identified useful emulsifiers in potato protein. Many other opportunities exist to obtain flavourings and preservatives from protein-containing waste materials.

Scientists are developing a method that can scan side streams for valuable proteins with functional potential

Apart from optimising raw material utilisation, protein extraction makes excellent business sense - increasing the value of side streams by a thousand-fold. The fact that the new additives come from proteins which have been in the food chain for centuries also meets the growing consumer demand for natural functional ingredients.

The method is not limited to potatoes and seaweed but can be used to scan any protein-containing crop or side stream.

**Case by DTU and Aalborg University**



Photo: DTU

# ALTERNATIVE PROTEIN FROM THE LOCAL CLOVER FIELDS

A new biorefining technique has unlocked the high protein content of Danish clover grass and will soon make it available in feed for organic pork and poultry producers.

Containing more than 40% protein and all the right amino acids, clover grass has great potential as locally sourced nutrition feed. Results from livestock feeding trials have proven that the extracted protein is an efficient alternative to soya meal in pig and poultry feed.

The technique has been co-developed by research partners from the private and public sector and involves squeezing large amounts of freshly and finely cut clover grass in a screw press. The juice is then transferred to an acid tank, heated and fermented using a lactic acid culture.

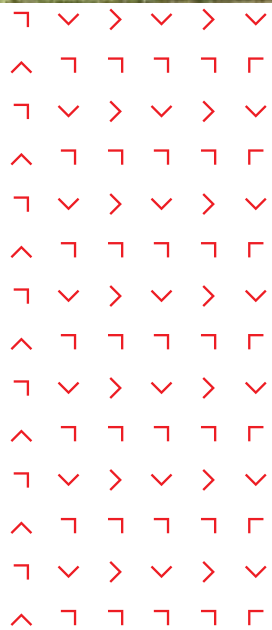
Concentrated protein is removed from the juice by centrifugation. Residues from production can also be used to feed cows and fuel biogas plants.

Once ready for commercial launch, the green protein feed will provide organic and conventional farmers with an additional, locally produced supply of essential nutrients for their livestock.



Photo: SEGES, Danish Agricultural & Food Council

Containing more than 40% protein and all the right amino acids, green herbage has great potential as locally sourced nutrition



**Case by SEGES**

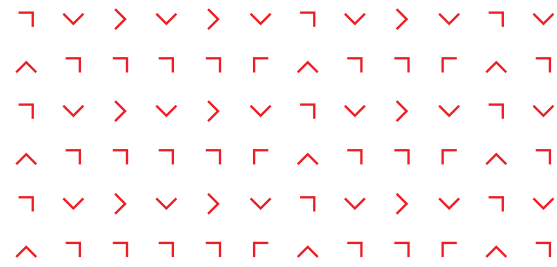
**Danish Agriculture & Food Council F.m.b.A.**

An aerial photograph of a tractor in a green field. The tractor is moving from the bottom center towards the middle of the frame, leaving a dark, muddy trail behind it. A large, wide, white water spray is directed from the left side of the frame towards the tractor. The field is filled with rows of green crops. In the background, there are trees and a line of utility poles under a grey, overcast sky. The text is overlaid on the top left and top center of the image.

**CHAPTER 2**

**EFFICIENT AGRICULTURE  
WITH A SUSTAINABLE  
MINDSET**

**TAKING THE INITIATIVE ON FARMING WITH  
AN ENVIRONMENTAL FOCUS**



## Generations of Danish farmers have protected their livelihood by taking good care of their livestock and natural surroundings. Today they are role models for efficient farming around the world.

Denmark's farmers are known for being among the most climate-efficient in the world – a position they aim to maintain while inspiring other countries to follow suit. Across generations, they have made a virtue of maximising and recirculating resources to the benefit of nature and the environment. Targeted breeding, optimised feed efficiency, improved plant varieties, better soil care, the establishment of wetlands and best practices for handling manure – the list of initiatives goes on.

Notable achievements include the fact that greenhouse gas emissions from Danish milk production are among the lowest per litre in Europe, closely followed by emissions from the production of Danish beef when measuring pr. produced unit. Another is that Denmark today produces around 50% of all grass and clover seeds in the EU and 25% of world exports. Among climate-friendly crops, grass seed production is hard to beat due to the natural binding of carbon dioxide in the soil with minimal nitrogen leaching.

**Advanced technologies improve yield and quality of crops - all of which benefit farmers' bottom lines**

When it comes to renewable energy, farmers are a major supplier of solar and wind energy, manure for biogas production and fast-growing willow, poplar and straw for district heating.

### **Precision technology in the field**

Danish farmers are also frontrunners within precision farming, using satellites and drones to localise specific growth areas that require attention or to optimise fertilising, seed sowing and water use. Advanced GPS systems steer agricultural equipment with centimetre accuracy.



For the growing number of farmers who make use of these advanced technologies, the bottom-line benefits stand out in the improved yield and quality of their crops. Due to more efficient use of input factors, precision farming also means a reduced foot print in relation to climate and the environment.

### **Microbial solutions from nature**

In many agricultural regions, crop yields are already at high levels, and climate change is a growing stress factor. That calls for innovative solutions if agricultural productivity is to be further improved. One promising approach comes from nature itself in the form of the microbial communities that live in, on and around plants.

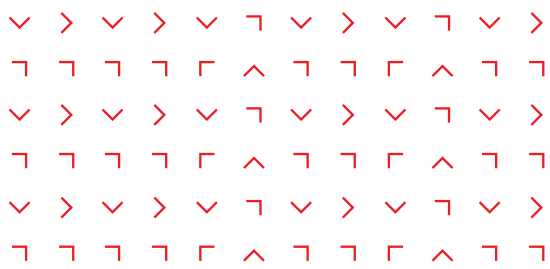
Danish bioscience company Chr. Hansen has used these natural microbes in the development of natural solutions that help plants withstand heat, drought and diseases. In a similar way, the company's probiotics for pigs, poultry and cattle promote a stable digestive tract, increase nutrient availability and reduce pathogen load – facilitating healthy and efficient livestock production.

