



## Preface

The rest of the world often looks to the Netherlands for the latest knowledge and innovations in agriculture and horticulture, food and water. Logical, since for many years, the Dutch knowledge infrastructure, the leading position of industry and the close collaboration between businesses, knowledge institutes and government have generated outstanding innovations that have solved major social problems.

Since 2011, the establishment of 'top sectors' in the Netherlands has accelerated this collaboration between the private and public sectors. Within these top sectors, sectors where Dutch industry and research centres excel globally, the players determine which important knowledge topics to invest in and work together to produce concrete solutions in the 'innovation helix'.

In this collection, you will find a number of examples of projects where industry and knowledge institutes have worked together to develop innovations with a positive social impact in the fields of agriculture, water and food. For a full summary of the projects, please visit [www.kia-landbouwwatervoedsel.nl](http://www.kia-landbouwwatervoedsel.nl).

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# Healthy food turns out to be tasty too

“At home, children asked for vegetables they had tasted at school.”

“With a healthy diet, children perform better.”

**Children’s eating habits improve if they are offered lunch at school: this was the conclusion of the Gezonde Schoollunch (Healthy School Lunch) project led by Wageningen University & Research and financed by the Agri & Food Top Sector. Teaching healthy eating habits at a young age can help prevent major health problems later in life.**

The statistics are clear: Dutch children eat far too little fruit, vegetables and wholemeal bread and drink too many sugary drinks. For example, boys between 14 and 18 eat an average of 100 g of vegetables each day, while the standard is 250 g. And they eat less than 70 g of fruit, while the recommended daily consumption is 200 g. The consequences can already be seen: 13% of young people in the Netherlands are overweight. And in the long term, these unhealthy eating habits will lead to a major increase in obesity and diabetes. By influencing eating patterns at an early age, you can prevent a great deal of misery later. The Healthy School Lunch project studied the effects of offering

primary school children a lunch that fully complies with the Healthy Eating guidelines. The pupils of three primary schools were given lunches at school for six months. They were offered the choice of wholemeal bread, healthy toppings, vegetables, water, milk and buttermilk. There was something extra each day, such as soup, salad, an egg or fruit.

One of the participating schools was De Blauwe Lijn, a primary school in Amsterdam. “Not all our pupils eat a balanced diet at home”, explains office manager Anissa el Khayati, “and they are often unfamiliar with some types of fruit and vegetables. It was great to see that children began asking at home for vegetables that they had tasted at school. The children discovered that a healthy meal is actually tasty.” The project has produced interesting results. Compared to lunches brought from home, many more children ate vegetables (50% with school lunches compared to 7% with lunches brought from home). More children also ate wholemeal and brown bread (85%

compared to 52%), more children drank water or milk (75% compared to 44%) and fewer children drank sugary drinks (4% compared to 28%). A large majority of the pupils said they wanted school lunches all the time. De Blauwe Lijn also aims to continue offering healthy meals.

El Khayati: “We see that children who eat a healthy diet also perform better. We already offer our pupils fruit and vegetables as standard and are making plans to offer the older children a healthy breakfast. Hopefully, we’ll be able to start doing this soon.”

Together with those of other projects, the results of this project will be combined in a report for the Ministry of Health, Welfare and Sport on the introduction of a healthy school lunch in all Dutch primary schools. This will help 1.5 million children learn to eat a healthier diet while laying the foundation for a systematic improvement in their eating behaviour.

*The Gezonde Schoollunch project was implemented by Albert Heijn, Dutch Cuisine, the Municipality of Ede, GroentenFruit Huis (Fruit and Vegetable House), Koninklijke Vezet, the Nederlands Bakkerij Centrum (Dutch Bakery Centre), the Nederlandse Zuivel Organisatie (Dutch Dairy Organisation), Sarphati Amsterdam, VU Amsterdam and Wageningen University & Research.*

# Towards a climate-neutral greenhouse

**The Dutch greenhouse horticulture sector aims to be climate neutral by 2040. In concrete terms, this means eliminating CO<sub>2</sub> and pesticide emissions, making full reuse of the water in the greenhouses and tackling diseases and pests organically. A demonstration greenhouse has been established in Bleiswijk. Here, researchers from Wageningen are working each day on the sustainable cultivation of the future to reach this goal.**

In the demonstration greenhouse, with four sections of almost 350 m<sup>2</sup>, researchers and growers are learning how to grow plants without fossil fuels and without emissions of water and nutrients. Frank Kempkes is an Energy and Greenhouse Climate researcher at Wageningen University & Research in Bleiswijk. "In this greenhouse, we can try things that are not possible in practice. Once we have a better understanding of what is needed to cultivate plants without emissions, we can help the horticulture sector achieve cleaner cultivation and better harvests."

The greenhouse horticulture sector certainly needs that help: the sector's goal is to become fully climate neutral by 2040. The greenhouse in Bleiswijk has been operational for two years. "We are taking major steps towards emission-free greenhouse cultivation. While we aren't there yet, we will eventually succeed in growing without fossil fuels and being practically emission free."

## CO<sub>2</sub>

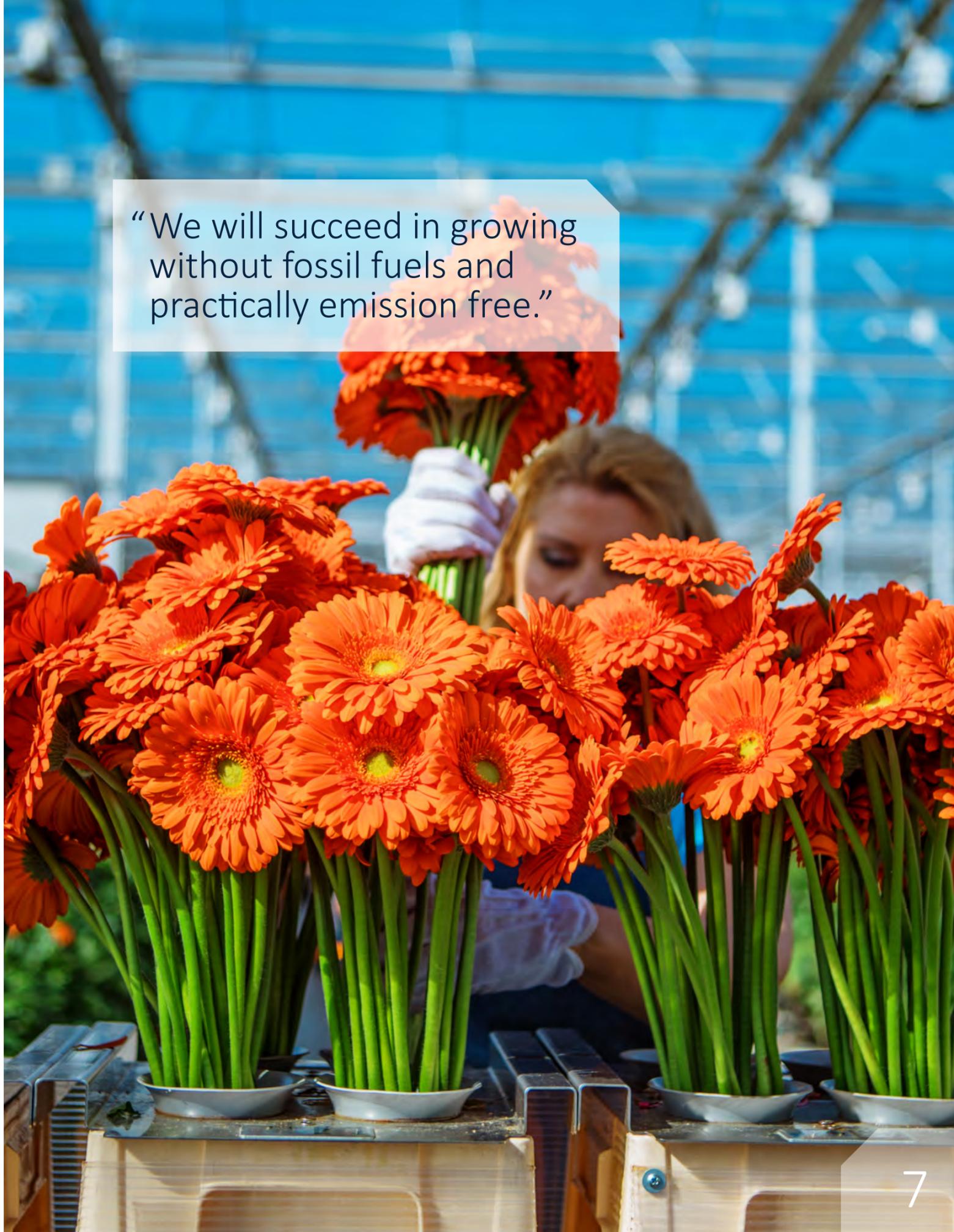
In Dutch greenhouses, energy is required to heat and light the crops. The greenhouse horticulture sector is a major consumer of fossil fuels, such as natural gas. The researchers are working with strawberries,

Gerbera, Freesia and potted Anthurium. These products occupy the middle range in terms of energy consumption. At present, growers often use boilers or a co-generation system to heat their greenhouses. These systems convert fuel (natural gas) into heat and/or electricity. Burning natural gas releases CO<sub>2</sub>. CO<sub>2</sub> is a greenhouse gas and a contributing factor in climate change. However, CO<sub>2</sub> is also important for the horticulture sector, as the plants in the greenhouse need this gas to grow. Kempkes: "In the winter, when there is a high demand for heat, a great deal of CO<sub>2</sub> is available. However, the plants require little CO<sub>2</sub>, which means it cannot be put to good use. In the summer, the opposite is true: there is a high demand for CO<sub>2</sub>, but less is available. This imbalance is a challenge. In the future, alternative CO<sub>2</sub> sources will be necessary if we are no longer burning fossil fuels."

