

By Denmark

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for solutions of tomorrow



FOOD QUALITY & SAFETY

WORLD-LEADING INNOVATION IN THE
DANISH FOOD CLUSTER

INSIDE THIS WHITE PAPER:

- Setting the standards for food safety control
- Quality and food safety assurance from farm to fork
- Technology supporting high-quality and hygienic production



Solutions of tomorrow
By Denmark

Food quality & safety

World-leading innovation in the Danish food cluster

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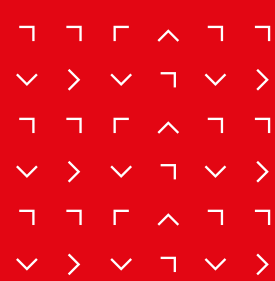
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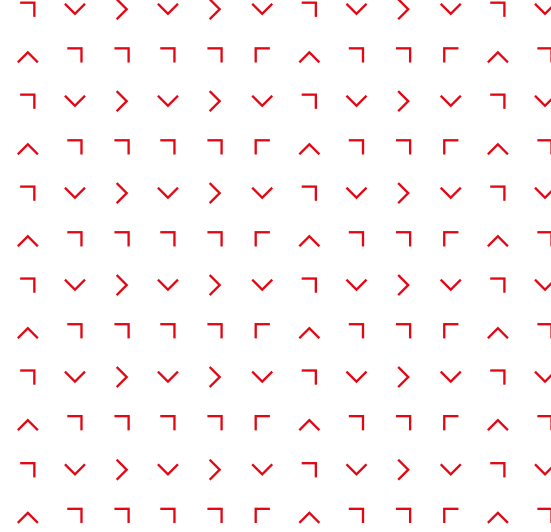
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EXECUTIVE SUMMARY



The global food supply is facing vast challenges: uneven distribution to consumers, the impact of climate change, undernutrition and overnutrition. As the population continues to grow, this raises an important question. How will we ensure a reliable supply of safe, high-quality food to consumers all over the world in the future?

This white paper is about Denmark's contribution to solving this challenge and to creating new business opportunities for international partners in the process.

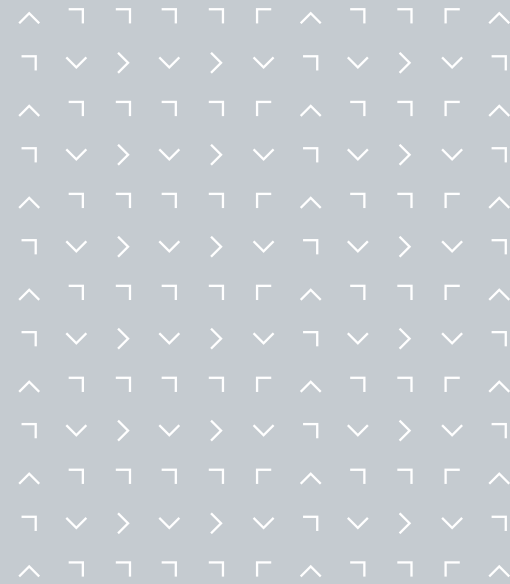
are also continuously improved. Today, they secure full traceability and transparency in the food value chain, enabling a fast response to any food safety threat.

Continuous research and development is key to maintaining Denmark's leading position on the international stage

Specialised food processing technology is another Danish strength. Essential to ensuring the efficiency and profitability of production, this technology takes food hygiene, quality and safety to new levels.

The Danish food cluster stands out for its culture of collaborative innovation. Primary producers work together to produce the very best raw materials for food production. Through their best practices, new international standards for quality and safety are often set. Danish quality assurance systems

Continuous research and development is key to maintaining Denmark's leading position on the international stage. With this in mind, a vision for world-class innovation has been set for 2030. The aim is to continue building on the strong foundations for producing safe, high-quality food – to the benefit of the country's international business partners and to consumers the world over.



INDEX

Foreword

Chapter 1 Facing up to the global food challenge

The responsibility to ensure safe, high-quality food for all

Chapter 2 Everything starts with the raw material

Investments in raw material quality and safety are the key to consumer trust

Chapter 3 Setting the standards for food safety control

Best practices at home lay the foundations for trusted exports

Chapter 4 Quality and food safety assurance from farm to fork

Cross-disciplinary collaboration monitors microorganisms and chemicals in food

Chapter 5 Technology supporting high-quality and hygienic production

Efficient processing and high-quality food are the hallmarks of Danish food production

Chapter 6 Innovation for a better and safer food supply

Research and innovation drive the solutions to global challenges

Chapter 7 Denmark – a leading nation for safe, high-quality food

Learn more about the Danish food cluster and its strongholds at Food Nation



Supporting the SDGs – how does Denmark contribute?

The UN's 17 sustainable development goals (SDGs) have become an important topic for companies, organisations and stakeholders within the Danish food cluster.

Many have pinpointed how they actively support the goals. At national level, we see the SDGs 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.

FOREWORD



Securing a safe, high quality food supply is the backbone of the Danish food industry. Cooperation and innovation holds the key to solve many of today's global challenges.

The growing global population is putting pressure on food producers to provide a sufficient supply of healthy, safe and accessible food. Finding solutions to this challenge has long been top priority for Danish authorities, businesses and universities and over the years, their joint efforts have raised international standards for food quality and safety.

Today, Denmark is a frontrunner when it comes to safe food production. We were the first country to introduce compulsory pasteurisation of milk, the first to ban trans fats in food production and one of the few countries granted special EU status as a producer of salmonella-free poultry.

To many global producers, Danish food manufacturing companies serve as an inspiration for safe and sustainable food production, using some of the market's most sophisticated equipment. Elsewhere in the value chain, Danish ingredient and technology companies help food producers ensure the uniform quality and safety of their products

that is demanded by the consumers. Others again have developed analytical tools for monitoring microbiological and chemical substances in primary food production. At government level, maintaining this leading position and developing new technologies and solutions are key areas of focus and investment. The goal, as always, is to innovate timely solutions that keep the Danish food cluster one step ahead of the global agenda.

The goal is to be one step ahead of the global agenda

I am proud that Danish contributions to food safety are in daily use, both at home and abroad. Here in Denmark, a continuous flow of new technology is available to increase production output and consolidate our position as a food safety leader. Abroad, our technology helps farmers and other food manufacturers take their food safety standards to new heights.

Denmark has bilateral cooperation agreements with many countries and is a proactive participant in the work of international standard-setting bodies, including the World Organization for Animal Health (OIE) and Codex Alimentarius.

This white paper covers our wide portfolio of food quality and safety competences. I am very pleased to share it with you and hope you will be inspired.



Jacob Jensen

Minister for Food, Agriculture and Fisheries



CHAPTER 1

**FACING UP TO
THE GLOBAL
FOOD CHALLENGE**

**THE RESPONSIBILITY TO ENSURE SAFE,
HIGH-QUALITY FOOD FOR ALL**

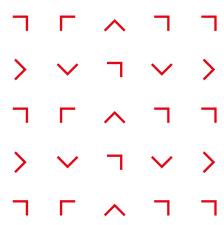


Photo: modpol

Population growth, climate change and food security have pushed food quality and safety higher up the global agenda in recent decades. Denmark is a leading player in driving standards for safe, high-quality food.