### **Minimal use of pesticides and antibiotics**

A direct result of the ongoing commitment to reducing pesticide use is that Danish fruit and vegetables have a significantly lower content of pesticide residues than products from other European countries – and, importantly, that Danish ground water is safe to drink. Pesticide traces are continuously monitored by the Danish Veterinary and Food Administration and Technical University of Denmark, which produce an annual report.

Likewise, testing by the Danish Veterinary and Food Administration confirms that the use of antibiotics in Danish dairy, poultry and pork production is among the lowest in Europe.

The drive to cut the use of pesticides has direct positive consequences for the environment – promoting biodiversity and water quality. Reduced use of antibiotics has a similarly positive impact on human health by lowering the risk of antibiotic-resistant bacteria.



# DAIRY FARMING WITH A LOWER CARBON FOOTPRINT



Photo: Arla Foods

Reducing the carbon footprint of dairy farming is an important priority. This is why the global dairy cooperative Arla Foods offers a free climate check to its farmer owners. The climate check helps the farmers identify opportunities to optimise energy consumption, feed efficiency, manure handling and feed production.

Most of the climate check recommendations lead to cost savings. For example, heat from fresh milk can be recycled to heat the farmhouse.

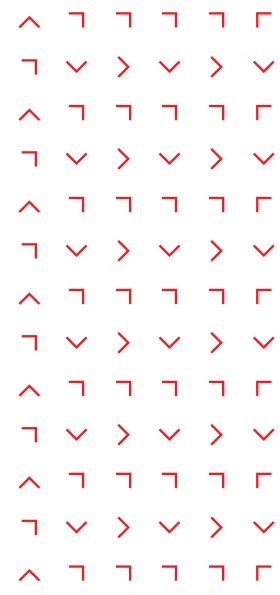
Many Arla farmers produce renewable electricity based on solar, wind or biogas. The amount produced is comparable to 61% of the annual use on an average farm. This and other initiatives have reduced the climate impact of milk production significantly over the years. In fact, since 1990, good farm management has saved the world from 1.7 million tonnes of CO<sub>2</sub> equivalents a year – a 25% reduction.

Climate check recommendations leads to cost savings for the farmer

Through the climate check programme, farmers can benchmark their overall performance and gain inspiration from other farmers for continuous improvements.

Arla is also exploring how to mitigate climate change through carbon sequestration, where CO<sub>2</sub> is removed from the atmosphere and stored in the soil. A joint project with other companies is underway to establish a method for measuring CO<sub>2</sub> recapture on dairy farms.

**Case by Arla Foods**



# CLIMATE BOOST FOR POPULAR POULTRY

Poultry has become the consumer's favourite meat on markets around the world. A source of easily digestible proteins with a comparatively low climate impact, it is ideal for consumers who seek out high quality and affordable food as part of a balanced diet.

In OECD countries alone, poultry consumption has risen more than 70% since 1990 and, as global demand continues to grow, new solutions are required to produce poultry more efficiently and sustainably.

**The enzymatic product enables farmers to produce 3% more meat from the same amount of feed**

Novozymes, a world leader in biological solutions, has taken the matter in hand in partnership with DSM, a producer of animal nutrition products. Together, they have developed and tested a new enzymatic product with a positive impact on the growth of broilers.

The enzymatic product works by improving the functionality of chicken guts – enabling farmers to produce 3% more meat from the same amount of feed. And the potential CO<sub>2</sub> savings are huge. If the product is used in all broiler feed throughout Latin America, for example, the reduction in CO<sub>2</sub> could reach the equivalent of 500,000 Brazilian people's annual emissions. Inclusion in broiler feed

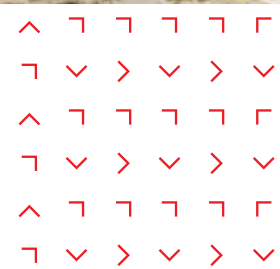
across the entire American continent would mean a CO<sub>2</sub> reduction of around 4.2 million tons a year.

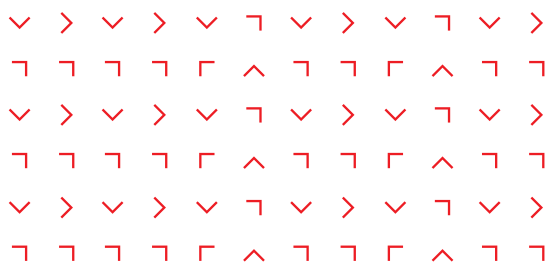
As feed accounts for around 70% of total production costs, farmers can look forward to significant financial savings too.

## Case by Novozymes



Photo: Novozymes





# BREEDING COWS FOR A FIRST-CLASS PERFORMANCE



Photo: VikingGenetics

A Danish Holstein cow produces around 10,300 litres of milk a year. The global average is just 2,200 litres

Nothing is left to chance when VikingGenetics develops solutions for breeding some of the most productive cattle in the world. This explains why a Danish Holstein cow produces around 10,300 litres of milk a year – more than four times the global average. Today, Danish Holsteins represent more than 70% of Denmark’s dairy cow population.

All breeding solutions are based on the Nordic Total Merit (NTM) index, which combines genetic traits that are heritable when mating bulls and cows. Animal welfare and production efficiency top the list of priorities.

When measured for productivity, VikingGenetics’ solutions are high scorers. For every ten units on the NTM index, farmers can expect an additional 100 EUR per cow in annual revenue. Cows scoring 40+ rank among the world’s best 2.5%.

That makes an important difference to the farmer and the environment. Improved productivity per cow enables farmers to increase milk volumes without increasing the size of the herd and with no additional environmental impact.

**Case by VikingGenetics**



# DANISH KNOW-HOW DEVELOP CHINESE PIG PRODUCTION

Pork consumption is rising in China, where each citizen now consumes on average 30kg of pork meat a year – closing in on the 40kg per capita average in the EU. For Chinese pig farmers, the trend has created an urgent need to improve efficiency so they can keep up with demand.