The demonstration greenhouse uses sustainably generated electricity for heating, rather than gas. The goal is to make the greenhouse as efficient as possible in terms of heating and lighting, as sustainable energy sources are not available in unlimited quantities. The crops are lit with efficient LED lighting. "We determine the ideal lighting mixture for each crop. This means considering not just the effects on the crop, but also on its disease resistance, its natural predators and the effect of these lighting conditions on employees."

## Overall picture

De Eindhovense lichtfabrikant Signify is een van de Signify, a lighting manufacturer from Eindhoven, is one of the project partners. Esther de Beer, Plant Specialists manager at the company, sees the integrated approach of this project as a major benefit. "LED lighting can make an important contribution to

A woman with blonde hair, wearing a white glove, is holding a large bouquet of vibrant orange gerbera flowers. She is standing in a greenhouse, with the metal frame and blue sky visible in the background. The flowers are in the foreground, and the woman is slightly out of focus behind them.

"We will succeed in growing without fossil fuels and practically emission free."

increasing the sustainability of the horticulture sector. But optimum growing with LED lighting means more than just good lamps: you need to consider the overall picture. It's not just about the right light and lighting mixture, it's also about the interaction with other cultivation factors. We can subsequently incorporate these insights into advice for growers who are starting out with LED lighting."

#### Taking steps

De Beer explains that the project has already generated interesting results: it has been shown that all four crops can be cultivated effectively with 100% LED lighting. However, she says there is still more work to be done. The study will continue for another two years, and there are more items on her wish list. "Strawberry growers want to be able to produce all year round, with stable yields and few crop rotations. In theory, this is possible with a particular type of strawberry: the 'everbearers'. While the production volumes realised with them are promising, there are still a number of technical challenges. It would be great if this study brings high-quality, year-round production within reach. As regards potted Anthurium, achieving sufficient quality in winter is still challenging. We are continuing to optimise the light and temperature balance and develop an energy efficient lighting strategy for Freesia and Gerbera. This offers new opportunities for increasing sustainability." The project has given the lighting manufacturer new insights into lighting, and also the relationship between light and other cultivation factors, such as temperature and humidity. "Both the project results themselves and the current exchange of knowledge are valuable. They help us develop new products that meet the needs of growers, and also allow us to give our customers better advice about using them in practice."

#### Dehumidifying

Heat pumps are used to dehumidify air. They also allow heat to be reclaimed. Kempkes explains that dehumidifying is important, as plants always produce humidity. "If the humidity in a greenhouse is too high, moulds can form. You don't want them on your crops. Humidity can also have a negative effect on product quality. It's just like at home: if we insulate well and completely seal the house, ventilation (dehumidifying) becomes more important. The challenge is to do this in an energy efficient manner, or even reclaim energy, as is possible in greenhouses."

"We determine the ideal lighting mixture for each crop."



#### Water

The demonstration greenhouse uses water efficiently, and already complies with water guidelines that will apply from 2027. The drainage water is captured, filtered, decontaminated and reused together with the condensation water. This means no nutrients are lost and no pesticide residues are released into the natural environment. Rainwater is the primary means of irrigating the crops in the greenhouse. "By using normal rainwater, you avoid the accumulation of elements that are harmful to the plants. In many locations, tap water contains too many salts for plants. In most cases, well water is also only suitable for irrigation after treatment, as it is too salty in coastal areas or contains too much iron. This means reusing clean water is very important in greenhouse horticulture. If the water you start with is good, recirculation is no problem at all."

#### Army

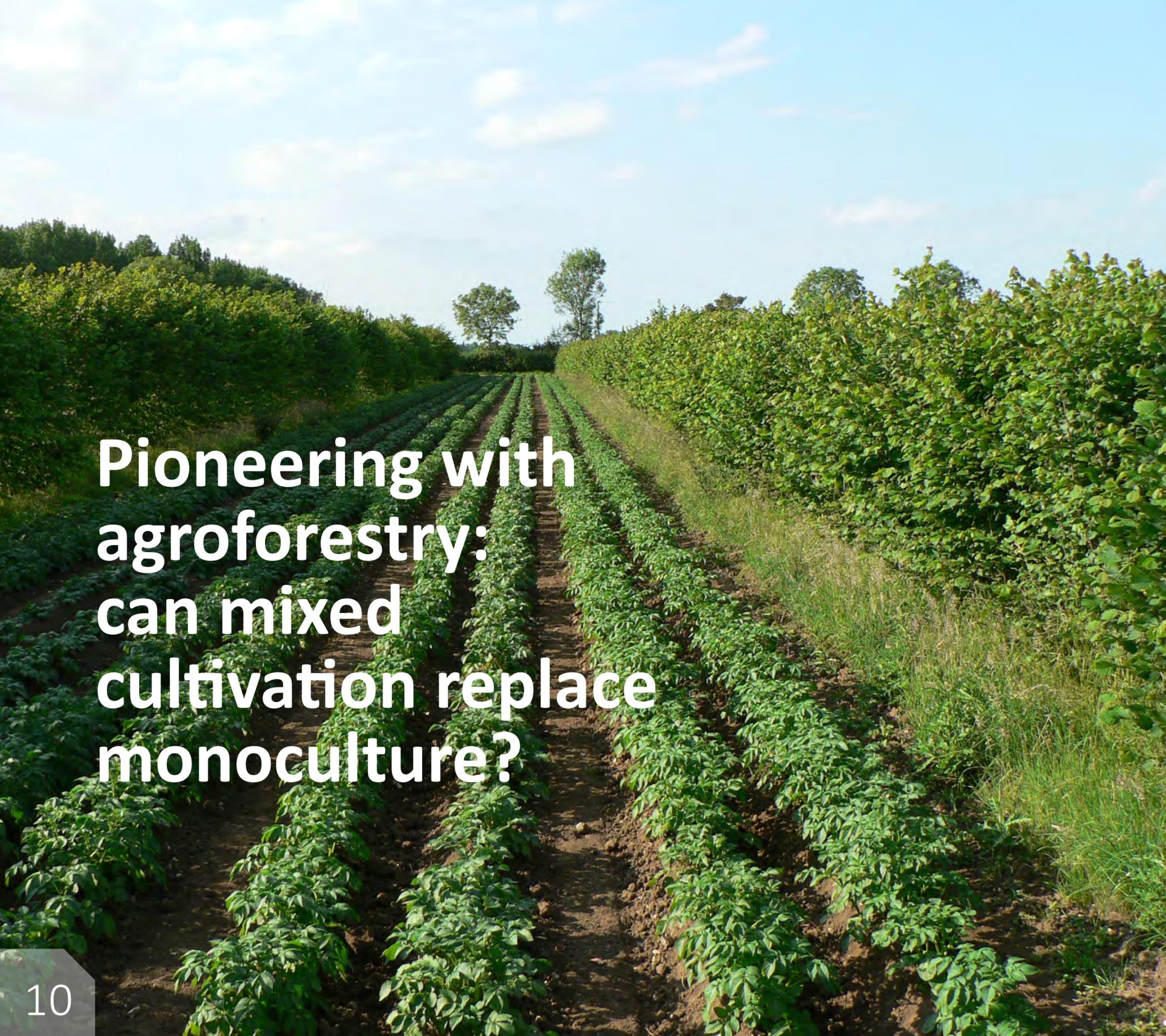
In the greenhouse, experiments are also being carried out with a "standing army" of organic fighters such as predatory mites, bugs and parasitic wasps that are always present in the greenhouse. These are natural predators of pests such as thrips, whiteflies and aphids. Growers already make extensive use of organic pest control measures. However, they often only order them once their crops are already affected by infestations. This takes time, and in the meantime the infestation can develop further. "If you ensure that you always have these natural pest predators in your crops, they can – just like an army – immediately attack when required. This allows you to create a natural balance in the greenhouse." However, the conditions in the greenhouse must allow these natural predators to survive. "For example, we currently have a number of plants among the crops where these natural predators feel at home and lay eggs. By feeding them now and then, they continue to survive and can fight pests when required. However, there are also insects with a double role. The larvae of some hoverflies attack aphids, while the adults feed on pollen and nectar. They thus contribute to the pollination of crops such as strawberries. As researchers, we are delighted by these wonderful side effects." At the same time, we don't yet know the natural predators of all pests. A team of

entomologists is researching the conditions required to ensure the continuous presence of these natural pest predators and their effects. Kempkes: "Once we have gained more experience and a greater understanding of this, the use of chemical pesticides can be reduced considerably and consequently, also the emissions of these chemicals. Of course, this will also reduce growers' costs."