The global population is growing so fast that, over the next 40 years, we will have to produce more food than we have ever done in the past 8,000 years. Never before has the need for sustainable means to produce safe, high-quality food been so great.

Through the decades, food safety and food quality have become dynamic issues that reflect global climate change, disease risks and changing consumer patterns and trends. And, for each issue, there are many perspectives to consider along the food value chain. For example, the concerns of a producer delivering raw materials to the food industry are quite different from those of a consumer buying a ready-to-eat meal from a multinational food chain.

Solutions to such challenges rely on field to fork innovation – new ideas, new raw materials, new technology, new ways to interact and collaborate, and new ways to make use of data. The ultimate goal is to provide consumers with appetising meals where quality, safety and profitability coexist and where

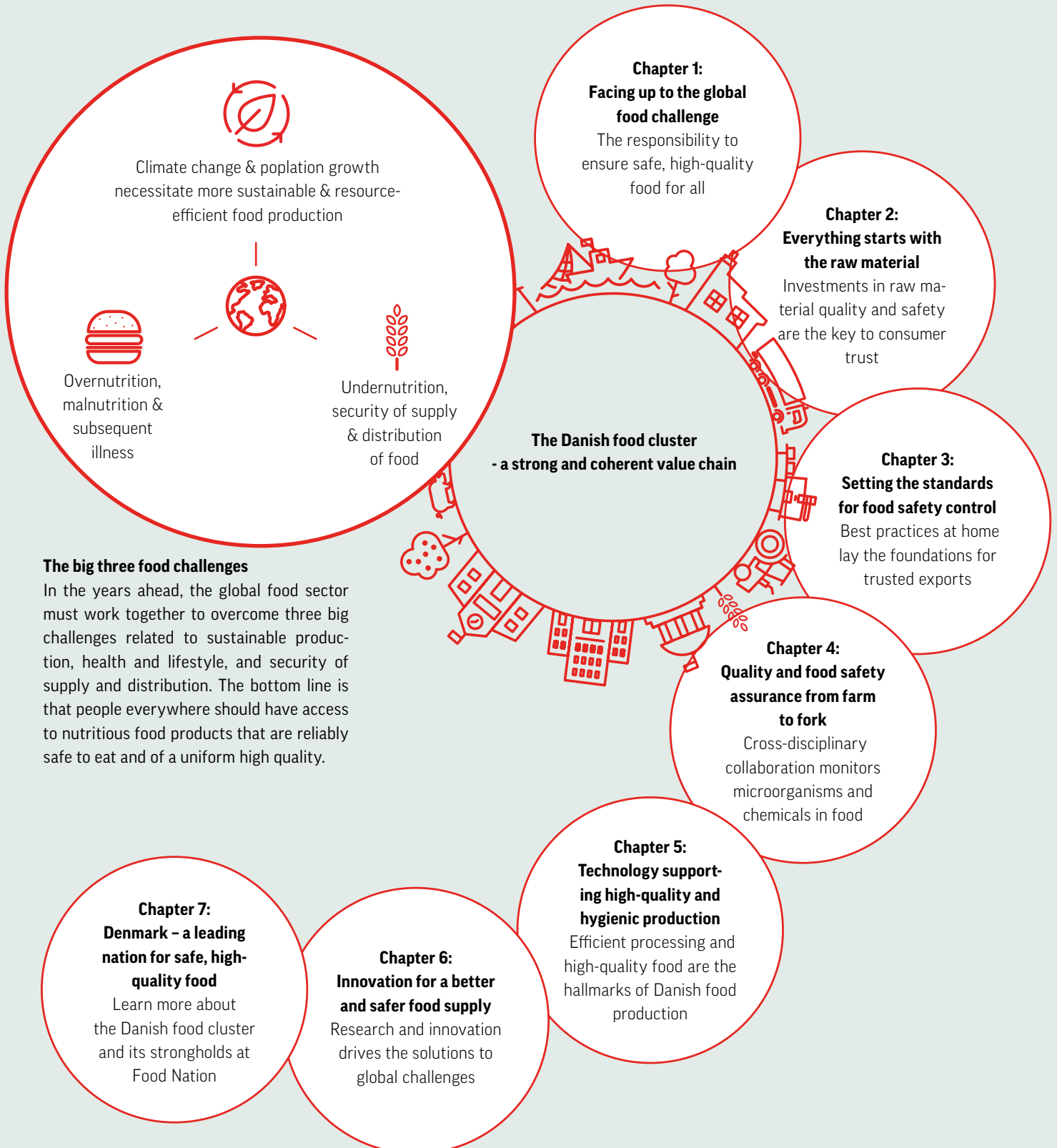
production is sustainable. Several of the UN's sustainable development goals set the direction for achieving this.

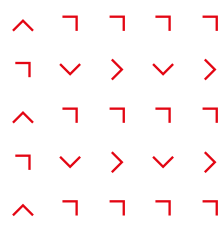
The ultimate goal is to provide consumers with appetising meals where quality, safety and profitability coexist and where production is sustainable

Why is Denmark ahead?

In Denmark, the culture for collaboration – spanning industry, academia and authorities – is at the heart of the national approach to food safety and quality. This has been our strength ever since we introduced Danish butter and bacon to European consumers in the late 19th century. And it is becoming even more important now as raw materials are increasingly sourced from around the world, with the additional risks that brings.

DENMARK'S CONTRIBUTION TO A HIGH-QUALITY AND SAFE GLOBAL FOOD SUPPLY





Today, as we look back on more than a century as a food-exporting nation, the roots of that success lie very much in our tradition for cooperative enterprise. From the groups of farmers who came together and founded cooperative dairies and slaughterhouses in the 1880s, multinational concerns have grown. Their tradition for shared technological research and investment has laid the foundations for our food processing industry – and of Denmark’s development into a leading producer of safe, high-quality food.

The shared cost of research and development

Most sectors of primary producers continue to pay a fee when delivering raw materials to food manufacturers. This revenue goes to a national fund, part of which is used to support research activities for improved quality and safety to the benefit of each sector – pigs, cattle, dairy and so on. Food processing companies and food authorities raise further substantial amounts for research and development.

Our collaborative culture holds the key to building greater transparency and consumer confidence

One of the latest opportunities to create new quality and food safety solutions lies in the big data that companies are now collecting across the value chain. Here, our collaborative culture holds the key to building greater transparency and consumer confidence through the use of digital technologies.



Photo: Chris Tonnesen

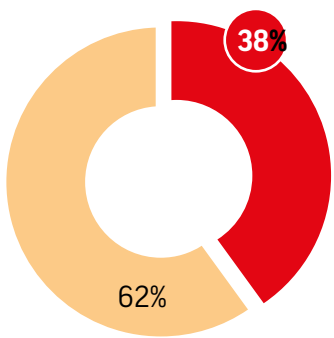
Commitment through the value chain

Another essential aspect of the Danish food industry is the shared food quality and safety mindset that has grown across the value chain – partly due to a highly effective control system established by governmental authorities and food producers in collaboration. Self-regulation and voluntary agreements also contribute to an extremely high level of food traceability and compliance with national and EU food regulations. As a result, the level of trust in our products is high, both at home and abroad.

Such competences are the reason why 38% of Danish food exports are sold as high value products at prices 20% above the EU average. Of Denmark’s total exported goods, around a quarter come from the food cluster.

