

Plant-Based Foods

R&D Strategy for a New Area
of Growth in Denmark's Food
Production System

November 2020



Shared ambitions to increase plant-based food products

Denmark's agricultural and food industry has a powerful vision of being climate neutral by 2050. In addition, a number of the industry's companies have set their own targets aimed at making the entire value chain more sustainable, which includes reducing the climate footprint. The Danish government aims to reduce Denmark's total climate gas emissions by 70 % by 2030, compared to 1990. In this context, the Climate Partnership for the Food and Agricultural Industry presented a number of recommended initiatives in the spring of 2020 that can help reduce the climate footprint.

The industry aims to become a green engine of growth by supplying the most climate-friendly products, technologies and know-how to the rest of the world.

The green transition must be a competitive parameter and create new business areas, while developing Denmark's existing positions of strength at the same time. The Climate Partnership also indicated that the agricultural and food sector needs to develop new plant-based products that can meet consumer demand for vegan and vegetarian food products.

Achieving this goal and cultivating this segment of the agricultural and food industry, concurrent with its remaining segments, requires the allocation of targeted resources to ensure R&D throughout the farm-to-fork value chain.

Through this R&D strategy for plant-based food products, we outline the need for specific research and development that will make it possible to promote more plant-based food products under the 'Made in Denmark' brand. The strategy was drawn up by a new partnership comprising the Danish Agriculture and Food Council, the Vegetarian Society of Denmark, the Frej think tank and food industry players based on input from a number of the cluster's undertakings and stakeholders. This Partnership gathers forces from farm to fork, from rural to urban and from across generations.

Scope for further developing our positions of strength

In addition to the recommendations of the Climate Partnership, the Strategy is largely based on Denmark's existing positions of strength, expertise and achievements within the food industry. For generations, Danish farmers have been helping to supply foodstuffs to both Denmark and abroad, and they currently supply the ingredients used in packed lunches, meal boxes and the menus of Michelin restaurants. But the possibilities don't stop here.

The intensifying focus on climate and health has also intensified focus on the plant-based segment of our diet and on plant-based foods and proteins. The demand and market for plant-based food products and ingredients is growing concurrent with this and is expected to grow even further.

There is also growing interest among farmers and horticulture enterprises to supply the products that the food industry needs for products such as plant-based drinks and minced proteins and which restaurants and the rest of the foodservice sector need in their daily catering of Danish customers. The food industry is already supplying quality, healthy plant-based foods, but further development is needed, not least because these developments are world-wide and embody enormous export potential.

Solidifying the industry's commitment to the production of vegetable crops can be based on our existing positions of strength in the Danish food industry. Many consumers in both Denmark and abroad demand healthy Danish food products, arising both from our proud culinary traditions, livestock well-being, organic production system, food safety, taste and nutritional qualities, but also because the industry aims to become climate neutral by 2050.





Targeted R&D can generate growth for Danish society

In our view, a targeted R&D effort in this area can help create new products, new undertakings and more jobs in the food industry, as well as increase growth and earnings for Danish society. The strategy appeals to authorities and the government to allocate more challenge-driven resources for this area. We have a strong Danish eco-system in the field of R&D, but new stakeholders must also be brought into play, and we need to reinforce our international collaboration to obtain the knowledge needed for Denmark and amass the expertise required in this area.

To the Danish Agricultural and Food Council, this strategy does not stand alone, but supplements other R&D strategies aimed at developing the food-product cluster as a Danish position of strength and includes: World-Class Food Innovation towards 2030 and the 2030 Research Strategy for Danish Agriculture.

Our R&D strategy for more plant-based food products identifies eight recommendations.