#### Freesia

Every two or three weeks, growers visit to see the progress and discuss the next steps. There are still challenges for each crop, according to Kempkes. For example, Freesia is still grown in soil. To fully close the water cycle, the plant must be grown in a substrate. "We have begun cultivating in containers in the ground that are filled with river sand. While the crop grows well in these containers, we have been unable to make them fully watertight. In our low-lying polder in Bleiswijk, this leads to the ingress of groundwater, which contains fluorine. Unfortunately, Freesia is very sensitive to this. If you reuse this water, the substance remains in the water, which leads to serious cultivation problems. This is a puzzle we still have to solve." The water cycle can be almost completely closed for strawberries, Anthurium and Gerbera. Kempkes says there is still a great deal of cutting-edge research to be done. "Each crop requires a unique mix of energy, crop protection measures, water and nutrients. We are experimenting here with four crops, so we still have a lot of work to do."

*KAS2030 (GREENHOUSE2030) is financed by the Kas als Energiebron (Greenhouse as Energy Source) programme, which promotes energy saving and the use of sustainable energy in greenhouse horticulture. The programme is financed by the Horticulture & Propagation Materials Top Sector, Glastuinbouw Nederland (Greenhouse Horticulture Netherlands) and the Ministry of Agriculture, Nature and Food Quality.*



# Pioneering with agroforestry: can mixed cultivation replace monoculture?

**In Lelystad, the first large-scale research facility for agroforestry in the Netherlands is under construction. This type of farming system combines trees with agricultural and horticultural crops on a single plot. Such a combination of different crops leads to greater biodiversity, as well as more resilient and more climate friendly agriculture. Can this system increase the sustainability of Dutch agriculture?**

With agroforestry, monoculture – which focuses on large fields with a single crop – is replaced by mixed cultivation system of vegetables, arable crops or grass, and woody crops such as fruit trees, fruit bushes, nut trees or trees for timber production. This combined cultivation has the potential to perform better than monoculture in economic and ecological terms. However, there is still insufficient knowledge about and experience with the combined cultivation of woody crops and annual arable and vegetable crops.

Maureen Schoutsen is a sustainable agricultural systems researcher at Wageningen University & Research. She leads a four-year research programme financed by the Agri & Food Top Sector, in which the university is working with arable farmers to investigate the potential of agroforestry in the Netherlands. “Farmers need knowledge most of all. We need to accumulate practical experience with agroforestry to discover where the opportunities and sticking points are. We are doing this in partnership with arable farmers who have already started out with agroforestry. Which problems do they face as regards techniques and mechanisation, which crops are suitable, what are the regulatory challenges? There are so many unanswered questions. We’re currently playing a really pioneering role.”

The research must also provide answers to major questions: what can this agricultural system deliver in terms of production and soil fertility, and how can nature and biodiversity be integrated into profitable business operations?

### Diverse

Dutch agriculture is known worldwide for its highly efficient food production. However, Schoutsen says it is becoming apparent that there are limits to the extent to which agriculture can be scaled up and intensified. "Thanks in part to the use of artificial fertilisers and pesticides, monoculture has worked well for many years. This crop cultivation system produces large quantities of the same thing, but also makes crops more vulnerable to disease and pests. For a long time, we have been able to keep these at bay with pesticides. However, these substances also have an adverse effect, and their use is increasingly being curtailed. We really need to transition towards a more diverse agricultural system."

### Benefits

Wijnand Sukkel, a senior researcher in sustainable agriculture at Wageningen University & Research, is involved with this research. He sees agroforestry as a serious alternative to the existing monoculture. "Previous research has shown that the crops in this

"We are the only industry in the world capable of capturing the greenhouse gas CO<sub>2</sub>"

agricultural system consume light, water and nutrients more efficiently than in monocultures. Examples from abroad have shown that the productivity achieved with agroforestry can even exceed that of conventional agriculture. Combined cultivation of agricultural crops and trees also offers more shelter and sources of food for useful natural predators that attack the insects that affect plants. This creates a more resilient and biodiverse system, where crops are better protected against extreme weather and where there's more space for insects, animals that

live on the ground, birds etc." The researcher also sees social benefits to agroforestry: the combined cultivation leads to more organic material in the soil, captures more carbon (in the trees and soil) and creates a varied and attractive landscape.

### Image

Within the project, the researchers are collaborating intensively with farmers who have already started working with agroforestry. Schoutsen says the participants have a variety of motivations. "Some believe the current agricultural system is no longer sustainable, some want to improve their image, while some are looking for a new revenue model. Others are obliged to adopt a more environmentally friendly cultivation system to retain the lease on their land. We are investigating what these farms are doing and how we can make this system efficient and profitable."

### Climate change

Piet Hermus runs a 53-acre arable farm in the Zevenbergschen Hoek in Brabant, where he grows potatoes, winter wheat, grass seed, onion sets, sugar beet, carrots and celeriac. As an arable farmer, he foresees major challenges as a result of climate change, with periods of both extreme drought and rain. "The way we all live now is unsustainable. We need to come up with something new. And that means not just talking, but also doing." He has 'freed up' 4.2 hectares of ground for agroforestry, where he is experimenting with a combination of hazel, willow and arable crops. His goal is simple: to discover whether this new system works. "I'm curious to see whether agroforestry can create a more robust system, which is more climate resilient and which can reduce our reliance on pesticides."

### Society

He also hopes that his participation in the research will lead to a discussion with society at large. "Farmers are often seen as part of the problem as regards climate change. However, we could also be a major part of the solution. We are the only sector in the world that is capable of capturing the greenhouse gas CO<sub>2</sub> rather than emitting it: plants and trees 'capture' CO<sub>2</sub>, as they need it to grow. That means our crops can help reduce global warming. We just need space to make it work from an economic point of view. Farmers are not the

only ones with responsibility for doing something about climate change. Our society also needs to change. My farm is on the road from The Hague to Brussels. My message to the politicians is: please drop by!"

### Experiment

Hermus has chosen to plant rows of trees at a distance from his arable crops, so that he still has space for his machinery and does not need to purchase new equipment to harvest and fertilise his crops. As a farmer, he really sees it as an experiment. "Firstly, we all (entrepreneurs and researchers) need the space to develop new systems, to try them out and refine them. By experimenting, you discover what works and what doesn't. It will take some time before you really see results. I'm 55 years old and won't be able to benefit, but I hope the next generation of farmers will."

### Results

The research has been ongoing for two years. The knowledge acquired has been used to publish a series of factsheets that farmers can use to investigate the opportunities for agroforestry on their land. The research facility in Lelystad is another result of the project. It is partly financed by the project and partly by WUR. At the facility, researchers from various specialist fields will study the applicability of agroforestry in the Netherlands. The facility will be equipped with sensors to collect data on the climate, microclimate, wind (speed) and soil conditions (temperature and humidity). "This allows us to use real scientific data to determine whether this system has potential", explains Schoutsen. In the coming two years, the researchers will focus on continuing the research and supporting the arable farmers, accumulating experience with mechanisation, biodiversity and readings in the various agroforestry systems etc. and – in Lelystad – collecting data on the microclimate. We're also setting up communities of practice, in which all players in the field of agroforestry, from farmers to government agencies, can share knowledge."

### Transitioning

Sukkel: "The developments in mechanisation and technology are proceeding very rapidly. At the same time, we are learning more and more about what works in agroforestry and what doesn't. If regulations were to offer more scope for this promising form of sustainable agriculture, we could rapidly transition and agroforestry could develop into a mature, productive part of Dutch agriculture within fifteen years."