All eyes have been on Denmark to help the Chinese achieve that, drawing on the sustainable agricultural methods that make Danish sows twice as productive as the Chinese standard and much less prone to disease.

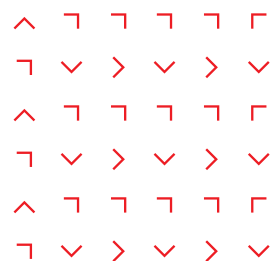
**Danish agricultural methods can make Chinese sows more productive and much less prone to disease**

Since 2014, a partnership between the Danish agricultural cooperative DLG and the Chinese feed company Puai Feed Group has supported China's transition from small-scale farms to larger, more productive and climate-friendly businesses.

The partnership combines Puai Feed Group's in-depth market knowledge and production facilities with DLG's long-standing expertise in producing and supplying feed to the world's most quality-conscious customers: the Danish farmers.

Today, Puai Feed Group has gained a leading market position through its ability to deliver high-quality compound feed to the large Chinese livestock industry. As a result, pig producers can now look forward to healthier animals, lower mortality rates and more efficient production overall.

**Case by DLG**

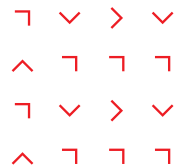




CHAPTER 3

# SUSTAINABLE FOOD PROCESSES ARE A PROACTIVE CHOICE

THE UNITED MOVE TOWARDS  
SMARTER PRODUCTION



## Denmark's food manufacturers invest heavily in sustainable energy, water and packaging solutions without compromising on quality and food safety. Resource-efficient production is a hallmark of responsible business.

Wherever you look in the Danish food industry, targeted efforts are underway to improve energy and water efficiency in production and distribution and explore new opportunities for sustainable food packaging. There are many good examples to highlight.

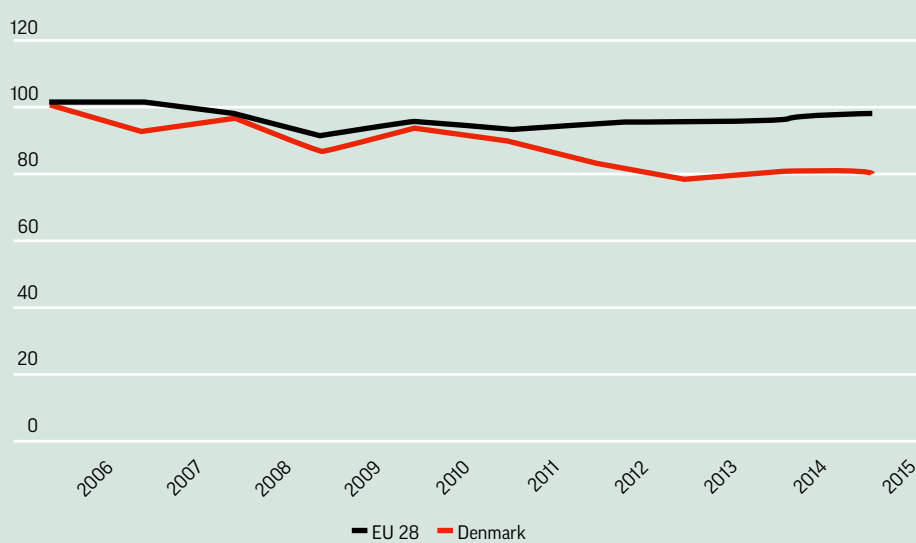
Since 2006 the share of renewable energy has increased more than threefold

Two of them are the large agricultural suppliers DLG and Danish Agro. DLG is gradually replacing its truck fleet with more fuel-efficient models and building high-efficiency production facilities. Results include an 80% reduction in energy consumption at an existing feed factory. At Danish Agro, recent investments have focused on the construction of a new biofuel plant and the training of truck drivers in eco-friendly driving.

Danish Crown operates Northern Europe's largest pork processing facility in Denmark. Here, a new demand-driven ventilation system for drying equipment after cleaning has reduced electricity consumption for the drying process by 90%. Reclaimed process heat is used in production during the day and for heating cleaning water at night, covering 40% of total heating needs.

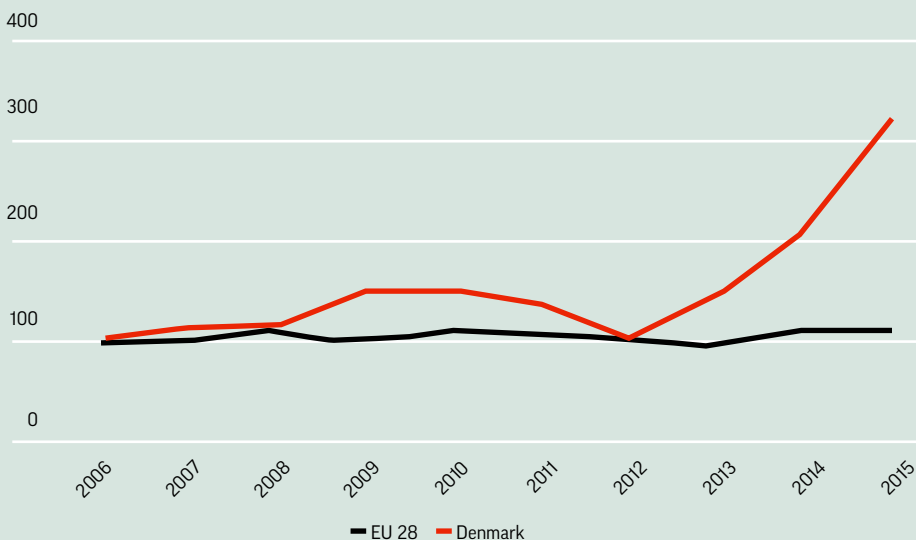
Altogether, the food industry's combined efficiency improvements have reduced total energy consumption by 20% since 2006. Over the same period, the share of renewable energy has increased more than threefold.