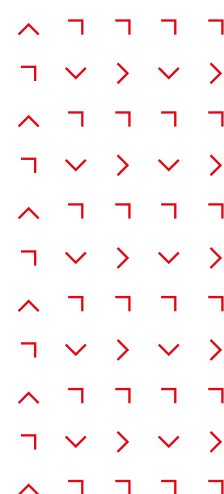
Food safety is about preventing food-borne illness by safe handling, preparation and storage of food.

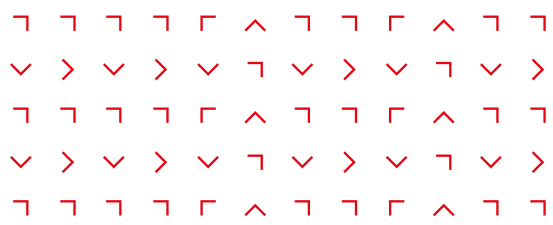
High food quality has to do with ensuring food products and solutions that meet customers’ expectations and specifications.



40% of Danish food exports are sold as high value products

Source: Danish Agriculture & Food Council





STRONG SAFEGUARDS AGAINST LIVESTOCK DISEASE



The animal disease surveillance system is strong in Denmark thanks to a close collaboration between authorities, the agricultural and veterinarian sectors and research institutions.

The animal disease surveillance system is strong in Denmark thanks to a close collaboration

The first meat inspections in slaughterhouses date back to 1886. A few years later, in 1901, Europe's first veterinary research laboratory was opened in Denmark to eradicate animal diseases and prevent infections. To reduce antibiotic resistance, strict thresholds are today in place for farm antibiotic use.

Case by Food Nation

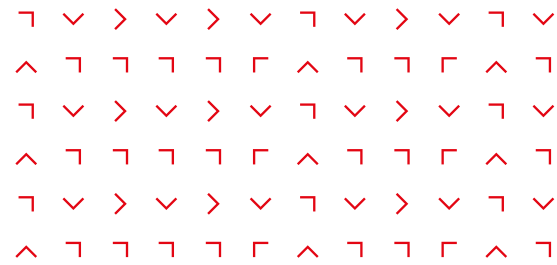




CHAPTER 2

EVERYTHING STARTS WITH THE RAW MATERIAL

**INVESTMENTS IN RAW MATERIAL
QUALITY AND SAFETY ARE THE KEY
TO CONSUMER TRUST**



Farmers and food manufacturers have a mutual interest in high-quality raw materials. Their cooperation helps inspire international confidence in Danish food products.

The global incidence of food contamination is alarming. According to the UN Food and Agricultural Organization, one in ten people in the world fall ill after eating contaminated food, and 420,000 die each year.

The statistics say it clearly: at global level, keeping food fit and safe for human consumption is still a major challenge – with high costs for everyone involved.

Raw materials are the most important and most expensive ingredient in food production. Take raw milk as an example - this accounts for 70% of total cheese production costs. So it makes absolute sense to ensure raw materials both are of the right quality for successful processing and that they bring no risk to food safety into the production plant.

It pays to invest

In Denmark, food safety and consumer health are top priorities. Our national food regulations closely follow the legislation set out by the EU and, occasionally, exceed it if we find a need for higher food safety in certain areas. All legislation is prepared and implemented in dialogue with the authorities, food sector and research and innovation institutions. The mutual respect at the heart of this collaboration makes it possible to set ambitious food safety and quality goals.

The long Danish tradition for investing in food safety begins with the raw materials, whether produced on our farms, landed by fishing boats at our harbours or imported into the country for processing. This investment has been key to establishing the high level of confidence in Danish food products worldwide. To maintain that confidence, a coherent control structure covers the entire food chain from farm to fork.

Safeguards for livestock health

Denmark's strong veterinary contingency capabilities are a powerful illustration of the national food safety commitment.

In Denmark, food safety and consumer health are top priorities

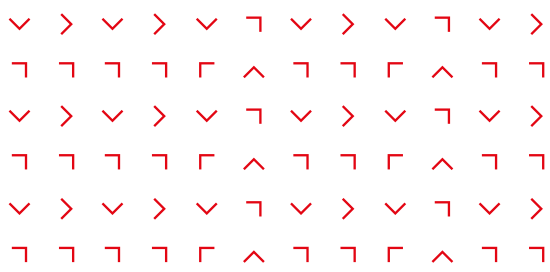
Like all countries, exports of live animals and meat depend on the ability to avoid outbreaks of contagious livestock diseases and to breed healthy animals in general. Denmark's safeguard against disease is the so-called veterinary contingency – a long-standing and close-knit cooperation between the authorities and industry on surveillance, control and prevention. Through this, livestock health is fully documented at all times, so potential disease risks can be quickly isolated and eliminated.

Quality management through fair payment

For all types of raw material, there are certain traits that directly influence production efficiency and the quality of the final food product. This could be the content of fat and protein in raw milk, the fat and lean meat ratio, or the moisture and protein content of grain-based cereals – to name just a few examples.

Denmark's long tradition for cooperation between farmers and food processors supports a common interest in high-quality raw material production. A key to this is a transparent payment system, where food processors pay for the quality that farmers provide. Farmers have a clear incentive to deliver the minimum quality defined by the payment system and are rewarded with premium payments when they optimise their production practices to supply raw materials of the highest quality.





THE DANISH GRAIN NETWORK – FAIR PAYMENT THROUGH RELIABLE QUALITY TESTS

Today 99% of all Danish grain is tested through the Danish Grain Network

Like many other countries, the Danish grain payment system is based on an evaluation of grain quality, including the moisture and protein content – and was one of the first to be based on aligned quality testing right across the country.

Faced with fluctuating and inaccurate analysis results back in the 1980s, the farmers' association, grain companies and governmental authorities got together to secure accurate and uniform analyses at all Danish trading sites and a fair payment system for all.

The initiative marked the beginning of the Danish Grain Network, a voluntary, non-profit cooperation forum with a mission to ensure the reliability of test results over time and across payment sites. These days the first innovative moisture testing system has been replaced by Near-Infrared Transmittance (NIT), which analyses several payment parameters, including moisture, protein and oil.

The network comprises the independent actors that handle grain testing and farm deliveries, the suppliers of analysis solutions, and a laboratory which manages ring tests and reference samples for validating analyser quality. The suppliers of analysis instruments also provide annual maintenance and instrument checks and a software system for central quality management of the large analyser fleet.

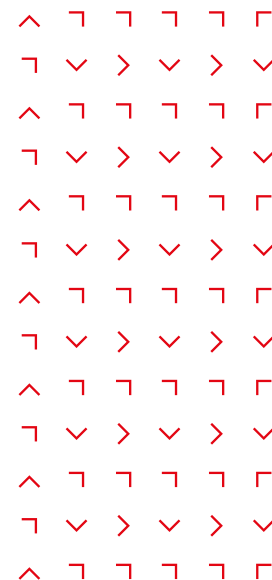
Today, 99% of all Danish grain is tested through the Danish Grain Network. Farmers trust the quality test that determines the payment for their delivery, knowing they would get a similar result at any payment site in the country.

Case by Kornitnet



Photo: Organic Denmark/Morten Telling

THE DANISH TRANSPORT STANDARD KEEPS LIVESTOCK FREE FROM DISEASE



Denmark's high dependence on pig exports means the economic consequences would be severe if disease should break out. The DANISH Transport Standard (DTS) was established in 2010 to minimise the risk of disease being spread between herds across borders.