"Agroforestry can be more productive than conventional agriculture"

*The Agroforestry project is being implemented by Wageningen University & Research, arable farmers, the Nederlandse Notenvereniging (Dutch Nut Association), Rombouts Agroecology and the Stichting Agroforestry Zuid-Nederland (South Netherlands Agroforestry Foundation).*



# Insects, bacteria, moulds and viruses on plants know no borders

**The Netherlands is a major player in the import and export of agricultural and horticultural products. Sales of fresh vegetables, fruit and ornamental plants alone amount to more than €23 billion annually. A single harmful organism on a cucumber or tomato can bring all these trade flows to a standstill. How can you prepare yourself as a sector – and as a country?**

In a study financed by the Horticulture & Plant Propagation Materials Top Sector, researchers are acquiring knowledge about plant pathogens that are not yet present here, but which nevertheless represent a concrete threat to Dutch cultivation and trade, and which we simply know too little

“This knowledge is really essential to determine where the risks are.”

about. Dutch vegetables, flowers, fruit, plants and propagation materials are sold across the world. However, internationalisation and climate change mean the ‘borders’ that hold back harmful organisms such as viruses, bacteria and moulds are also disappearing. If these organisms appear in the Netherlands, they can cause major problems. If a single harmful virus or a dangerous bacterium or mould is found on an apple, cucumber or chrysanthemum, entire batches of products or crops must be destroyed and trade flows will come to a standstill as a result of the measures implemented to prevent the organism establishing a foothold and spreading. This means it is essential that Dutch horticultural producers are protected against these harmful organisms. Not just to protect crops, but also to maintain access to global markets

#### Tracing

Peter Bonants leads the project from Wageningen University & Research (WUR). “It could easily happen to our country. Take Italy: there, olive trees are badly

affected by the deadly *Xylella fastidiosa* bacterium. This nasty bacterium destroys entire orchards, and an effective remedy has still not been found. If you take home an olive tree as a souvenir of your holiday in Italy, such bacteria can easily spread and adapt here. In the Netherlands, we really need to be prepared for such plant pathogens, which are just waiting to attack our horticultural products.” Globally, all these pathogens lead to revenue losses of 30%. Climate change may make those losses even greater, as a result of new viruses, new insects that transmit these viruses and more severe reactions by plants. According to Bonants, when new outbreaks occur, there is often little known about how to trace the organism, the risks, how it spreads and how to tackle it.

#### Priorities

In this project, researchers from WUR, businesses and government agencies are working together to study a number of organisms that could or do form a threat to Dutch agriculture and horticulture. Together with these businesses, a list of seven priority organisms has been prepared for which the lack of knowledge is currently

most pressing. This study aims to map the risks and generate knowledge about those priority organisms. “For each organism, we must also determine which research is necessary to obtain answers to our questions. This research will naturally take place in a lab or quarantine facility, because it is important that these harmful bacteria do not escape.” For example, research is being carried out into a rapid detection method for the *Xanthomonas* bacteria in Anthurium. “With new technologies such as Next Generation Sequencing, you can determine within 25 hours whether a plant has been infected with a pathogen or not. We are now investigating whether this technology can also be used for Anthurium and whether certification services can use it.”

#### Routes

Another example is the virus vector pathway. “Plant viruses need help to spread: many of them make use of insects. Due to internationalisation, more and more trade routes are emerging, for example between Africa and Europe. Certain viruses that do not yet

occur here may reach the Netherlands from Africa by way of insects such as whiteflies, with all the negative consequences this entails." The study is investigating where the risk of new viruses lies, which pathways are important and what impact these insects will have on the Netherlands. "It may be that these insects will not find our climate hospitable at all and will not survive. Or we may find ways to ensure that the insects are unable to survive here", explains Peter.

#### Basic knowledge

LTO Netherlands is one of the project partners. According to Anneke van Dijk, a specialist in plant health/phytosanitary policy, this research is important for their members as it will allow basic knowledge to be acquired rapidly when new threats from pathogens arise. "This knowledge is really essential to determine which risks exist in relation to the introduction and spread of pathogens, to develop diagnostic tests, detection and monitoring methods and to develop prevention and control measures." When the research started almost two years ago, a number of new threats were already known. The researchers immediately started working on them. According to Van Dijk, this has generated a great deal of knowledge, which the sector and certification services can put to good use. "The great thing about this project is that it builds a bridge between fundamental knowledge about harmful organisms and the application of that knowledge in practice. This delivers validated testing methods and a range of concrete factsheets that explain how to deal with certain pathogens in practice." The knowledge acquired is sometimes more fundamental, as Van Dijk points out. For example, it might be testing new methods of characterising the various types of a virus and acquiring more knowledge about known pathogens.

#### Threat

Growers, traders, importers and regulatory bodies can use the knowledge acquired to protect Dutch products against the pathogens that threaten to overwhelm the country. However, Van Dijk also believes that knowledge will also allow a more targeted approach to fighting pathogens. "If you understand an organism and know how to identify and tackle it, you can implement targeted measures to prevent such harmful organisms taking hold and spreading." While the study is taking place over a period of four years, Bonants says the work is never done. "As long as plant diseases and pests are spreading across the world, we will have plenty of work to do."

"The project builds a bridge between fundamental knowledge and its application in practice."

*In the project, LTO Netherlands, Plantum, Glastuinbouw Nederland (Greenhouse Horticulture Netherlands), VBN, the GroentenFruit Huis (Fruit and Vegetable House), Naktuinbouw, NAK and the Nederlandse Voedsel en Waren Autoriteit (Dutch Food and Consumer Product Safety Authority) are working together with the Ministry of Agriculture, Nature and Food Quality and Wageningen*

# Closing regional nutrient cycles by extracting biogas and minerals from pig manure

**Groot Zevent Digestion has been producing renewable energy from co-substrates and manure for 17 years. With the Green Mineral Mining Centre, the company has taken a major step forward in nutrient recycling. Alongside biogas and electricity, Groot Zevent now also uses their residual digestate to produce an organic soil improver with a low phosphate content, clean water and biobased nitrogen fertiliser to replace synthetically produced nitrogen fertilisers and a phosphate rich organic fertiliser. The Green Mineral Mining Centre fits perfectly with the Dutch government's vision for the circular economy and circular agriculture. The Top Sector Agri & Food and the Top Sector Energy financed a number of projects that helped the Green Mineral Mining Centre come to fruition.**

Groot Zevent Digestion has been processing excess manure from pig farms in the Achterhoek region for many years. "In 2004, we were one of the first companies in the Netherlands co-digesting manure in our biogas plant", explains Arjan Prinsen, an innovator at Groot Zevent Digestion. "We used it to produce biogas, which we are able to convert

almost entirely into electricity via a combined heat and power installation. We were able to sell the co-digested manure, also known as digestate, to arable farmers too. That used to be worth money at first. However, once the manure surpluses increased, we had to start paying for the disposal of digested manure and to transport it over long distances with high costs. Because of this and the introduction of the circular economy, we began looking for another solution and new revenue models."

#### Biogas for FrieslandCampina

In 2017, Groot Zevent Digestion was able to supply 10 million Nm<sup>3</sup> of biogas annually to the FrieslandCampina dairy products factory in Borculo via a 5.5 km pipeline. Prinsen: "To make this possible, we had to invest in an innovative cleaning and compression system, which allows us to upgrade our biogas to the minimum gas quality required by the factory. We also wanted to feed the system with grass and fibrous biomass for extra biogas production. The clean biogas allows the boiler at FrieslandCampina to operate at a very high efficiency. This resulted in major cost savings for both parties."

“We are closing nutrient cycles at regional scale”

#### Extracting minerals from digestate

The production of biogas creates digestate as a by-product. Prinsen: “Digestate contains valuable substances like nitrogen, phosphorus, potassium and organic matter. To make use of them, we established the Green Mineral Mining Centre in 2019 in partnership with Nijhuis Industries and for part of the installation with Wageningen University & Research. Some new technologies are in use at the Green Mineral Mining Centre such as the RePeat process developed by Wageningen University & Research. “We separate the digestate into a solid and liquid fraction with a decanter centrifuge. Using the GENIAAL process, we concentrate the nitrogen and potassium as mineral concentrates from the liquid fraction by using membrane technologies. The cleaned water that remains is returned to the surrounding surface waters. Using the RePeat process, we extract the phosphate from the solid fraction, and a fibrous, low phosphate organic soil improver is produced.