Eight recommendations for developing plant-based food products

Overarching recommendation

R&D recommendations for the plant-based value chain

1. 
New collaboration model in the value chain

2. 
Crops

3. 
Processing

4. 
Food production

5. 
Retail, foodservice and consumers

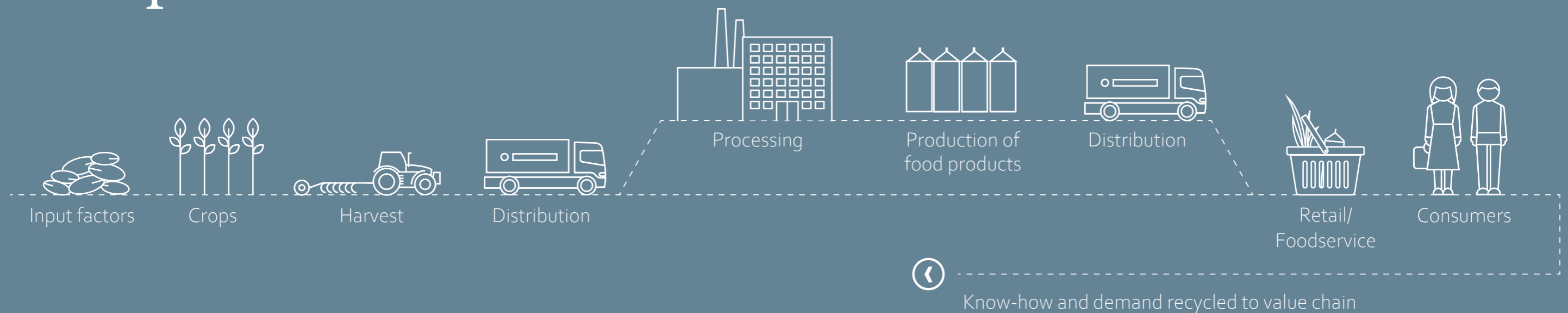
6. 
Four interdisciplinary topics:
– Health and nutrition
– Traceability and food safety
– Documentation of sustainability
– Reduced waste and exploiting residual flows and side flows

7. 
Establishment of testing and demonstration facilities

8. 
Ensuring know-how transfer and training

Recommendations for strengthening knowledge-based development of the plant-based value chain

Value chain for plant-based food products



What are plant-based food products?

The raw materials used include

- Fruit
- Vegetables
- Mushrooms
- Legumes
- Grains
- Seeds
- Nuts
- Seaweed and algae
- Other; grass, hemp etc.

Plant-based food products

These types of produce can either be eaten directly (e.g. fruit and vegetables) or be processed into plant-based products, such as bread, oatmeal and beer, but also new products such as oat milk or tofu.

Hybrid products

Examples of hybrid products are a combination of animal foods and plants/plant-based food products, such as adding vegetables to minced meat.

The value chain

The value chain has several links. From input factors (such as fertiliser, seeds and pesticides) for cultivating crops outdoors or in greenhouses to output factors such as harvest and distribution. Some produce is delivered directly to the retail trade and foodservice sectors, whereas other produce is processed (e.g. peas are shelled, dried and fractionated into ingredients) after which it is manufactured into actual food products. The final link of the value chain comprises sales and marketing targeting the retail trade, foodservice and consumers.



The potential of more plant-based foods

Growing demand

The global market for plant-based food products is growing. A new market survey shows an expected annual growth rate of 12% from 2020 to 2027.¹ In 2019, US sales of plant-based products that actually replace animal products rose by 11%, whereas other categories rose by 2%.² Plant-based developments in Europe are primarily driven by flexitarians seeking to reduce their consumption of animal products and add more and more vegan and vegetarian products to their shopping lists. Sales of vegan and vegetarian products are growing rapidly in Denmark, too. Food retailer Coop reported that the consumption of processed vegetarian products tripled in Denmark from 2012 to 2019, and that it expects this category's growth to continue.³ Similar high growth rates are noted by the Salling Group.

Young people in particular are demanding a wider, more varied assortment of plant-based food products.⁴ This means that demand will steadily increase going forward. The market is expected to transition from niche-based to mainstream.

The demand for foods that contribute positively to the climate, environment and sustainability agendas is rapidly growing. Plant-based food products have every opportunity to be marketed on the basis of these parameters. This will require a transparent, well-documented production process, however. Multiple studies show that a more plant-based diet will reduce the environmental and climate impact of the production process.⁵

The Danish foodservice and retail sectors are experiencing great interest in and demand for more plant-based food products, providing scope for teaching consumers about new tastes and products. A number of foodservice companies are ambitiously working on this, such as Dansk Cater, Meyer's and Fazer.