### Development in total energy consumption in the food processing industry in Denmark and EU-28 (2006=index 100)

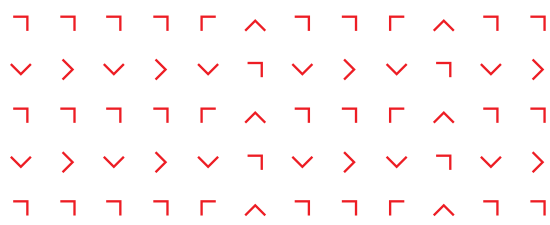


Note: The food processing industry includes the tobacco industry  
Source: Eurostat

### Development in the total use of renewable energy in the food processing industry in Denmark and EU-28 (2006=index 100)



Note: The food processing industry includes the tobacco industry  
Source: Eurostat



### **Water-efficient food production**

Over the years, Danish slaughterhouses, breweries and dairies, among others, have worked hard to reduce their water consumption. Ongoing improvements in slaughterhouses, for instance, have reduced water consumption from 600 litres per pig in the 1980s to 150 litres today. However, as the need to protect this valuable resource becomes increasingly urgent, it has become clear that more must be done. In response, major innovation projects have been launched to develop new sustainable technology for minimising water consumption by the food industry at large.



The Danish Partnership for Resource and Water-Efficient Industrial Food Production (DRIP) is one such project. Comprising food companies, technology suppliers, universities and research institutions, the public-private partnership aims to develop technology to reduce groundwater consumption and increase the use of purified recycled water. The overall goal is to reduce the amount of water used in Danish food processing by 15 to 30% - without, at any point, putting food quality and food safety at risk.

All solutions are to be tested in pilot or full-scale at food production plants, with impressive outcomes already achieved.

### **The race for sustainable packaging**

Today, one of the biggest environmental challenges is waste from single-use plastic packaging. In the race to find sustainable alternatives, many Danish food companies are engaged in designing reusable, recyclable or biodegradable packaging that can both keep food fresh and safe and comply with the strict requirements for food contact materials.

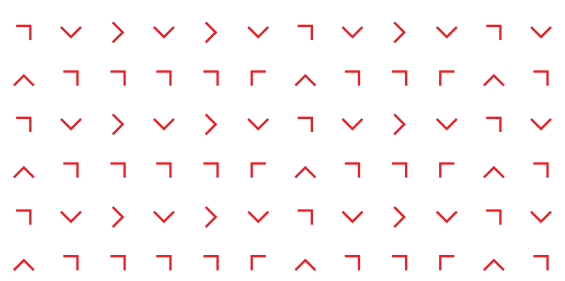
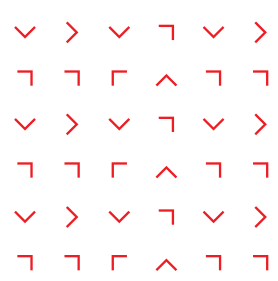
Arla Foods, for example, has removed a layer of material from its FSC-certified milk carton and replaced the fossil-based plastic with bio-based. Compared to the previous design, the new carton has a carbon footprint that is about 20% lower.

Fishing company Royal Greenland has also halved CO<sub>2</sub> emissions by changing the way loaded pallets are shipped from Greenland to industrial customers. In the new packaging system, cardboard containers, which can be reused up to 20 times, have replaced single-use boxes.

At Danish Crown, the 55 million meat trays sold each year to Danish consumers are now made from 80% environmentally-friendly PET plastic, which can be recycled as food packaging. The switch to PET plastic means CO<sub>2</sub> emissions are halved for each tray that is recycled.

Ever since 1922, Denmark has operated a deposit and return system which ensures that nine out of ten deposit-marked bottles and cans are returned and recycled. In 2018, Danish brewers set a new goal, the most ambitious yet for plastic bottles in Europe: that they should contain at least 50% recycled plastic by 2025.





# BREWERY PROGRESS TOWARDS ZERO EMISSIONS



The Snap Pack is one of the initiatives in the Carlsberg Together Towards ZERO global sustainability programme, which has set four ambitions for 2030: ZERO carbon footprint, ZERO water waste, ZERO irresponsible drinking and a ZERO accidents culture.

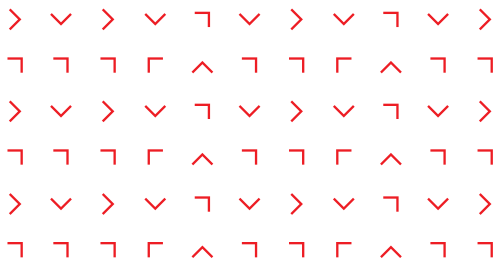
Today, the brewery uses on average 3.1 litres of water per litre of beer produced – the lowest in the beverage industry

Carlsberg is making good progress towards the goals. One brewery is already running on 100% carbon-neutral energy. The brewery is powered by green electricity and biogas, with 25% generated by the brewery's own wastewater - and there are more to come.

Another example is the target to cut Carlsberg's water consumption 50% by 2030 through the use of advanced water technologies. Today, the brewery uses on average 3.1 litres of water per litre of beer produced – the lowest in the beverage industry. The aim is to reduce water use to 1.7 litres per litre of beer by 2030.

Gone are the plastic ring can holders and shrink plastic on multipacks of Carlsberg beer in Denmark, Norway and the UK. Drawing on glue technology and fruitful partnerships, Carlsberg has introduced the Snap Pack, a new minimalist approach to holding beer cans together. The concept is expected to cut plastic waste by more than 1,200 tonnes a year – a reduction of up to 76% compared to traditional multipack packaging.

**Case by Carlsberg**



# CLEAN CHICKEN FEET WITH HALF THE WATER

Danish meat processor HKScan has found that saving water and energy is sometimes surprisingly easy. In its poultry abattoir business, the company has cut water consumption by 100 cubic metres a day on its chicken feet line, simply by reversing the water flow. A lower water temperature has also brought daily energy savings.