#### Sustainable biobased tailor made fertiliser

Using the mineral concentrates from the liquid fraction, Groot Zevert creates sustainable alternatives to synthetic nitrogen fertiliser. These replacements are adapted to the needs of the crop and the soil fertility. Prinsen: “The biobased fertilisers produced can be more sustainable in terms of ecological footprint, but it depends on the context. We do not use natural gas, as is the case with the production of synthetically produced nitrogen fertilisers. The transport distances to deliver the product to the farmers are also much shorter, as we supply our liquid, mineral fertiliser locally.”

From the mineral concentrate and regional produced other recovered nutrients a tailor made fertilising product is made which is tested in the pilot project Biobased Fertilisers Achterhoek. The fertilising product is tailored to crops requirement and known soil fertility status. Wageningen University & Research monitors its agronomic and environmental performance. The agronomic performance approaches that of synthetic nitrogen fertilisers while there is no differences in environmental performance. Thus there are clearly perspectives for replacement of synthetic nitrogen fertilising products by this tailor made fertilising product.

#### Fibrous soil improver

Groot Zevert also uses the solid fraction of digestate. “We wash the phosphate out of the organic matter. At present, the extracted phosphate goes to agricultural areas with a phosphate demand, but it could also be used as a raw material for the fertiliser industry. The fibrous organic material that remains is an effective soil improver, with high levels of effective organic matter and little phosphate. Besides, Groot Zevert is exploring opportunities to use this product to replace fossil peat in the potting soil industry. For Prinsen, this means the nutrient cycle is practically closed. “The minerals we obtain from manure are returned to agriculture via the Green Mineral Mining Centre. In this way, we are closing the nutrient cycle here in the Achterhoek region.”

*Groot Zevert Digestion, Nijhuis Water Technology and Wageningen University & Research worked together in the Top Sector project Meerwaarde Mest en Mineralen (Valorisation of Manure and Minerals) project.*



New roof cools,  
captures water  
and increases  
biodiversity

**Smartroof 2.0 has shown how a project can create a spin-off effect for both the participating partners and others far beyond. This innovative blue-green roof – which cools, captures water and also increases biodiversity – is showing cities how to adapt effectively to the changing climate. “The eyes of the world are focused on this roof”, claims co-founder Joris Voeten.**

When the Smartroof 2.0 project began five years ago, a great deal of work still had to be done by the supplying industry, as Joris Voeten from Drain Products Europe BV explains. He was responsible for bringing together all the required technologies and materials. “Many innovations are required to create a blue-green roof. You need to consider numerous factors simultaneously, from water management to vegetation development. The fact that a great many delegations from across the world have come to see it demonstrates how successful we were.”

**Tackling urban heat island effect**

This is confirmed by Sacha Stolp, Future-Proof Assets Director at the Municipality of Amsterdam, where the smart blue-green roof has been installed at the heart of the city on the Marineterrein, a former naval dockyard. Stolp: “Amsterdam aims to be circular, climate adaptive and energy neutral by 2050. I am always looking for projects like Smartroof 2.0, and I bring parties together wherever I see opportunities. We wanted to see whether we could use urban roofs to cool using rainwater, to combat the urban heat island effect. We also wanted to demonstrate the effectiveness of the new roof system using hard data. To achieve this, we engaged KWR as our scientific partner. By initiating this partnership as a TKI (Top Consortia for Knowledge and Innovation) project, we have seen how these consortia can overcome sectoral boundaries. By bringing together knowledge institutes,

government and business, we can take each other’s interests into account. Everyone is always talking about the enormous challenges posed by climate adaptation. And if we’re being honest, we know: the solutions are there, you just need the courage to put them into practice.”

**Characteristics Smartroof 2.0**

Which characteristics does the blue-green roof have, and which results does it deliver? Smartroof 2.0 is a new roof system that provides maximum cooling, retains water and is nevertheless lightweight.

By employing a Permavoid hollow, water-retaining base with special fibre columns, the water that falls on the roof is retained and released again via capillary action when the plants need it. With this solution, the plants can use the water over a longer period of time for evaporation and to contribute to tackling heat stress. The blue-green roof also makes a major contribution to biodiversity. “Compared to other green roofs and roof gardens in the western Netherlands, we came out on top two years running in terms of species diversity”, explains Voeten proudly. “That is a huge bonus.”

**Urban water technology**

For KWR, Smartroof 2.0 has increased the visibility of scientific research into the urban water chain enormously. Gijsbert Cirkel, a hydrologist at the knowledge institute with responsibility for substantiating how the blue-green roof works, is enthusiastic. “It meant we could transfer technologies we were already developing for drinking water companies to the city”, he explains. “And Smartroof 2.0 provided great topics for student assignments. By mapping the water and energy balance of the blue-green roof, we have refined our knowledge about them. This has been published in a peer-reviewed paper, which is a great result for KWR as a research institute. The value of this type of project is that it delivers demand-driven research, with knowledge and insights that can be used in practice. By demonstrating that the roof does what it promises, it is much easier for the supplier to sell the product.”

**Revolution in water management**

Despite all this, Voeten believes the most important impact of Smartroof 2.0 is

not that it has created a market. “It is mostly about creating a new mindset in urban water management”, says the enthusiastic engineer. “You can’t express that in sales of a certain number of square metres of an innovative roof. It’s about changing the mindset of ‘rainwater needs to be disposed of’ to ‘rainwater needs to be harvested’. For me, the great thing about TKI projects like Smartroof 2.0 is that the government offers industry the opportunity to invest in an innovation that has been scientifically proven to work. In answer to the question of whether the Top Sector policy is strengthening the Dutch knowledge economy, my answer is very clear: yes!”

**Spin-off**

The fact that Smartroof 2.0 has had a huge spin-off effect can be seen on many fronts. “With the new European Resilio project, we are scaling up to other roofs in the city”, says Stolp. “This will include studying the interaction between various stakeholders. We are also investigating the possibility of using the same technologies under asphalt to cool it. And with CitySports – also a TKI project – we are developing applications for artificial grass sports fields.”

**Publicity explosion**

countries”, explains Stolp with great enthusiasm. “It is no coincidence that we received the Zonnetje (Sunshine) award from the former delta commissioner Wim Kuijken in 2018. This is an award for projects that are leading examples of innovation. For us, Smartroof 2.0 was the

“The mindset must change from ‘rainwater needs to be disposed of’ to ‘rainwater needs to be harvested’”

**Subsidy scheme adapted**

Innovation promoter Stolp is also happy with the top sectors. “For example, it isn’t hard to convince investors that we are going to test something new”, she explains. “In the case of the Marineterrein, we knew that something had to happen with the roof. So we said: we’ll do it, but better. That ‘better’ was co-financed by the Water Technology TKI, which allowed the roof’s effectiveness to be demonstrated scientifically. Now we know that the blue-green roof works, we have adapted the municipal subsidy scheme for traditional green roofs. The water buffering capacity of these roofs must increase, otherwise no subsidy is available. In this way, we can scale up with solutions that have proven themselves in practice. In the end, you work on the basis of economies of scale. Thanks to Smartroof 2.0, we have been able to adapt our policy to achieve our ambitions more rapidly.”

litmus test. We have shown how you can create inspirational capital: by showing what you do. Everyone who stood on the roof could see, feel and experience what it does. That’s huge added value.”

*Drain Products Europe, KWR, Creative Industries, Bureau Marineterrein Amsterdam, Ingenieursbureau Amsterdam (Amsterdam Engineering Agency) and Waternet collaborated on the project.*

“New mindset in urban water management”

# Not all cows are the same

**Cows are an integral part of the Dutch landscape. According to Statistics Netherlands (CBS), there are 1.6 million dairy cows in the Netherlands. As they ruminate and digest grass, these cows emit methane, a greenhouse gas that is around thirty times stronger than CO<sub>2</sub>. However, not all cows are the same. With selective breeding, it is possible to reduce the methane emissions of cows considerably.**

Dutch agriculture faces a major challenge. The Climate Agreement states that methane emissions must be reduced by 2.1 million tonnes by 2030. This means it is essential to take a critical look at methane emissions from dairy cows. Dairy farmers are looking for efficient and cost-effective ways of reducing methane emissions.

An average dairy cow emits 125 kg of methane annually, with the emphasis on average – because researchers from Wageningen University & Research have discovered that there are differences between cows: some cows emit less methane than others.

A study financed by the Agri & Food Top Sector is investigating whether it is possible to use this natural variation in methane emissions by selectively breeding animals that naturally produce lower amounts of methane.

## **Selective breeding**

Extensive research has already been carried out into the effects of factors such as feed composition on methane emissions. However, this is the first time that research will be carried out into selectively breeding cows that naturally emit less methane. According to Yvette de Haas, project leader and researcher at Wageningen Livestock Research, this selective breeding is cost-effective, permanent and

can be easily incorporated into the daily operational management without extra costs. The research has been ongoing for a year. Preliminary research has been conducted at 15 farms and a simulation study has been carried out based on the results. The results are startling: with selective breeding, it is possible to realise a reduction in methane emissions of around 1% per kg of milk annually, increasing to a 29% reduction in methane by 2050.