¹ Meticulous Market Research, 'Plant-based Food Market Worth \$74.2 Billion by 2027', 2020.
² The Good Food Institute, 'U.S. State of the Industry Report Plant-Based Meat, Eggs, and Dairy', 2019 <https://www.gfi.org/files/soti/INN-PBMED-SOTIR-2020-0507.pdf>
³ Coop Analyse, https://cooanalyse.dk/analyse/02_447-vegi-varer-salg/, 2019
⁴ Coop Analyse and Vegetarian Society of Denmark, 2020
⁵ J. Poore and T. Nemecek, Reducing food's environmental impacts through producers and consumers, 2019
⁶ IFRO, Jensen, Assessment of the socio-economic benefits of increasing compliance with dietary recommendations, 2020

Calculations from the Ministry of Food, Agriculture and Fisheries show that Denmark could save almost DKK 7 billion a year if Danes were to follow existing dietary recommendations.⁶

The organic production system is a driving force in the development of plant-based food products, and it is assessed that there is every opportunity to widen the organic food market. A 2019 survey by the Vegetarian Society of Denmark showed that flexitarians, vegetarians and vegans have a pronounced preference for buying organic products. There is also a demand for conventional products, however, which is why there is potential for developing both the organic and conventional segments.

The interviewees on which this strategy is based believe there is both great potential in products that 'imitate' animal products and in products that are unique in and of themselves.

Similarly, consumers demand that Danish produce be used in the production process, which is why Danish farmers have the potential to produce products to meet this demand

Fulfilling the potential must be built on Danish expertise

Well-founded expertise already exists within Danish agricultural and food research. This existing knowledge must be exploited in new plant-based areas. For example, existing knowledge and expertise in the field of ingredients and extracting proteins, as well as know-how relating to produce structures, textures, tastes and nutrition must be used to develop new plant-based products.

Denmark has a tradition for close collaboration within the farm-to-fork value chain. Many new plant-based food products will require a new value chain to be built up. To achieve this, we must draw on the close partnerships and organisational expertise already in the industry.

Denmark has unique strengths within organic production, clean label and clean produce, which is why we have the potential to gain a position of strength within plant-based food products that meet these requirements.





Limits and challenges of more plant-based food products

Consumers: Reservations and the need for know-how and expertise

Many products do not meet consumers' expectations of taste and quality. This results in disappointed consumers who don't re-buy. The nutritional make-up of some products can be challenging. For instance, the salt and saturated fat content of some products is just as high as in the animal products they seek to replace.⁷

Many categories of plant-based food products have a limited selection, and the variation is limited in others.⁸

Consumers, cooks and kitchen managers need to be trained in how to use and cook new types of products. Also a new food culture needs to be built up, and this takes time.

Price is an important driver for consumers. It is difficult for consumers to understand why some plant-based replacements for dairy and meat products are more expensive than their animal-based counterparts.⁹

Fragmented and/or missing links in the value chain

Cooperation and coordination in the value chain are inadequate, which means that the entire chain can be optimised.

Consumer information and behavioural know-how need to be recycled into the value chain.

Knowledge-based product development is lacking. Many plant-based products are developed by small start-ups which often lack the capacity to take a knowledge-intensive approach to product development, lack access to technology and production facilities, lack innovative capacity and distribution channels or lack capital for upscaling operations. Established food companies already possess detailed knowledge of consumers, production processes and distribution channels. Coordinating the efforts within these two elements would be beneficial.

The supply and processing of produce is lacking. Farmers must experience a demand, and it must be

possible and profitable to process the produce for the ingredients and food products in Denmark.

Crop production must reach a level whereby the contribution margin makes them competitive in relation to other crops. This requires optimisation of the entire value chain.¹⁰

Access to pilot-scale facilities, testing facilities and full-scale commercial production plants is lacking.