Chicken feet are big business. But, before the feet can be packed and exported, they are exposed to a lot of water, both to soften them so the skin can be removed and for cooling.

**The new approach has cut daily water usage on the chicken feet line by 50%**



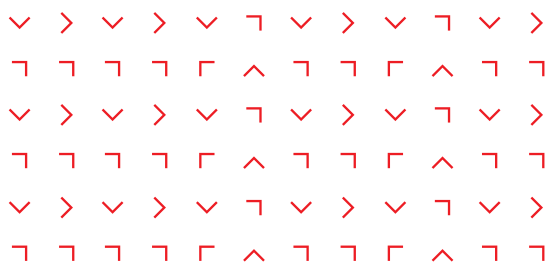
In the past, clean water was used for every processing step and then sent to the factory's wastewater treatment facility. Now, by pumping counter-clockwise, the water is moved from the clean cooling process to the earlier dirty processes.

The new approach has cut daily water usage on the chicken feet line by 50%, equivalent to 7% of the factory's overall water consumption.

Furthermore, in the skin removal process, HKScan found that they could lower the water temperature from 55°C to 35°C at no expense to hygiene or product quality, cutting energy costs by EUR 100 a day.

For HKScan, their efficiency project has been a real eye-opener - and an inspiration for many other improvements, which are now underway.

**Case by HKScan**



# SAFER PACKAGING ADDITIVES FROM A SUSTAINABLE SOURCE



Sustainable vegetable-based emulsifiers from Danish ingredient company Palsgaard are making inroads in the plastic packaging industry as alternatives to conventional additives.

The emulsifiers have various functions. In polyethylene film, they act as an anti-fogging agent so chilled food products in trays continue to look appealing and maintain their quality for longer, resulting in reduced food waste. In other applications, the emulsifiers serve as anti-static agents and dispersing aids.

Because these bio-based additives are safe enough to eat, they are a simple answer to concerns about additive migration from packaging into foods. Compared to conventional plastic additives, they also deliver improved performance, faster production runs and better cost-in-use.

Good news for producers of food wrap, film and packaging who have safety, sustainability and long-term business viability high on their agendas.

Sustainable vegetable-based emulsifiers maintain food quality for longer, reducing food waste

**Case by Palsgaard**



# ON-SHORE FISH FARM IS A GAME-CHANGER

Fish is tasty, nutritious and in growing demand. Amid rising concerns about overfishing, Sashimi Royal is helping Denmark lead the way with innovative solutions.

At its on-shore fish production facilities, the company has become the first large-scale producer of the warm-water yellowtail kingfish in Northern Europe – taking the pressure off wild fish stocks and reducing the environmental burden and cost of transportation.

95% of the water is recirculated at the Danish on-shore fish farm

Precise temperature and salinity control at the plant provides the particular water characteristics that the popular fish requires. These conditions also ensure parasite-free production without the use of antibiotics, vaccines or artificial additives, making the fish ideal for raw consumption in sushi and sashimi dishes.

As 95% of the water is recirculated, the Danish production is among the most environmentally friendly in the world.

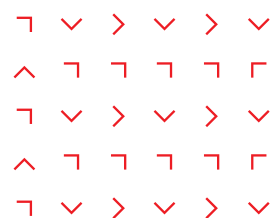
The Sashimi Royal facilities represent a game-changer in on-shore fish farming. Eventually, the plant will produce up to 5,000 tonnes of fish a year, making it the largest on-shore fish farm in Europe.

With forecasts now predicting a 23 million ton increase in fish consumption in the decade ahead, on-shore farms are poised to play a key role in assuring tomorrow's sustainable supplies.

## Case by Sashimi Royal



Photo: Sashimi Royal

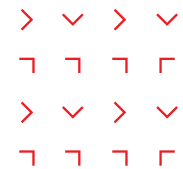




**CHAPTER 4**

# **FIRM ROOTS IN THE CIRCULAR BIOECONOMY**

**RESOURCEFUL SOLUTIONS FOR A WORLD IN BALANCE**



## Responsible management of limited resources comes naturally in the Danish food industry, where a circular value chain and upcycled side streams are the heart of good business.

As the world population grows, the earth's resources are coming under increasing pressure. Resource extraction and consumption and subsequent waste disposal are a strain on the environment. And, while biological raw materials can largely replace mineral-based ones, the challenge we face is to produce sufficient food of good quality and sustainable biomass to meet demand.

In the future, our prosperity and welfare will depend on our ability to utilise and recycle non-renewable resources. Circular and bio-based solutions are vital for restoring the climate and environmental balance and can be combined in the circular economy.

### Generations of practical innovation

The Danish food sector is already a circular bioeconomy frontrunner – skilled in making the very best use of each part of a raw material and, finally, returning any remaining nutrients to the soil as a natural fertiliser.

For generations, the food industry has developed practical and efficient solutions that make the most of resources without depleting them. So, today, it is only natural to seek the most resourceful solutions – with mini-

mum loss and waste throughout the supply chain from field to consumer – and make good business out of them.

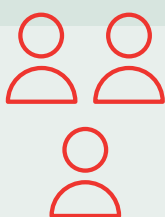
Both primary producers and food manufacturers focus on using side streams, for example, for the production of biogas, livestock feed or agricultural fertilisers. At the same time, companies throughout the value chain work closely with scientists to develop new processes and technology to the benefit of the industry at large. Cascade utilisation ensures side-stream components are extracted in order of value, from highest to lowest, before being turned into ingredients, medicine and dietary supplements.

Circular and bio-based solutions are vital for restoring the climate and environmental balance

## THE CIRCULAR VALUE CHAIN



Nothing is wasted in the food processing industry. Side streams become feed, energy, medicine and more. For example, slaughterhouse waste is used for biogas production; spent grain from beer brewing goes to animal feed; and whey from cheese production is upgraded to valuable whey proteins.



70% of EU food waste occurs at household, food service or retail level (FUSIONS, 2016). Safe means of reducing and sorting food waste is important to return nutrients and biomass to the biological cycle, for example as biofertiliser or biogas.