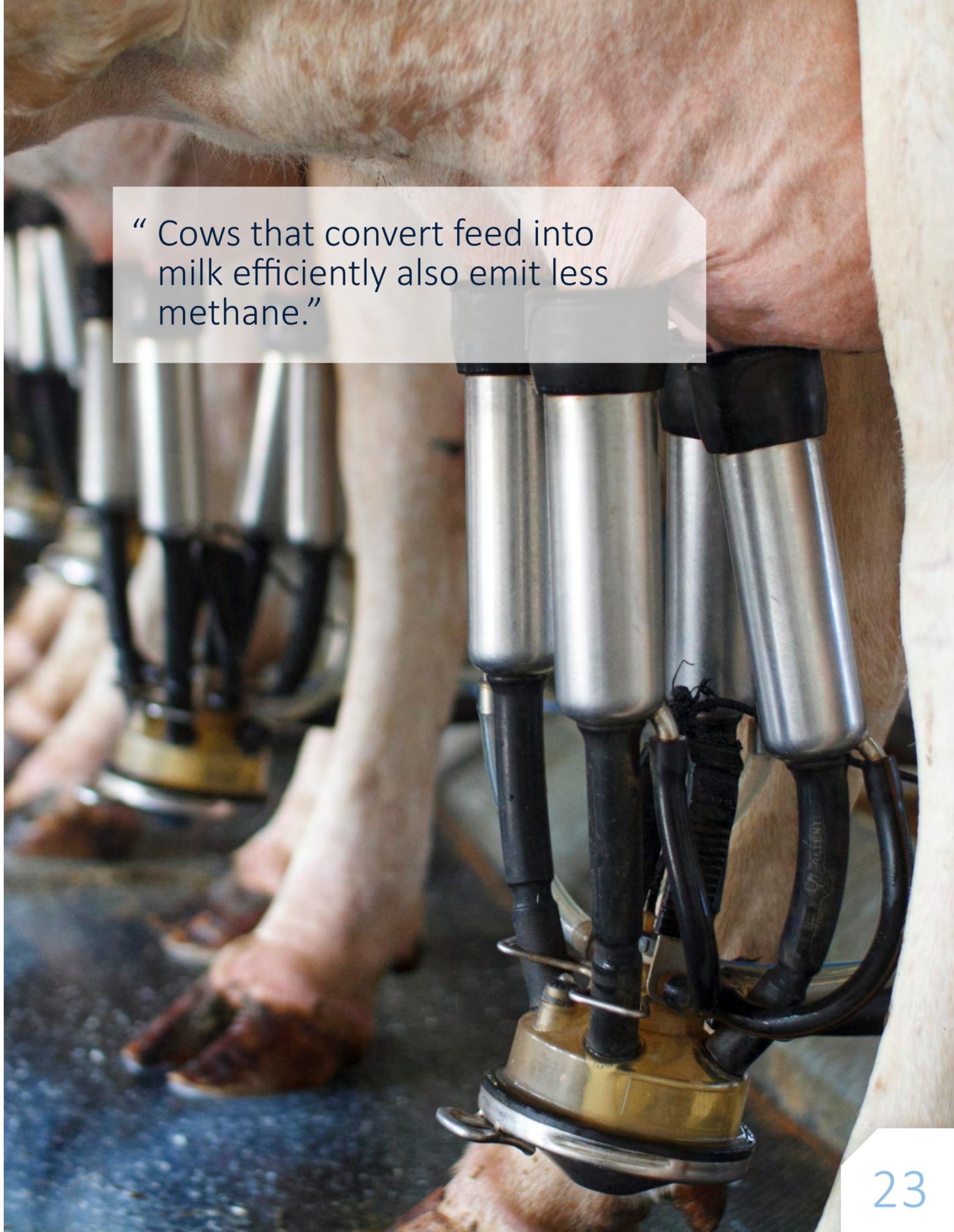
## **Sensors**

The next step is to upscale from the research project to 100 farms with on average 150 cows. This spring, these farms will be equipped with sensors that will collect information about the methane concentrations of individual cows. “To compare cows with different genetic backgrounds, the research must take place on multiple farms simultaneously. We want to know exactly how each cow performs. If a cow and bull produce naturally low methane emissions, we can select them as parents for the next generation.”

## **Practical tool**

One company also participating in the study is FrieslandCampina. Research specialist Marleen Visker hopes that this study will eventually result in a practical tool for dairy farmers. “Almost 40% of the carbon footprint of milk is caused by methane. As a sector, we need to tackle this. Our target is to realise a reduction in emissions of 33% among our member dairy farmers by 2030. Selective breeding may be one of the ways of achieving this.”

The company presented its new sustainability programme, Nourishing a Better Planet, which consists of six priorities, including carbon neutral dairy farming. “Via the Foqus Planet quality and sustainability programme, we aim to help our member dairy farmers



“Cows that convert feed into milk efficiently also emit less methane.”

increase the sustainability of their operations. They can choose themselves how to do this. The better they score for topics such as climate, biodiversity and animal welfare, the more points they will score and the higher the payment they will receive.”

Selective breeding offers dairy farmers a new method of reducing methane emissions. “The major benefit is that it is relatively easy to integrate into their daily management. After all, cows have to be inseminated.

“With selective breeding, we can achieve a reduction in emissions of up to 29% by 2050.”

If you know which bull has the best breeding values, including methane emissions, you can select that one for breeding.”

#### Rewards

While the real practical research has yet to begin, Visker is enthusiastic about the initial results. “Via this research, we have discovered that methane emissions are heritable, which means you can reduce them by breeding. This alone is a major success, particularly as we know that methane is not formed by the cow itself, but by the micro-organisms in the rumen. During this research, we also aim to develop a system that will allow compensation to be claimed for emission reductions achieved, so that farmers are rewarded for their efforts.”

#### Efficient

The CRV breeding organisation is also involved with this research and is strongly committed to breeding healthy and efficient cows “with a lower

environmental impact”. “Methane reduction goes hand in hand with efficiency. Previous research has shown that cows that convert feed into milk efficiently also emit less methane”, explains Maarten Moleman, lead innovator at CRV. “Via this joint research project, we will be able to contribute more to methane reduction in the future, while retaining production levels and other important features”.

#### Breeding value

The researchers’ ultimate aim is to determine a breeding value for each cow that farmers can use in practice. De Haas: “That breeding value can then be combined with the existing breeding values for the milk value, fertility, health and conformation traits of the cow. Naturally, a farmer prefers to breed animals that perform well across the a broad range of traits. If an animal emits low methane, but is often sick or produces little milk, then farmers will draw their own conclusions. In the end, it is up to farmers to decide which breeding values to apply.”

#### Unique

De Haas is convinced that there is a future for cows in the Netherlands. “A cow is really unique: the animal eats crops that we cannot eat and produces a completely new product (milk) that we can eat. However, achieving a lower carbon footprint for dairy products is an important part of making dairy production sustainable. Breeding is one way of achieving this. Other studies are examining nutrition and manure management. We want to support Dutch dairy farmers with a series of tools they can use to reduce methane emissions on their farms.”

*The Climate Smart Cattle Breeding project is being implemented by CRV, FrieslandCampina and Wageningen University & Research.*

# Deploy plants themselves to work against disease and pests

**Plants are very smart. They can protect themselves against nasty bacteria and moulds by making good use of their ‘own’ micro-organisms, which already live in, on or around the plant. Researchers from Wageningen University & Research are investigating how they can make even better use of these micro-organisms to tackle troublesome pests.**

Many horticultural crops are sensitive to infections and insect infestations. They ruin around 30% of harvests globally. With an ever-increasing world population, the demand for food is growing all the time. This means it is important that lettuce, carrots, potatoes, tomatoes and other crops can grow undisturbed, without being affected by disease.

To protect plants against disease and pests, farmers and growers currently have to use pesticides regularly. However, these chemicals can have negative effects on people and the environment. As such, the government aims to reduce the use of pesticides in and beyond agriculture and horticulture. In recent decades, the sector has already taken major steps towards reducing the quantity and number of chemicals used. However, sustainable change is dependent on the availability of alternative means and methods. There is a high demand for organic crop protection products based on the living bacteria and moulds that are naturally present on plants: the microbiome.