According to Danish law, all pig and cattle transports must be registered with the Central Husbandry Register

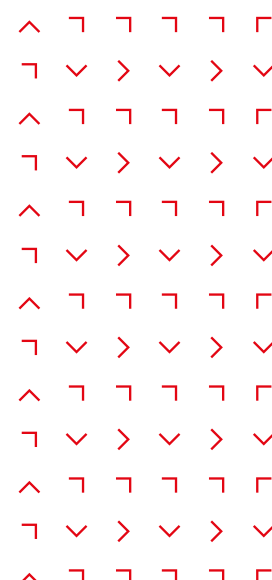
DTS covers hauliers of live pigs and cattle, collection centres, exporters, and cleaning and disinfection stations for transport vehicles entering Denmark from abroad. Approved DTS hauliers are required to use DTS cleaning and disinfection stations before loading and transporting from DANISH approved herds.

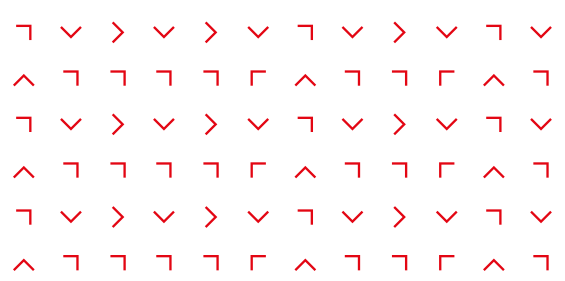
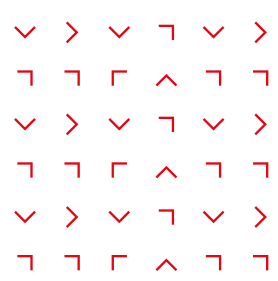
According to Danish law, all pig and cattle transports must be registered in the Central Husbandry Register. This transport data is then merged with a central database, which collates washing and disinfection certificates, to verify DTS compliance.



If vehicles have entered countries identified as high risk or are unable to document their route over the previous seven days, strict quarantines are imposed before they are allowed to approach a herd. Another important step in risk minimisation.

Case by Danish Agriculture & Food Council





PESTICIDE TRACES ARE LOWEST IN DANISH FRUIT AND VEGETABLES



If you want fruit and vegetables with minimal pesticide residues, then the Danish market should be your first choice. Produce from Denmark has a significantly lower pesticide content than other countries inside and outside the EU – a direct result of farmers' ongoing commitment to pesticide reduction.

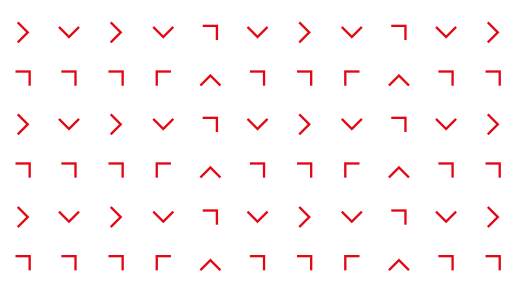
In an official report for 2016, the Danish Veterinary and Food Administration (DVFA) and the Technical University of Denmark state that a random check found pesticide residues on 27% of Danish vegetables, compared to 55% of vegetables from the rest of the EU.

Similar results were obtained in a random fruit check. Here, pesticide residues were found on 45% of Danish fruit, while the number was 72% for fruit from other EU countries and 74% for non-EU fruit.

The report concludes that no Danish product exceeded the legal maximum. Of the fruit and vegetables allowed into Denmark from other EU countries, less than one percent exceeded the maximum, while four percent of produce from non-EU countries was found to be above the limit.

**Case by
Danish Veterinary and Food Administration
The Technical University of Denmark**

Produce from Denmark has a significantly lower pesticide content than other countries inside and outside the EU



DAIRY QUALITY PROGRAMME ENSURES HIGH SAFETY



Photo: Arla Foods

All the farmers in Denmark's largest dairy cooperative Arla follow a joint quality control programme with strict procedures for producing and handling milk deliveries to the dairy. The programme is called The Arla Farm and has four cornerstones: milk consumption, food safety, animal welfare and the environment.

A qualified farming consultant pays regular visits to the farms to give advice and ideas for continuous improvement and ensure that procedures are carried out. The farms are

audited once every three years. If standards are not met, Arla will reject their milk until issues are resolved.

The Arla Farm is an excellent example of how a focus on quality, traceability and sustainability can make a difference in primary production

The Arla Farm is an excellent example of how a focus on quality, traceability and sustainability can make a difference in primary production – and act as an incentive to producers to ensure the high quality of their raw materials. Implemented in Denmark and Sweden since 2003, the programme is now also in operation in Germany.

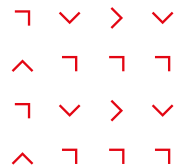
Case by Arla Foods



CHAPTER 3

SETTING THE STANDARDS FOR FOOD SAFETY CONTROL

**BEST PRACTICES AT HOME LAY THE FOUNDATIONS
FOR TRUSTED EXPORTS**



The high level of animal health and food safety in Denmark has opened the door to many export markets. Much of the responsibility for this achievement lies with food producers' own control systems.

More than 30 years have passed since the last outbreak of foot & mouth disease in Denmark – a record symptomatic of the high standard of animal health and food safety control. Today, Danish food exports are accepted in more than 190 countries around the world.

During Denmark's early years as a food exporting nation, the Danish Veterinary and Food Administration (DVFA) had full responsibility for the quality and safety of food products. But, as the Danish food cluster has grown and international food authorities and customers have stepped up their demands, this responsibility has gradually shifted and is now largely in the hands of Danish food producers.

The system is called 'own controls', which means companies are required to implement transparent control systems that document the safety and hygiene of their food production and their compliance with legislation. Regular checks by DVFA ensure these requirements are met.

When did own controls start?

The introduction of own controls coincided with the first EU directive on food hygiene in 1994:

"Food business operators shall identify any step in their activities which is critical to ensuring food safety and ensure that adequate safety procedures are identified, implemented, maintained and reviewed on the basis of the principles, used to develop the system of HACCP (Hazard Analysis and Critical Control Points)"

With this directive, the scene was set for building a system of own controls upon HACCP principles. In the years that followed, all companies prepared an approved own control programme, often based on existing industry guidelines. Own controls are today a well-established system that

Today, Danish food exports are accepted in more than 190 countries around the world

verifies whether production is under control and provides the knowledge to intervene if necessary.

In addition, the food industry in Denmark has developed a number of internationally recognised standards, including the Global Red Meat Standard (GRMS) and the DANISH Transport Standard, and has had a major influence on HACCP-related industry standards such as ISO 22000. These standards support food producers in meeting the requirements of international legislation and industry best practices.