Primary producers focus on increasing crop yield, optimising feed efficiency and the circular utilisation of resources. For example, nutrients in manure are returned to the field and excess milk is used to feed calves.

# PIGS DELIVER ESSENTIAL MEDICAL INGREDIENTS



Photo: Danish Crown

Everything has value at the slaughterhouses of Danish Crown, where as much of every animal as possible is processed into foods for consumers around the world. Residual side streams are upgraded for use in livestock feed or biogas production – or as high-value products for the pharmaceutical industry.

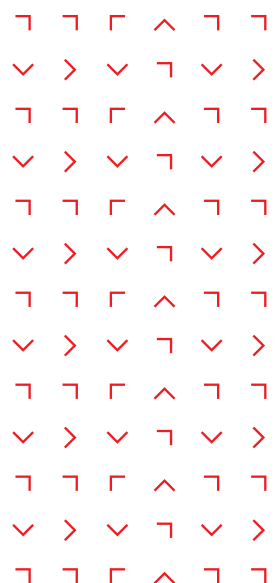
Not all value is visible to the naked eye. Few may be aware, for example, that the mucous membranes of pig intestines are a source of heparin, a polysaccharide widely used in anticoagulant drugs and named by the World Health Organisation as an essential medicine.

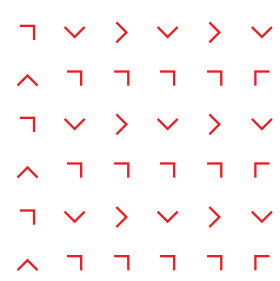
The content of heparin in the intestines is miniscule. From the 60 tons of mucosa obtained from the 32,000 pigs that pass through Danish slaughterhouses every day, it is only possible to extract 10kg of raw heparin.

Nevertheless, the stable demand from the global pharmaceutical industry has made heparin a valuable venture for Danish Crown subsidiary DAT-Schaub.

Residual side streams are upgraded for use in livestock feed, biogas production or the pharmaceutical industry

**Case by Danish Crown and DAT-Schaub**





# FROM FOOD WASTE TO GREEN ENERGY

Food waste has become a profitable business for Daka Denmark. Since 2012, a novel initiative – Daka ReFood – has run a food waste collection service for supermarkets, food producers, canteens, hotels and restaurants. While used cooking oil is recycled as biodiesel, all other waste is used for the production of biogas.

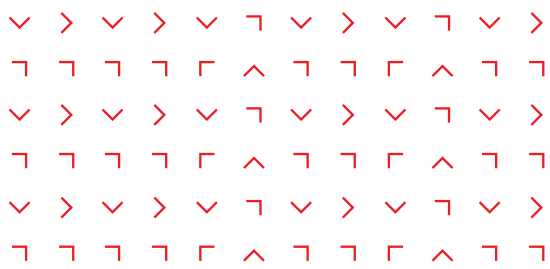
Daka ReFood also advises customers on how to sort food waste correctly and has launched a ReFood label in collaboration with the Danish Agriculture and Food Council and the Danish Stop Wasting Food organisation. The label is a green seal of approval for organisations, institutions and companies that make an active effort to reduce food waste and increase recycling.

Daka ReFood is a natural extension of Daka Denmark's established business, which is a circular bioeconomy role model. For decades, the company has received the animal by-products that slaughterhouses cannot sell, such as blood, ground bones and fat. These ingredients are the raw materials for feed products and biodiesel – a climate-friendly alternative to fossil fuels. Altogether, Daka Denmark produces 55 million litres of biodiesel a year.



Animal by-products from slaughterhouses are used as the raw materials for feed products and biodiesel

**Case by DAKA Denmark**



# UPCYCLED BREWERY GRAIN BECOMES A POPULAR BISCUIT



Photo: Bisca

Spent grain leftovers from beer production are typically sent to farmers for use in animal feed. But on the small Danish island of Møn, the local brewery wanted to use the spent grain for a higher purpose. They found the value-added answer in collaboration with biscuit producer Bisca.

Instead of sending grain waste to local farms, Møn Brewery now sends the by-product of its beer production to its partners at the Bisca factory. The outcome is a delicious new line of Møn biscuits – great for serving with fine cheese and a glass of the local brew.

The brewery produces 66,000 gallons of beer a year. That provides enough spent grain for Bisca to maintain steady production of its biscuit line, which has rapidly become a hit with consumers. A good example of how local collaboration can create more value with less input and support the circular economy.

**Case by Bisca and Møn Brewery**

The biscuit stands as an example of how local collaboration can increase product quality and enhance a circular economy

# USING THE POWER OF THE POTATO

Danish potato farmers comply with some of the toughest environmental regulations in the world. So when farmer-owned cooperative KMC uses their harvest to make potato-based ingredients, their biggest responsibility is to create as much value as possible from every single part – from the potato starch to the protein and fibre and the mineral-containing juice.

Since its founding in 1933, KMC has specialised in producing functional ingredients from potato starch for a wide range of food products.

Today, side streams of that production – the protein and fibre – are also finding their way into higher-value applications in the food industry. The fibre is an excellent water-binder, while the protein has a balanced content of nutritious amino acids.

Every single part of the potato is used - from the potato starch to the protein and fibre and the mineral-containing juice

In the past, the side streams were mainly sold for use in animal feed. Now only the juice goes back to the fields, where the remaining goodness nourishes the soil. In KMC's circular supply chain, nothing goes to waste.

## Case by KMC

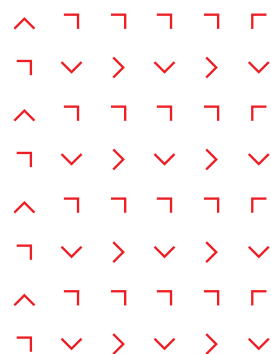


Photo: KMC

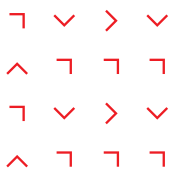
A woman with dark hair in a bun, wearing a light blue shirt and a woven basket, stands on the left holding a bunch of fresh carrots. A young girl with blonde hair, wearing a grey jumpsuit, sits on a wooden bench on the right, holding a large green vegetable with a yellow filling. The background is dark and out of focus.