⁷ Vifu, Danske forbrugeres forhold til plantebaserede fødevarer (Danish consumers' view of plant-based food products), 2019

⁸ Vegetarian Society of Denmark, Vegetarian & Organic: preferences for organic products in the vegetarian consumer segment, 2019

⁹ Vifu, Danske forbrugeres forhold til plantebaserede fødevarer (Danish consumers' view of plant-based food products), 2019

¹⁰ SEGES, based on interviews with multiple players in SEGES, 2020



Research efforts in the value chain

Six primary R&D actions focused on optimising the value chain were identified through a series of interviews with stakeholders.

Cooperation recommendations

The Partnership has identified eight strategic recommendations for developing a plant-based value chain.

Overarching recommendation

1. New cooperation model within the value chain

R&D recommendations for the following areas of focus:

2. Crops
3. Processing
4. Production of food products

5. Retail, foodservice and consumers

6. Four interdisciplinary topics:

- Health and nutrition
- Traceability and food safety
- Documentation of sustainability
- Reduced waste and exploitation of residual flows and side flows.

Recommendations for enhancing the knowledge-based development of the plant-based value chain:

7. Establishment of testing and demonstration facilities
8. Ensuring know-how transfer and training



Denmark has unique strengths within organic production, clean label and clean produce, which is why we have the potential to gain a position of strength within plant-based food products that meet these requirements.



» Overarching recommendation



Recommendation 1:

New cooperation model within the value chain

At present, the value chain is highly fragmented, and Danish produce is difficult to obtain and process. The value chain is not coordinated or cooperating, and it is experienced that the consumer demand and product range do not mesh in a combined optimisation of the value chain. Agriculture lacks a pricing system, contractual bases and supplier agreements, and farmers are uncertain about whether they can sell their crops. Food companies have limited knowledge of which crops are suitable for cultivation in Denmark; they lack knowledge about the level of quality a farmer can cultivate or how a farmer can adjust the cultivation methods to enhance crop quality.

The Partnership recommends taking the following actions:

- Establish a new cooperation model that strengthens developments in every link in the chain. Exploit knowledge of consumers, distribution and production from existing established food companies and cooperate with the small start-ups that demonstrate innovative capacity, agility and new thinking.
- Exploit the potential to match up producers, processing companies, food companies and the retail trade.
- Join forces to develop 'missing links' in the value chain: pre-processing/processing of produce (e.g. husking, winnowing, ingredients).



R&D recommendations for a plant-based value chain

Recommendation 2: Crops

An important driver for developing more plant-based food products is to make sure the right produce and ingredients are available. This is why 'Crops' is an area of research by itself. This involves breeding and selecting varieties and crops, and adapting cultivation methods to the production of crops for human consumption so these crops can be cultivated in Denmark with high, reliable yields of the right quality.

The Partnership recommends that R&D efforts be focused on:

- Selecting crops and varieties of high quality in terms of proteins, fibres, vitamins, etc., and good sensory properties for processing, as well as selecting crops and varieties for direct consumption. Crop development must target both organic and conventional cultivation systems, and must be adapted to Danish/Nordic farming conditions.
- Crop refining focusing on:
 - o adapting crops to the Danish climate and new climate conditions to make it reliable to cultivate them and achieve high yields;
 - o creating or retaining good taste, odour and texture and subsequent processing potential for produce, ingredients and the food product;
 - o being able to break down the crop into different fractions, e.g. proteins, amino acids, vitamins, etc. In this respect, it is also possible to develop better nutritional properties and higher absorption of nutrients while retaining produce quality;
 - o being able to document crop sustainability and avoid waste;
 - o being able to produce high yields, also under organic cultivation conditions (without the use of pesticides).
- Optimised application of fertiliser during crops' growing season.
- Improved guidelines for and knowledge of cultivation, crop rotation, species selection and catch crops: e.g. focus on cultivation, irrigation, grafting, pollination and plant protection. Both organic and conventional produce.

Recommendation 3: Processing of produce

This link of the value chain processes produce for ingredients/processed raw materials that can be used for the subsequent production of food products. There are many short-comings in this link of Denmark's value chain. At present, it is difficult to process a wide range of crops and produce in Denmark.