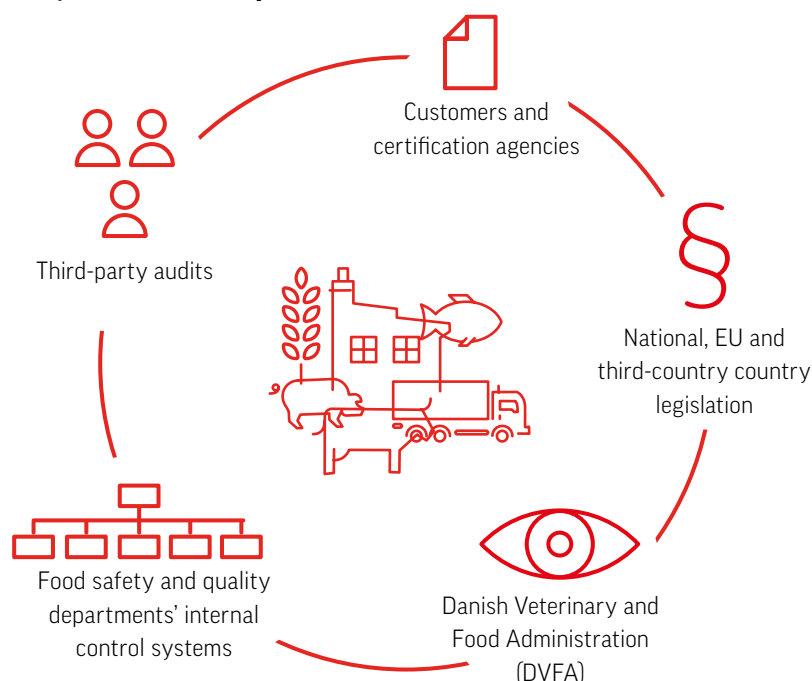
Control via third-party certification

Over the years, it has become increasingly necessary for food manufacturers to obtain third-party certification according to recognised global standards before customers will buy their products. The requirements set out in the standards often differ from those laid down by legislation.

In Denmark, manufacturers develop own control programmes in preparation for audit by a third-party certification body. The efficiency of these programmes is central to a successful certification process.

Third-party certifications are widespread among Danish companies. In some cases, these certifications replace part of the official control made by DVFA. This means areas, such as pest control, that score well in the third-party audit will not then be subject to further control, freeing the DVFA to focus on other aspects of food safety and quality.

Core elements of the Danish approach to quality and safety control in food production



THE GLOBAL RED MEAT STANDARD – DELIVERING TRANSPARENCY TO THE MEAT INDUSTRY



Developed by the Danish Agriculture & Food Council in partnership with its slaughterhouse members and the Danish Meat Research Institute, GRMS was published in 2006. It was recognised by the Global Food Safety Initiative just three years later. Like other global standards, GRMS qualifies for third-party certification.

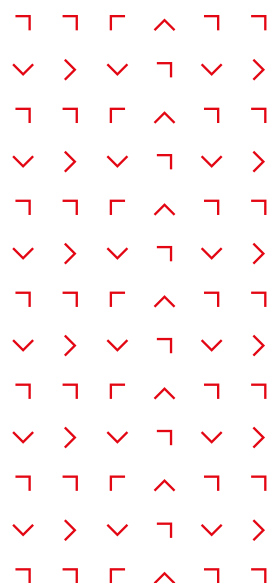
The aim of GRMS is to deliver transparency within animal welfare, quality, food safety and hygiene in factories that slaughter, cut, debone, process and handle meat and meat products from pigs, cattle, lambs, sheep, goats and horses.

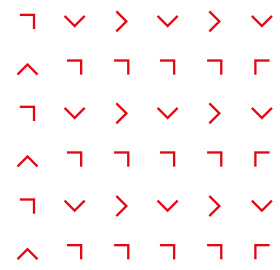
GRMS is maintained and continuously developed in cooperation with meat industry and food safety experts and industry association professionals. The current version of the standard is available at www.grms.org

Case by Danish Agriculture & Food Council

The Danish meat industry is renowned for its ability to produce safe, high-quality meat for customers around the world. Today, this experience and expertise benefits meat manufacturers everywhere through the Global Red Meat Standard (GRMS).

The aim of GRMS is to deliver transparency within animal welfare, quality, food safety and hygiene





THE DAIRY GUIDE TO HARMONISED FOOD SAFETY CONTROL

The Danish Dairy Board responded quickly to the introduction of own control programs in the early 1990s. To support dairies in establishing their own site-specific food safety management systems, the board drafted the first dairy sector guide, which was approved by the Danish Veterinary and Food Administration (DVFA) and published in 1993.

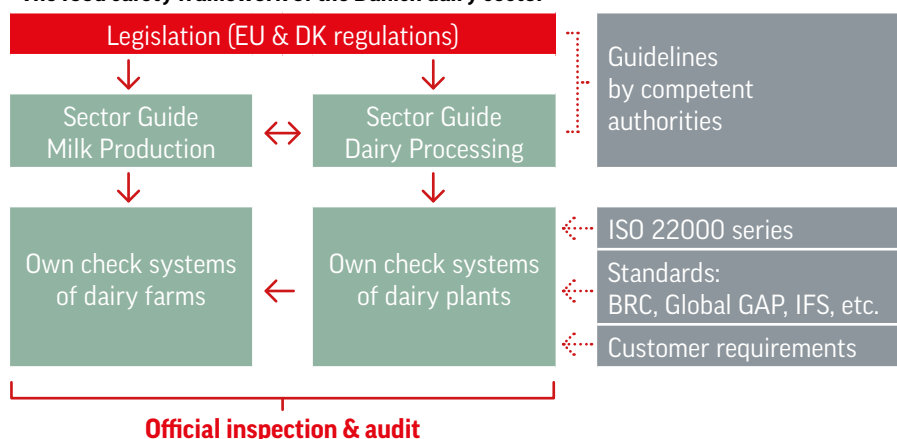
The Danish dairy sector now has a fully harmonised approach to food safety management

The guide has been revised several times to reflect changing EU regulations and approaches to food safety within the dairy sector. Today, the most recent version is available on a web-based platform and includes comprehensive hazard analyses for various product types. A key goal is to support both the less experienced quality staff and the skilled staff of small and large companies.

After 35 years of own control based on the sector guide, the Danish dairy sector now has a fully harmonised approach to food safety management, facilitating trade in raw materials and intermediate products.



The food safety framework of the Danish dairy sector



Case by Danish Agriculture & Food Council

A young, fluffy white chick is the central focus of the image, standing on a bed of light-colored wood shavings. The chick is facing right, with its head slightly turned towards the viewer. Its feathers are soft and downy. The background is blurred, showing other chicks and a warm, indoor farm environment. The lighting is soft and natural, highlighting the texture of the chick's feathers and the wood shavings.

CHAPTER 4

QUALITY AND SAFETY ASSURANCE FROM FARM TO FORK

**CROSS-DISCIPLINARY COLLABORATION MONITORS
MICROORGANISMS AND CHEMICALS IN FOOD**

In 1898, Denmark became the first country to introduce compulsory pasteurisation of milk. It was the start of a long tradition for identifying and eliminating food-borne risks to consumer health and ensuring a consistently stable quality in food production.

Even the most careful selection of raw materials cannot eliminate all potential microbiological and chemical hazards in the final food products. A farm to fork strategy is critical to assuring the quality and safety of foods throughout production, during transport and storage and all the way to consumers.

As knowledge of food contaminants, production processes and food stability during shelf life continues to grow, new risks to health may also become apparent – bringing a need for evaluation and action plans for risk removal.

Denmark has a strong record for identifying risks from pathogenic and chemical sources and for initiating effective quality assurance strategies.