**CHAPTER 5**

**THE CONSCIOUS  
CONSUMER'S PANTRY  
OF CHOICE**

**A LAND OF OPPORTUNITIES TO MAKE  
A SUSTAINABLE DIFFERENCE**





## Agenda-setting consumers demand healthy, safe and high-quality food, produced with minimal environmental impact. The Danish food cluster is ready to deliver.

Consumers worldwide focus on food quality and safety, healthy nutrition and wellbeing. At the same time, still more consumers want a sustainable lifestyle while making a difference through their purchasing choices and consumption habits.

Such concerns are stimulating an increased interest in organic products, plant-based meals and snacks and foods with a high content of protein. Locally grown seasonal raw materials have also earned a place in the spotlight as consumers are increasingly on the lookout for opportunities to reduce food waste.

The Danish food sector has already come a long way with meeting these demands and becoming the pantry of choice for the conscious consumer. Food ingredient companies, for example, can offer innovative solutions for protein-rich and low-fat diets and natural food protection, which ensures both food safety and shelf life.

Personalised nutrition, which targets specific consumer needs, for example among elderly people, is a subject of growing attention. Co-development efforts that pool the knowledge and expertise of Danish ingredient companies with the specialist know-how of the pharma and medical industries have great potential in this respect - with a constant focus on sustainable solutions.

### An organic world leader

It is no coincidence that Denmark is the home of the world's largest organic dairy company and Europe's biggest organic meat company, exporting organic pork and beef all over the world. Denmark was the first country in the world to draw up regulations for organic production, the first to introduce national organic standards and the first to launch an organic label, which, today, is recognised by nearly all Danes.

In addition to their success with organic dairy and meat products, Danish companies are widely recognised in the global market for organic eggs, grain and vegetables.

Consumer desire for more sustainable convenience foods has become an important driver of organic food innovation. This is why Denmark's organic retail market is the biggest in the world in terms of purchases per capita. More than 2,900 professional kitchens, including restaurants, hotels and canteens, have also taken the organic mindset on board and qualified for an official Organic Cuisine Label in recognition of their efforts.

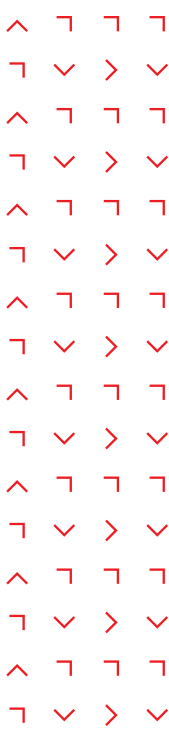
### Inspiring sustainable cuisine

Creative use of natural, locally sourced and seasonal raw materials is a core principle of the New Nordic Cuisine that has put Denmark on the gastronomic world map. Ever

since a group of visionary chefs joined forces to create a new Nordic food manifesto in 2004, high quality and sustainability have come together.

The principles they established are now visible throughout the Danish culinary world and internationally - a great source of inspiration for consumers, retailers and food manufacturers alike. Out of the New Nordic movement, a new market for sustainable, gourmet products has grown for consumers to buy and enjoy with a good conscience.

Consumer desire for more sustainable convenience foods has become an important driver of organic food innovation



# NATURAL FOOD CULTURE KEEPS YOGHURT FRESH AND SAFE



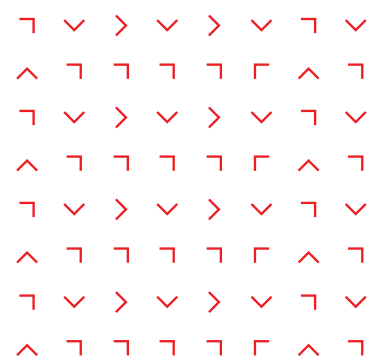
It's an uncomfortable truth that 17% of all yoghurt in Europe ends up in the bin - the outcome of a relatively short shelf life. The challenge manufacturers face is how to delay the onset of spoilage for a few more days, so yoghurt is less likely to end up as food waste.

The potential in Europe alone  
is a 30% reduction in wasted  
yoghurt

Danish bioscience company Chr. Hansen has developed an efficient solution - a range of natural lactic acid bacteria cultures that reduce the risk of yeast and mould spoilage and help increase yoghurt shelf life by at least seven days. The potential in Europe alone is a 30% reduction in wasted yoghurt.

Food cultures that enhance food safety, extend shelf life and reduce food waste have become a Chr. Hansen speciality over the years - and not just for dairy products. The company's well-documented portfolio also includes lactic acid bacteria cultures for natural food protection of meat, fish and ready-to-eat salads.

**Case by Chr. Hansen**



# THE LOVE OF THE FRENCH FOR FRILAND ORGANIC HAM

The story of Friland started in 1993 with a group of farmers who wanted to create an organic alternative to intensive pig production. The piglets were to be born in huts on free range pasture and raised with a strong focus on animal welfare and consideration for the pigs' natural behaviour.

Friland is Europe's biggest organic meat company, with responsibility, integrity and safety as the driving values

From early on, Friland cooperated with Animal Protection Denmark to develop the best framework for organic farming and conduct an annual audit of each farm. This is why, for over two decades now, all product labels have carried the statement 'Recommended by Animal Protection Denmark'.

Today, Friland is Europe's biggest organic meat company, where responsibility, integrity and safety are still the driving values.

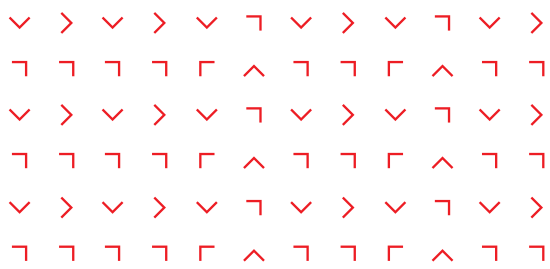
Friland's organic pigs are exported all over the world. However, the population of one food-loving, European country has a particular fondness for them - that's France, where Friland sends 44% of its exports.