#### Resistance

In the Versterking van plantweerbaarheid tegen ziekten en plagen door aanpassing van het plant-microbiom (Increasing plant resistance to disease and pests by adapting the plant microbiome) project, the Horticulture & Plant Propagation Materials Top Sector has carried out research into the effects of the plant microbiome. The goal is to acquire knowledge about ways of adapting the microbiome in such a way that the resistance of the plant increases and it can protect itself even better against troublesome diseases and pests. Leo van Overbeek, a microbial ecologist at Wageningen University & Research (WUR), leads this project. “Plants live together with many different micro-organisms. As a biologist, I therefore don’t just look at the plant and its diseases, but at the entire ecosystem in, on and around the plant. In the past, there wasn’t much you could do with it. But now, with sequencing – mapping the DNA – and bioinformatics, you can identify many more organisms. We can see and measure them. The next step is to influence this in a natural way.” Before now, little was known about the exact composition of the microbiome and how useful bacteria and moulds help plants defend themselves against attackers. And we still don’t know what happens if the natural microbiome is modified by adding new bacteria and moulds. This study aims to change that!



“The knowledge we are now acquiring about the microbiome will serve as the foundation for plant resilience.”

“This type of research shows how a subtle intervention can affect the natural disease resistance of the plant.”

#### **Tomatoes, chrysanthemum and lettuce**

During the past three years, the researchers released ten moulds and bacteria (known and unknown) on tomato plants, chrysanthemum and lettuce plants and investigated the effects on insects (thrips) and parasitic moulds (*Fusarium*). “The interactions between plants and microbiome are complex. While there are many different organisms you can use to help plants, they may work totally differently in a chrysanthemum than in a tomato plant. This study aims primarily to increase our knowledge: what happens between the added moulds and bacteria, the plant, the composition of the microbiome and the disease? Where do the added bacteria go: to the roots, the seeds or do they remain present throughout the plant?”

#### **Testing**

The study has shown that both the microbiology in and around the plant and the plant physiology change when micro-organisms are added. However, the researchers do not yet know if this is positive or negative. Van Overbeek: “We need this knowledge to be able to take the next step. More and more chemical pesticides will eventually disappear. This means farmers and growers must find other means of protecting their plants as well as possible. The knowledge we are now acquiring about the microbiome will really serve as the foundation for plant resilience.” The researcher already sees that businesses are being inundated with biostimulants (plant growth enhancers), but he says it can be hard to separate the wheat from the chaff. “With the knowledge we have acquired, we will – eventually – also be able to test if a new product really has an effect on the plant or the microbiome.”

#### **Learning from nature**

The vegetable seed company Bejo is convinced of the importance of research into the microbiome and is a partner in the project. The company has sold an organic seed range for many years and is very interested in how the protection of seeds and crops can be “done differently”, i.e. without the use of chemicals. Liesbeth van der Heijden, senior researcher at the Seed Technology department at Bejo, is enthusiastic about the project. “We want to supply healthy and resilient propagation materials to our customers. To achieve this, we are working to

improve the resistance of our varieties. However, we also aim to learn from nature, which has a wide range of beneficial micro-organisms available. As seeds are the foundation for a healthy plant, adapting the microbiome to the seed is perhaps not such a big step towards increasing plant disease resistance.” The researcher hopes this research will provide knowledge about the effects of the microbiome in the soil, the roots and the plant, so that it can be used to protect plants against diseases and pests. “We are primarily interested in how we can achieve a beneficial effect from the microbiome on our seeds, for example through a unique seed treatment.”

#### **Balance**

Van der Heijden says the growers must find a new balance with these new organic products. However, she sees the regulatory framework as the greatest challenge. “I really hope it will become possible to use micro-organisms as crop protection products. There is a fear that the composition of the soil will change if you add micro-organisms. However, I’m convinced that they actually restore balance to the soil. This type of research shows how a subtle intervention can affect the natural disease resilience of the plant.”

#### **New generation**

The research can also be used as a guideline for comparable research into the effect of other micro-organisms. This may eventually lead to simplified registration of new organic crop protection products, which will allow them to be brought to market more rapidly. Van Overbeek: “I hope that this research can pave the way for a new generation of organic crop protection products.”

*The Versterking plantweerbaarheid door aanpassing van het plantmicrobioom (Increasing plant resistance by adapting the plant microbiome) project is being implemented by Wageningen University & Research, Glastuinbouw Nederland (Greenhouse Horticulture Netherlands), the Stichting Programmafonds Glastuinbouw (Greenhouse Horticulture Programme Fund Foundation), Incotec, Bejo Seeds and Enza Seeds.*

In the Netherlands, a quarter of all food is wasted annually. This must be reduced by half by 2030. In a Top Sector project, various companies have looked for solutions – and successfully.

“Reducing food waste in the production chain is a complex task”, says Joost Snels from Wageningen University & Research (WUR): “Everyone wants to reduce waste. It’s not only a shame that all that food isn’t consumed, it’s also a major expense. Companies lose around €2.5 billion annually due to waste. This huge sum shows how difficult it is to reduce waste.”

“Everyone wants to reduce waste. It is a shame that all that food isn’t consumed, and it is also a major expense.”

#### Increasing the value of return flows

The CARVE Top Sector project has shown that this is difficult but not impossible. In this project, companies from various sectors worked together to develop solutions to their most pressing waste problems. For example, the Sonneveld Group, which supplies ingredients to bakeries, investigated uses for unsold bread. Peter Weegels from Sonneveld Group: “Almost a quarter of all bread doesn’t make it to shopping baskets and is eventually turned into animal feed or incinerated. Sustainability is very important to us, and we wanted to find a higher quality solution for this return flow”.

#### Concrete business case

Sonneveld developed three sustainable alternatives. One of these involves processing the bread returned to produce new raw materials for bread. Weegels: “In this process, enzymes break down the bread into sugars that can be used again to produce gingerbread or normal bread. That way, we can reuse the returned bread to produce food.” Sonneveld has since carried out a test production run at 1000 kg scale with a bakery. Weegels: “We are now making the business

case as concrete as possible so we can attract investors. We believe we will eventually be able to reuse 30% of the returned bread in the Netherlands.”

#### Smarter ordering

Reusing products is a major step towards sustainability. It would be even better if waste could be avoided in the first place. In a sub-project of the CARVE project, several supermarket chains and dairy producers have investigated whether wastage of unsold desserts can be reduced by adapting the ordering process. Anne-Corine Vlaardingerbroek took part in the project on behalf of Jumbo: “We investigated whether introducing flexible ordering units could reduce losses. It turned out that smaller ordering units can sometimes be effective in reducing waste, but not always. For example, imagine you reduce the ordering quantity from six to four desserts. A branch manager who would normally order six desserts is then faced with the question: ‘Should I order four, with

# Preventing food waste with a new approach to production and distribution

“We believe we can use 30% of the returned bread to produce food.”

the risk that they may sell out, or should I order six, with the risk that two may be wasted?’ Every branch has its own turnover rate, which means it is hard to determine the optimum ordering quantity. Based on this insight, we decided to bring manufacturers’ packaging quantities used in our own distribution centres in line with the turnover rates of the branches as much as possible. That allows us to reduce losses after all.”

CARVE included a total of seven of these sub-projects. Each of these tackled a different waste-related problem. Snels: “For the participants, the sub-projects led to a major reduction in the quantities of food wasted. But we aren’t finished yet. If companies look beyond their own sectors, even greater improvements are possible. For example, waste flows from bread and dairy production can be combined to produce high-quality new products. Thanks to CARVE, we know exactly which raw materials come from which supply

chains, and that allows us to forge smart connections, avoiding waste and more besides.

The CARVE project was implemented by Albert Heijn, Aldi, the Alliantie Verduurzaming Voedsel (Sustainable Food Alliance), Arla Foods, Duynie Group, Iglo Netherlands, Jumbo, LambWeston, Plus, Royal A-Ware, FrieslandCampina, Sonneveld Group and Wageningen University & Research.

*The CARVE project was implemented by Albert Heijn, Aldi, the Alliantie Verduurzaming Voedsel (Sustainable Food Alliance), Arla Foods, Duynie Group, Iglo Netherlands, Jumbo, LambWeston, Plus, Royal A-Ware, FrieslandCampina, Sonneveld Group and Wageningen University & Research.*



# Tackling four water issues simultaneously

**It began with a big idea: take existing underground water storage and brackish water extraction technologies and use them on a large scale to produce freshwater in the low-lying parts of the Netherlands. The exploratory phase has now been completed, and the first pilots are in full swing.**

The COASTAR knowledge programme is unique in that it tackles multiple problems simultaneously, says Klaasjan Raat, co-initiator of the knowledge programme and a hydrologist at KWR. “In the Westland region, for example, there are four major issues: the demand for irrigation water from the greenhouse horticulture sector, salinisation, flooding after heavy showers and the discussion around what should be done with the by-products of brackish water extraction. In the COASTAR project, we are looking for solutions underground, something that is totally new. In the past, freshwater projects generally focused on surface water. Underground storage was forgotten.”