Towards the end of the 1980s, there was an alarming rise in the number of people infected with Salmonella from chickens and eggs. The poultry industry and the food authorities quickly joined forces to investigate the cause of the increased infection rate and turned the situation around. This marked the beginning of a new voluntary national action plan for Salmonella control.

The plan was drawn up by the University of Copenhagen, the then Ministry for Food, Agriculture and Fisheries and the Danish Poultry Council. Reflecting the focus on the source of Salmonella bacteria on poultry farms, a series of branch agreements were made for feed production, animal imports, vermin control and biosecurity. Some years later, in 1996, the voluntary plan was replaced by an official Salmonella control program targeting broiler chickens and egg-laying hens.

From then on, incidents of Salmonella infections from chickens and eggs continuously declined. In 2015, the infection rate was estimated to have reached zero. A success that

has brought Danish chicken meat and eggs a special status within the EU.

The first ban on trans fats

Occasionally, the source of a food safety risk is a specific processing method. This was the case when scientists first drew attention to trans fats as a potential risk factor in cardiovascular disease due to their negative effect on blood cholesterol. They raised the alarm about the high levels of trans fats formed during partial hydrogenation, a method widely used by the oil and fat industries for converting liquid vegetable oil into a solid product. Present in many everyday foods, such as margarine and bakery products, trans fats immediately became a matter of public concern.

In 2015, the infection rate of Salmonella was estimated to have reached zero – Danish chicken meat and eggs a special status within the EU

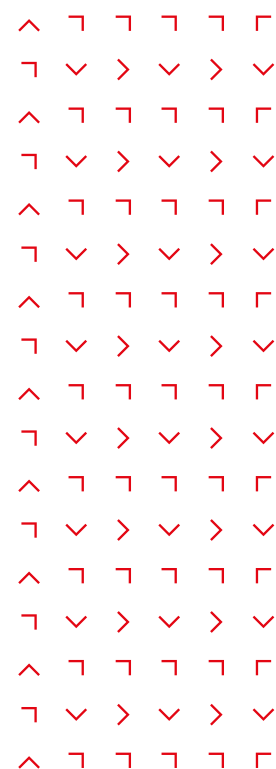
Responding to the concern, the Danish Nutrition Council published its first report on the health implications of trans fat in 1994. The Danish Margarine Producers Association immediately took the recommendations on board and, that same year, trans-free margarines were launched on the market. In 2004, Denmark became the first EU country to enforce a ban on trans fats in foods produced and sold nationally.

Reducing acrylamide in Danish products

Another food safety topic on the public health agenda is acrylamide. A known carcinogen, acrylamide is formed when foods such as bread, coffee and potatoes are subject to high temperatures during frying, roasting or baking. Danish food manufacturers, research institutes and authorities have

worked to minimise the level of acrylamide in foods since 2002. Due to these efforts, acrylamide intake in Denmark has been significantly reduced.

Danish food products cross international borders, and experience shows that collaboration between governments, producers and consumers is critical to making the food supply system work. A high level of trust when sharing knowledge between partners plays an important role in effective quality assurance that secures the highest possible food safety for consumers.



TRUST AND COOPERATION RULE OUT SAFETY THREAT



Photo: Organic Denmark

As the news broke, the Danish Veterinary and Food Authority (DVFA) quickly became aware that the threat to consumers could only come from imported eggs, because no Danish producer used the pesticide in question. So, the authority immediately contacted all major food retail chains to enquire if any fresh egg imports could originate from the suspected farms.

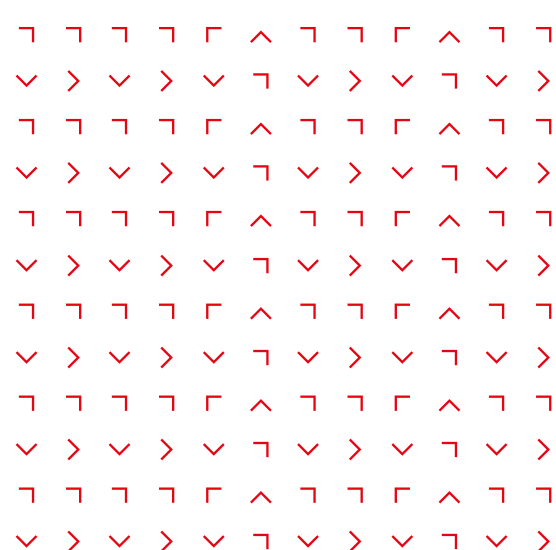
Due to the speed and efficiency of communications with the Danish trade organisation, the DVFA was informed about a small shipment of 40 eggs to a remote Danish bakery – the same day the eggs were delivered. This made it possible – still the same day – to send the local food inspector to the bakery to ensure no eggs were used.

Ensuring a high level of consumer trust and food safety is a shared goal for Denmark's food authority and industry. Transparency like this not only benefits Danish consumers. It also strengthens the international status of food "made in Denmark".

Case by The Danish Veterinary and Food Administration

Denmark's effective food traceability system was quick to respond in 2017 when the pesticide fipronil was found in eggs from several European countries, sparking a major egg recall from all over Europe.

Ensuring a high level of consumer trust and food safety is a shared goal for Denmark's food authority and industry



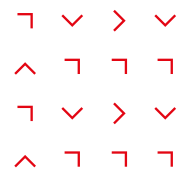




CHAPTER 5

TECHNOLOGY SUPPORTING HIGH QUALITY AND HYGIENIC PRODUCTION

EFFICIENT PROCESSING AND HIGH-QUALITY FOOD ARE THE HALLMARKS OF DANISH FOOD PRODUCTION



Necessity is the mother of invention in the Danish food industry, where the need for cost-efficient food production has led to the rise of world-leading food technology companies with a strong focus on quality and hygiene.

Danish manufacturers of innovative processing technology and equipment stand out for their strong presence on the global market. The impressive rise of the Danish food technology industry can be traced back to one fundamental parameter – Denmark’s relatively high production costs which led food producers to seek new ways to stay competitive in the global market. Out of this need, a whole industry has grown, including specialised processing machinery, robots, sensors, analysis solutions and IT systems that support the efficient and standardised production of food.

The Danish food technology industry includes the innovative companies behind some of the most technologically advanced solutions in the world. More than 80% of Danish processing equipment is exported to global markets, the highest growth rates being in sensor and analysis solutions and IT systems. A clear indication that quality, food safety and traceability are highly relevant all over the world.

Automation for uniform quality

As a major meat exporter, Denmark has led the way in technical solutions that enable efficient and high-quality pork loin production. “Technology Lighthouses of the Decades” shows how quality management has, for decades, been a key focus in the continuous technological development of the pig industry. Much of this progress has been achieved in collaboration with the Danish Meat Research Institute.

One example of this innovation is a 3D de-rinding robot developed for meat production. Using sensor technology and vision, the robot generates exact 3D images off each pork loin. A patented knife system then removes the rind and fat. Taking just four seconds to trim each loin, this automated process results in better, more uniform end-products.

Another Danish invention employs x-ray technology for exact and real-time analysis of fat relative to lean meat, directly on the production line – again optimising use of the raw material.