The Partnership recommends that R&D efforts be focused on:

- Developing pilot facilities for demonstrating the processing of produce in Denmark, including winnowing, extrusion, etc.
- Knowledge of separating raw materials into ingredients that retain characteristics such as taste, texture and produce quality, as well as developing processes for this that are also organically certifiable. Extraction of colour and taste that is not cost-intensive.
- Improving processed produce's keeping qualities and shelf life.
- Ensuring and documenting food safety, traceability and sustainability.
- Cascade utilisation of produce and utilisation of residual products and side flows (e.g. stems of pea plants).
- Knowledge of how plants react to heat treatment, etc.

Recommendation 4: Production of food products

This link of the value chain processes pre-processed or untreated produce into food products. Many small start-ups operate in this link of the value chain, which is also where established food companies can draw on the know-how and expertise within their existing production processes.

The Partnership recommends that R&D efforts be focused on:

- Developing and improving sensory properties such as taste, texture and odour.
- Improving functionality and nutrition by focusing on digestion and absorption of nutrients.
- Developing products that are unique (instead of replicating animal products) while developing products to replace animal products at the same time.
- Developing fermentation methods.
- Combining components, additives and clean-label products.
- Developing a production system for plant-based food products.
- Documenting food safety and traceability.
- Selecting produce and ingredients.
- Developing both organic and conventional products.

Recommendation 5: Retail, foodservice and consumers

Consumers must ultimately want to eat the products, whether they buy them themselves or if the products are served in canteens, restaurants or public kitchens. This link of the value chain is particularly focused on behavioural research and food-culture changes. The vast knowledge amassed by established food companies relating to consumer behaviour, the development of recipes and dietary meal planning can benefit small start-ups, which can reciprocate with innovative capacity, agility and new thinking to inspire established food companies.

The Partnership recommends that R&D efforts be focused on:

- Conducting behavioural research and nudging consumers, the retail trade and the foodservice sector.
- Developing food technology and recipe universes.
- Providing consumer information about dietary meal planning using plant-based food products.
- Reliably documenting sustainability and health.
- Identifying new tastes and the demand for brand-new products.
- Focusing on consumers in both Denmark and abroad and developing both organic and conventional products.
- Identifying the Danish marketing potential at export markets. Gaining knowledge of prospective new markets and of consumer preferences in these markets.

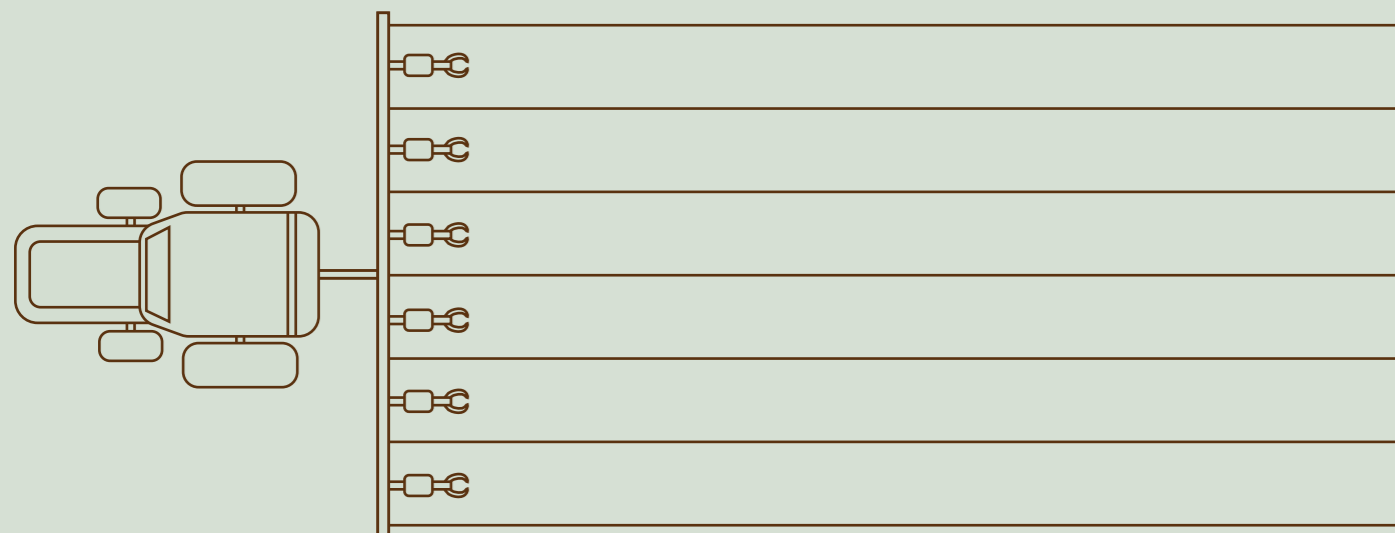
Recommendation 6: Interdisciplinary research and development