The ham is especially popular among French consumers because of the high, state-controlled organic standard, the professionalism of the farmers and the reliable, uniform quality deliveries.



Photo: Friland

**Case by Friland**



# DAIRY PROJECT BUILDS FOOD CHAIN IN ETHIOPIA



Photo: Gain

Low-income families gain access to affordable dairy nutrition

One of the main issues many developing countries face is a lack of healthy and affordable food – especially for mothers and children. In Ethiopia, roughly four in ten children suffer from chronic malnutrition with negative consequences for their physical and mental development and immune system. Malnutrition is also bad for national finances, reducing GDP by an estimated 16%.

In a three-year project led by the GAIN Nordic Partnership, companies and organisations in Denmark and Ethiopia have co-developed an affordable nutritious yoghurt using local milk and Danish technology. Addition of a whey-vitamin mix aims to benefit child development and stimulate the economy.

The partnership supports the whole dairy value chain in a country with 11 million dairy cows. Farmers gain help to produce more and better milk and improve their incomes. Dairy processors receive more milk and can produce and sell innovative products, while low-income families gain access to affordable dairy nutrition.

The GAIN Nordic Ethiopia project is a collaboration between Arla Foods Ingredients, DanChurchAid, the Confederation of Danish Industry, DSM and Loni Dairy.

**Case by GAIN Nordic Partnership**

# FROM WINDFALL FRUIT TO PRIZE-WINNING CIDER

The Copenhagen suburbs are full of apple trees that, year after year, are laden with fruit. Back in 2011, two students with a passion for gastronomy realised that most of that fruit went to waste, left to rot on the ground.

Although their actual interest was directed towards wine, taking up cider production was literally right up their street: they started going from door to door asking garden owners if they could take some of their apples. This first batch of mixed garden windfall apples was the beginning of a real cider adventure.

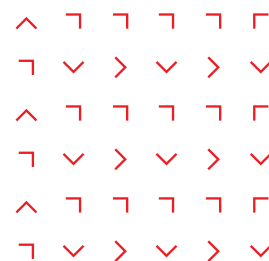
Danish fruit producers earn money for fruit that is otherwise hard to sell

The first year's harvest made 65 bottles, pressed, fermented and bottled in a small suburban garage. A Swedish Michelin restaurant bought the whole lot, and the two entrepreneurs realised their ability to supplement the wine lists of gourmet restaurants with a taste profile that matched the New Nordic Cuisine.

Today, their company is called Æblerov (Danish for apple scrumping) and produces more than 25,000 litres a year. Production as well as exports are in rapid growth. The cider is enjoyed in the Scandinavian and German markets so far, and interest is growing from the rest of the world.

Æblerov now produces most of its cider using fruit from organic plantations. Only the apples that are marked or otherwise unattractive to consumers are used. For Danish fruit producers, it is a welcome way to earn money for fruit that is otherwise hard to sell.

Case by Æblerov





**CHAPTER 6**

# **WORLD-CLASS INNOVATION FOR SUSTAINABLE SOLUTIONS**

**FIND OUT MORE FROM FOOD NATION**

## Guided by the UN Sustainable Development Goals, the Danish food cluster will continue to take the lead in producing more with less.

Yesterday's solutions provide few answers to tomorrow's challenges. Continuing innovation is essential to provide a reliable and accessible food supply for the world's growing population. To that end, food safety, health and nutrition and sustainable production will become even more important in the years ahead.

Mutually binding research and development partnerships are essential to fulfilling the UN Sustainable Development Goals. Denmark offers many examples of such collaboration – between partners in the public and private sector, between businesses and non-governmental organisations. Cross-sector teamwork between large and small stakeholders is underway in all regions of the country.



Mutually binding research and development partnerships are essential to fulfilling the UN sustainable development goals

It is through this commitment that world-class innovation takes shape, building the foundations for a sustainable food supply to nourish future generations.

### Food Nation

Food Nation is a non-profit partnership established by the Danish government and leading private organisations and companies. It is your gateway to information about the Danish food cluster and knowhow that can accelerate the growth of international businesses through better solutions, innovative products and trusting cooperation.

The Danish food cluster encompasses everything from primary production in agriculture and the fishing industry to the food products consumers buy in stores. Companies, universities, research institutes, local and

national authorities and other private and public organisations belong to the extensive, collaborative network. Together, they work hand-in-hand with international partners to maintain and improve food quality and safety along the value chain.

### Take an interactive tour

Food Nation's Visitor Centre in central Copenhagen welcomes international delegations, providing them with an introduction to Danish capabilities within food. An interactive installation at the centre gives visitors an up-to-date overview of the food value chain based on their individual interests. It is the ideal starting point before visiting Danish food producers and production facilities.

Food Nation is a great place to start learning about how Denmark can support sustainable development through collaboration. Find out more about our services, the Danish food sector and arranging a visit to the Food Nation visitor centre at [foodnationdenmark.dk](http://foodnationdenmark.dk)

**INGREDIENTS  
INDUSTRY**

Producers of enzymes,  
cultures and other ingredients

**PRIMARY  
PRODUCTION**

Agriculture, fishing  
& horticulture

**PROCESSING  
INDUSTRY**

Producers of food,  
beverages & animal feed

**The Danish food cluster**

Denmark is home to countless large,  
medium and small companies, research  
institutes and other organisations that  
make the country a European hotspot  
for innovative, sustainable food  
products, services and technology.

**RESEARCH  
& INNOVATION**

Research, education  
& counselling institutions

**FOOD  
TECHNOLOGY**

Producers of machines,  
technology & equipment

**GASTRONOMY  
& THE CONSUMER**

Retailers, consumers, restaurants,  
authorities, tourism & other  
related industries

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Confederation of Danish Industry



Danish Agriculture  
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