Safe and high-quality dairy processing

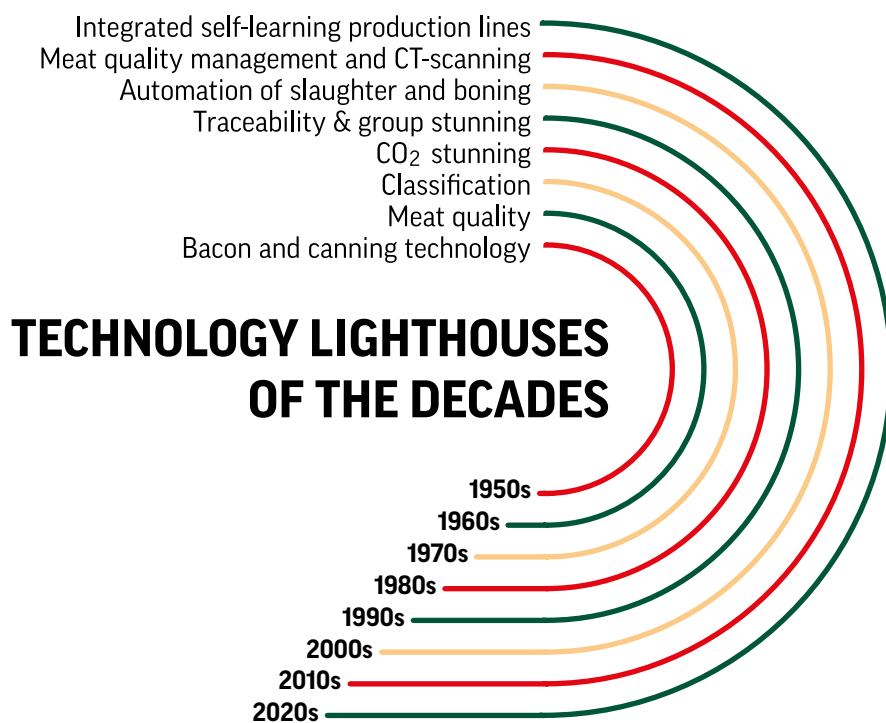
One critical success factor for the production of safe foods is to avoid contamination from the raw material, where just one bad delivery can spoil a whole production batch. In the dairy industry, for instance, milk deliveries are easily contaminated by harmful bacteria or excessive bacteria growth. Critical control points through the value chain are key success factors for the management and reduction of contamination.

Another Danish invention, bacterial analysers enable a fast, reliable and cheap tests of the bacteria levels in raw milk, so every

farm silo and every truck load delivered to the dairy are checked and abnormally high bacteria levels are detected in time.

More than 80% of Danish processing equipment is exported to global markets

Danish companies have also pioneered the introduction of membrane filtration technology in dairy processing. Membrane filtration is now used globally for uniform, high-quality and cost-effective cheese production. Dairy analysers tightly control the ingredients in the production process, providing instant feedback for efficient process regulation.



FOOD SAFETY IN THE INDIAN DAIRY INDUSTRY



Photo: FOSS

High-tech milk testing solutions from FOSS are making a big difference in India, where dairies have launched a campaign to protect milk from adulteration.

Dairy products are a key source of protein in Indian diets, and the price of raw milk is high. In recent years, the country's dairy industry has faced a challenge with foreign substances being added to the raw milk with the goal to sell it for more money.

Regular control has reduced milk adulteration by 98%

This unfortunate trend puts consumers at risk and undermines the trustworthiness of India's established dairy industry.

Developed to analyse the chemical composition of milk, including protein, fat, lactose and total solids, FOSS' milk testing solutions are a standard quality assurance tool in global dairies. In partnership with some of its biggest dairy customers, FOSS discovered that the technology is also sensitive to foreign substances in milk.

Indian dairies are now adopting the tool to safeguard the quality of the raw milk that enters their production lines. In one region, the regular control has reduced milk adulteration by 98%.

Case by FOSS

QUICK CHILLING TECHNOLOGY SUPPORTS HIGH-QUALITY MEAT

Carcass chilling in slaughterhouses has a high impact on meat quality and shelf life, making it a case for ongoing research at the Danish Meat Research Institute (DMRI). The quick chill tunnel (QCT) system is one of the results of this research, improving meat quality, reducing cooling loss and lowering the bacteria count.

Quick chilling is the primary method in use worldwide

Applying very hard chilling at -26°C , the QCT system was originally developed to reduce the incidence of pale, soft and exudative (PSE) meat. So, when the Danish breeding programme removed the gene responsible for PSE meat, DMRI set to work again to optimise the QCT system.

A milder QCT process with chilling at -16°C was then introduced. Today, this is the primary chilling method in use worldwide.

Case by Danish Meat Research Institute (DMRI)



Photo: Claus Sjödin



CHAPTER 6

**INNOVATION FOR A BETTER
AND SAFER FOOD SUPPLY**

**RESEARCH AND INNOVATION DRIVE THE SOLUTIONS
TO GLOBAL CHALLENGES**

Denmark is working towards a future where good, safe, healthy and sustainably produced food is accessible to the world's population.

Continuing innovation is essential to providing 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. This is where Denmark's triple helix model of innovation – involving industry, academia and government institutions – plays a key role.

In 2017, a new food research and innovation strategy was published which sets out Denmark's vision up to 2030 and beyond. Identified by the Danish Food and Drink Federation and the Danish Agriculture & Food Council in cooperation with several private companies, the strategy highlights six key challenges for future research and innovation activities. The objective is to convert these challenges into opportunities that will both benefit global society and keep the Danish food cluster at the forefront when it comes to producing foods, ingredients, process equipment and services, and developing the industry per se.

Politicians, funding bodies, industry and the research community are all part of the collaborative network that is putting action behind the strategy.

Danish companies already invest heavily in research and innovation. Their combined annual food research budget amounts to more than 403 million euro – two-thirds of which is funded by the industry itself. This strong commitment to developing the solutions of the future is supported by a large pool of talented developers with extensive knowledge of international markets and access to excellent raw materials. International customers often experience that their Danish partners have an ambitious approach to development projects. Their goal is not to meet expectations – it is to exceed them.

Big potential in data along the value chain

One of Denmark's hidden strengths in the new digital era is its production and collection of huge amounts of data throughout the value chain – from raw material producer to the final consumer. This is based on a long tradition for collecting data for traceability purposes in primary production and a high level of automation that enables collection of large data sets. Our collaborative culture is another major contributor.

Compared to most other countries, our data compiling capabilities are unrivalled. As a result, Danish producers of agricultural and food technology are at the forefront of complex data analysis. The ability to exploit the value of big data is particularly important to tomorrow's innovation, including the new solutions that will improve food safety and quality even further.

Food safety 2.0 in a smaller world

Globalisation is another factor in the drive towards ever-better food safety. With the increased transportation of people, animals and consumer goods around the world comes a higher risk of spreading communicable disease. Epidemics can have a serious impact on food production and, in the affected areas, will shut down exports.

While Danish food production is known for its well-documented food safety, high quality standards and strong reliability, this should never be taken for granted. There will always be food safety challenges to overcome, such as antibiotic-resistant bacteria or toxic chemical compounds. For this reason, food safety solutions to control these threats are high on Denmark's research and innovation agenda.

Food analytics and predictive tools

Analytical tools play a significant role in achieving that control and securing a competitive advantage. This includes quantitative measurements of food components and contaminants and rapid methods of analysis that can reduce testing time and, hence, the time to market for new products.