A number of R&D areas do not revolve around a specific link in the value chain but are interdisciplinary in nature, requiring cooperating, knowledge transfer and documentation.

The Partnership recommends that R&D be focused on the following interdisciplinary topics:

- Taste, health and nutrition. The consumer experience of products must be unrivalled in terms of both nutritional quality and taste sensations. For this reason, knowledge of consumer experiences, health profiles and sensory properties must be used to refine new and existing crops, and to optimise the value chain in the processing segments.

- Documentation of sustainability. The market potential of plant-based food products is related to consumer expectations of a sustainable product. Therefore, efforts must focus on documenting products' life cycles and reducing waste throughout the chain. This includes the use of data throughout the value chain.
- Traceability and food safety throughout the value chain. New types of crops and new cultivation methods, such as vertical farming, can pose new challenges to documenting food safety. Similarly, efforts must focus on managing allergens throughout the value chain, such as ensuring gluten-free products.
- Residual products can be better utilised. There must be focus on circularity, exploitation of side flows and residual flows, and correct management of produce and food products so they do not go to waste.



Recommendations for strengthening knowledge-based development of the plant-based value chain

Recommendation 7: Testing and demonstration facilities

Producing brand-new types of food products requires access to testing facilities for experimenting with crops, selecting varieties, cultivation, processing, etc.

Being able to optimise the value chain will require small testing and demonstration facilities that can process crops into the produce that can be used by food companies, so that the quality parameters achievable through cultivation and selection of varieties are measurable in the final ingredient/product.

The Partnership recommends taking the following actions:

- finding a locality for testing facilities and a model farm for outdoor vegetables, legumes, grain, kernels, seeds, fruit and berries, etc. (to replace the current model farm at AU, which is being shut down);
- increasing the amount of laboratory equipment, field experiments, growth chambers, etc., at universities;
- establishing a series of testing and demonstration facilities in Denmark for the processing of produce;
- establishing additional testing/demonstration facilities for small-scale food-product processing.

Recommendation 8: Ensuring know-how transfer and training

An important element of optimising the value chain is to make it more knowledge-based and ensure that new knowledge will benefit the entire value chain.

The Partnership recommends ensuring:

- supplementary training and research expertise focused on plant-based products;
- supplementary training and knowledge transfer to kitchen staff, domestic science teachers, dieticians, cooks and other segments of the foodservice sector;
- supplementary training of food-industry staff tasked with new types of produce;
- sufficient knowledge-based consulting services for farmers who want to cultivate new types of produce;
- training of retail staff on correct handling and storage of fruit and vegetables;
- knowledge for consumers on how to use new products.



Methodology

- The strategy was prepared by the Danish Agriculture and Food Council on the basis of interviews with a number of stakeholders in the area of plant-based food products.
- A series of existing research publications have also been involved in the process. These include Forsk2025, Green Solutions of the Future (Fremtidens grønne løsninger), World Class Food Innovation towards 2030, as well as the 2030 Research Strategy for Danish Agriculture.
- The strategy has been discussed and adopted by a steering committee made up of Arla, Danish Crown, Crispy Food & Nisco, the Frej Think Tank, the Vegetarian Society of Denmark, SEGES and the Danish Agriculture and Food Council.



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