Development of such tools requires a fundamental knowledge of the food safety risks that arise when changing product formulations – for example, when adding new ingredients, reducing salt or sugar, or changing the pH or heat treatment. The food industry must also be able to predict the changes that take place in products during transportation and shelf life and to understand how processing and packaging affect food quality.

In Denmark, research and innovation focuses on establishing advanced tools and reliable track and trace systems to ensure ever-higher standards of food quality and safety, guarantee the origin of locally and internationally sourced raw materials, and minimise the risk of food fraud. These capabilities are a cornerstone of Denmark's position as a leading food nation.

World-class innovation towards 2030

The six priority challenges in Denmark's food research and innovation strategy

1. Supply of high-quality raw materials in a circular economy
2. Products for the global consumer
3. Food safety 2.0
4. Foods for a healthier life
5. Efficient and agile production
6. Faster and safer to market through utilisation of big data

SUSTAINABLE PACKAGING KEEPS FRESH FOOD SAFE

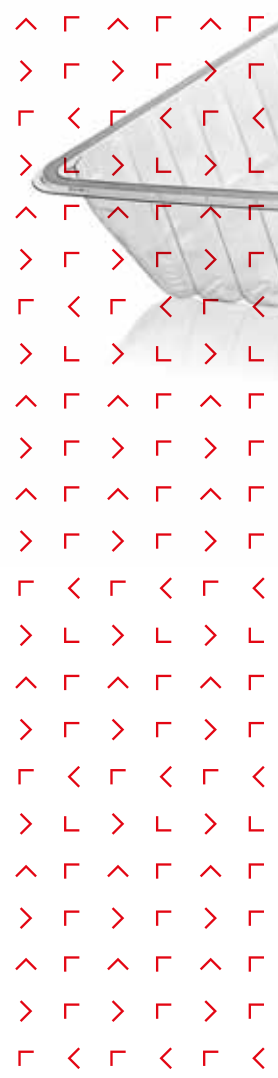


Photo: Færch Plast

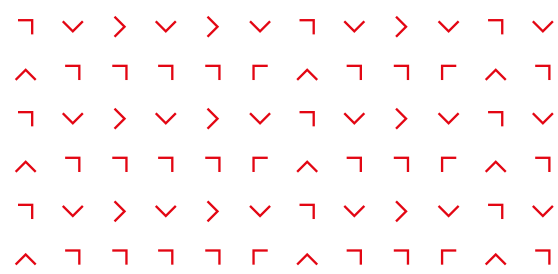
Packaging of fresh meat, poultry and fish has reached the next level of food safety and sustainability with the development of a new innovative packaging tray by the Danish company Faerch Plast. Made from a single material and sealed with a special food-safe adhesive, the tray provides better protection against spoilage and is easier to recycle than similar multi-layer packaging products on the market.

The tray provides better protection against spoilage and is easier to recycle

MAPET® II, as the tray is called, is produced using recycled materials, giving it a very low environmental footprint. The transparency is also excellent, so consumers can evaluate the visual quality of food products before they buy.

Faerch Plast has obtained a European patent for the innovative packaging. This supports the company's work to develop new sustainable and functional packaging solutions that extend food product shelf life and reduce costs.

Case by Færch Plast



MATHS IS A MAIN INGREDIENT IN SALT-REDUCED FISH PRODUCTS

Salt has traditionally been used to preserve many types of fish products, because it inhibits bacterial growth and increases product shelf life. So any change to the salt content can affect bacteria growth, spoiling the taste of the final product or making it unsafe to eat.

At the same time, the World Health Organization (WHO) dietary guidelines recommend a daily salt intake of less than five grams a day.

For people with a taste for preserved fish products - such as prawns in brine or smoked salmon – a cross-disciplinary research project has led to the development of new, reduced-salt products that comply with dietary recommendations without altering the flavour.

The project, funded by the Green Development and Demonstration Programme (GUDP), brought together researchers from the Danish National Food Institute, Technical University of Denmark, and the Danish seafood company Royal Greenland.

Modelling predicts bacterial growth

Mathematical models from the Danish National Food Institute were used to develop the recipes for the new range of fish products with less salt and more taste.

These models are designed for use with the institute's Food Spoilage and Safety Predictor (FSSP) programme, which predicts the growth of pathogenic *Listeria* bacteria along with lactic acid bacteria, which can result in spoilage.

A cross-disciplinary research project has led to the development of new, reduced-salt products

The project has equipped Royal Greenland's product developers to predict how a change in the recipe will affect bacterial growth in the final product. As a result, the company has been able to develop cold-water prawns in brine and pasteurised lumpfish roe with 40% less salt.

All the lightly-preserved fish products in the range have acquired the Nordic Keyhole label – a label that helps consumers identify healthier food products.

Case by Royal Greenland



Photo: Royal Greenland



CHAPTER 7

DENMARK - A LEADING NATION FOR SAFE, HIGH-QUALITY FOOD

**LEARN MORE ABOUT THE DANISH FOOD CLUSTER
AND ITS STRONGHOLDS AT FOOD NATION**

Consumers have a right to food they can trust. In Denmark, producing food to the very best quality and food safety standards has been part of the culture for generations. Today, it is the reason why Danish products and technology are respected all over the world.

Operating in a small country with high labour costs, Danish manufacturers have turned a challenge into a competitive advantage – not just for their own benefit, but for the benefit of international business partners, too. The need to make the most of raw materials with minimum waste means the efficiency of their food production, quality assurance and control systems is world class.

Solutions to the global challenges

Due to an unerring focus on continuous improvement throughout the food value chain, the Danish way of working is helping to shape global standards for food safety and quality. And ambitions are high. To meet the needs of the future, Denmark's research and innovation strategy is already exploring new opportunities to exploit big data, developing new analytical tools and building next-generation technology for high quality and safe food production.

In this way, Denmark is making a powerful contribution to solving the overriding challenge facing the global population: how to distribute sufficient volumes of safe, high-quality food to all while preserving a healthy planet for tomorrow's generations.

Food Nation Denmark

Food Nation is the gateway to information about the Danish food cluster and how knowhow made in Denmark 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 prod-

ucts 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 is a partnership established by the Danish government and leading private organisations and companies. Our visitor centre in central Copenhagen regularly 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 moving on to site visits at Danish production facilities.

Denmark is making a powerful contribution to solving the overriding challenge facing the global population

Food Nation is a great place to start learning about how Denmark can support food quality and safety goals. Find out more about our services, the Danish food cluster and arranging a visit to the Food Nation visitor centre at foodnationdenmark.dk

INGREDIENT INDUSTRY

Producers of enzymes,
cultures and other ingredients

PRIMARY PRODUCTION

Agriculture, fishing
& horticulture

PROCESSING INDUSTRY

Producers of food,
beverages & animal feed

The Danish agrifood sector

The Danish food and agricultural sector has a strong value chain, covering everything from primary and processed food production, food technology and ingredients industry, know-how and research to the wide range of products available to consumers all over the world.

RESEARCH & INNOVATION

Research, education
& counselling institutions

INNOVATIVE TECHNOLOGY

Producers of machines,
technology & equipment

GASTRONOMY & THE CONSUMER

Retail, consumers, restaurant,
authorities, tourism & other
related industries

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