#### **Developing together**

Toon Boonekamp, Water for Industry team leader at Arcadis, says not everyone is currently aware of the potential of underground storage. “Thanks to COASTAR, we can now combine surface and underground storage much more effectively. We include this in our discussions with clients. In the past, when providing advice about circular water management, we would not have considered temporarily storing rainwater underground. It has many benefits. For example, the company can keep the surface free for expansion. By increasing our knowledge of underground storage, our product portfolio has improved considerably. We have also become a better conversation partner for water companies, as we understand their approach to their water management and extraction systems. As water companies are also involved with COASTAR, we are developing together. That’s really great.”

#### **Freshwater Delta Plan**

COASTAR is being approached from both the Water Technology TKI and the Delta Technology TKI. Raat: “It’s about using underground storage as an additional solution for freshwater supplies. It brings together the strategic agendas of industry, water authorities, provinces and the horticulture sector. We are also fully affiliated with the Freshwater Delta Plan. The cases

“It brings together the strategic agendas of industry, water authorities, provinces and the horticulture sector.”

implemented within COASTAR integrate seamlessly with this plan.” Raat is enthusiastic about the first successes, including the Urban Water Buffer in Rotterdam, another project by the Water Technology TKI. “As knowledge institutes and technology suppliers, we contribute our own expertise. For example, KWR is a frontrunner in underground technology, Deltares knows a great deal about groundwater models, and Arcadis is close to the market with its implementations. In COASTAR, these three parties are working together very effectively.”

#### **Mission-driven innovation policy**

According to Raats, the TKI approach has allowed these ideas to really progress from the drawing board to being implemented in practice. “It’s really great how all the parties in this knowledge programme have come together and set a collective agenda. We can work on problems in an open atmosphere, while going beyond individual interests. The top sector policy now talks in terms of mission-driven innovation. I see COASTAR as a pioneer in this respect. Various sectors are involved, and the questions are crystal clear.”

“The ideas on the drawing board are now really being put into practice.”

Dunea needs extra water for drinking water supplies, and the greenhouse horticulture sector needs extra irrigation water. Delfland is worried about residents getting wet feet. It isn't necessary to sketch an abstract perspective for the future with all these parties. We restrict ourselves to concrete problems.”

#### Waterbank Westland

One of these concrete problems comes from the greenhouse horticulture sector. “We need a lot of irrigation water, and it must be of a high quality”, explains Margreet Schoenmakers, Water Programme Manager at Glastuinbouw Nederland (Greenhouse Horticulture Netherlands), who is responsible for the Glastuinbouw Waterproof (Waterproof Greenhouse Horticulture) innovation programme. “As well as rainwater, we also use groundwater. In the Westland region, we pump it out of the ground and desalinate it. The waste flow is returned to the soil. We asked ourselves whether this was sustainable in the long term.” This was a typical problem to include in COASTAR. It led to the Waterbank Westland case, in which growers themselves can regulate the balance between supply and demand for irrigation water at area level, while simultaneously tackling salinisation. Raat sees the Waterbank Westland case as an important example for the future. “It is primarily about establishing an organisational system. How do you organise groundwater management with all parties? We could also then help other parties, for example in areas with sandy soils. In these areas, solutions involving underground storage will also be required.”

#### Collective organisation

It is not yet clear which organisational model is most appropriate. For Arcadis, which is responsible for the cost-benefit analysis, this is an interesting detail. Boonekamp: “We have analysed the technologies, and they work. We now need to consider the interaction between those with a shortage of water and those with a surplus. How do you organise something like this collectively? In the Netherlands, it hasn't yet been attempted on this scale. For us, the power of this approach primarily lies in the fact that knowledge development is immediately tested in practice. This combination of theory and practice makes it easier to obtain agreement for projects within our organisation.”

#### Thinking in terms of solutions

Schoenmakers explains that all the COASTAR partners think in terms of solutions. “Imagine that we were to capture the rainwater that reaches the surface water from paved areas on industrial estates and villages by way of ditches and store it underground. By doing so, we can tackle drought problems in a broader sense. By taking account of the 3D effect of the soil, we can develop total solutions for everyone.” Schoenmakers also admits that working towards common goals isn't always easy. “Each partner operates within their own frame of reference. For example, the greenhouse horticulture sector had a particular vision for the organisational structure. We assumed we would receive regular feedback, so we could contribute more to the decision-making process. With hindsight, it turns out that we need to make clearer agreements about how we want to work together. That's something to learn from. However, as long as we are clear about each other's interests and the nature of the problem we wish to tackle, we can work towards common solutions.”

*In het project Coastar werken Allied Waters, Arcadis, Deltares, Dunea, Delfland, Evides, KWR, LTO-Glaskracht, Provincie Zuid-Holland en Gemeente Westland samen.*

# Studying the soil to achieve the best result

**The soil is the source of all our food, from vegetables, fruit and grain to animal feed for the production of milk and meat. However, a healthy soil isn't just important for the production of food: the climate, water management and biodiversity also benefit. Everyone wants something from the soil, but how can you ensure each piece of the jigsaw is in the right place?**

Almost all agricultural and horticultural crops begin their life in the soil. Due to the growing global population, the agriculture and horticulture sectors face the challenge of producing more and more high-quality food with less and less raw materials and with less impact on the environment. A healthy soil plays an important role in this. The soil also has other functions, such as filtering rainwater, which protects the quality of drinking water and it acts as a sponge during periods of heavy rain. It can capture greenhouse gases from the atmosphere and is essential for nature and biodiversity.

#### Sustainable

However, Dutch soil is under pressure. Due to climate change, there are increasingly long periods of extreme drought and rainfall. The pressure on the soil is also extreme: we want to produce more and more per square meter, using fewer pesticides. Heavy machinery is sometimes used, which can lead to soil compaction. However, more and more attention is being paid to soil health. Carola Schouten, the Minister for Agriculture, Nature & Food Quality, wants all agricultural soil in the Netherlands to be sustainably managed by 2030. The government and industry are working together to achieve this goal through the Nationaal Programma Landbouwbodems (National Agricultural Soil Programme).

#### Balance

Joeke Postma co-ordinates various studies into soil resilience at Wageningen University & Research (WUR). “We need to think really hard about how we can increase the balance in the soil in terms of quality. Achieving a healthy soil is all about creating a balance between three aspects: physical (structure), chemical (e.g. pH value and nutrients) and biological (bacteria, fungi and all the other life in the soil). Water and oxygen are also important for a healthy soil.”

#### Integrated

The Beter Bodembeheer (Better Soil Management) Top Sector project aims to increase knowledge of the soil and soil processes by taking an integrated approach to these three aspects, and with that, offer farmers tools to improve their soil management. As many processes in the soil take place slowly, long-term research is required. As such, this project builds on previous research (2013-2016). Following the conclusion of this preliminary study, a number of processes were monitored for almost eight years. For example, the project is investigating how better management can make the soil more resistant to pathogens, drought and flooding. Improving the soil quantity by introducing organic matter is also being studied. In addition, measurement methods are being developed to allow the quality of soil to be determined in a practical way.

“In the 20th century, we used more and more chemical inputs to produce as much food as possible. The 21st century is the century of biology: how can we keep diseases under control by promoting the naturally occurring defences against disease present in the soil? We are attempting to determine what happens and how we can make this applicable in practice. Using the knowledge generated by this research,

it will be possible to increase production, to reduce unwanted environmental pollution and to enhance 'societal soil functions', such as biodiversity and water management."

#### **Organic matter**

Janjo de Haan, also a researcher at WUR, is co-coordinator of the research project. "In this study, we are investigating factors such as the organic matter in the soil. Organic matter in the soil consists of the crop residues that have been degraded by micro-organisms and organic fertilisers. This organic matter provides a good soil structure, which ensures that sufficient oxygen reaches the plant roots and that rainwater can be absorbed by the soil more easily." Three long-term experiments at three locations – with different soil types – have investigated the effect of ploughing and the possible alternatives. De Haan: "In the Netherlands, ploughing is used a great deal to combat diseases and weeds in the topsoil and create a healthy base for sowing. That's certainly useful. However, the side effect is that the organic matter decomposes more rapidly and the soil structure is disturbed. In this research, we have investigated whether shallow ploughing leaves more organic matter behind, but we haven't yet seen this clearly in the soil. We have observed that avoiding ploughing improves the soil structure, as more organic matter remains in the topsoil. This is particularly interesting for clay soils, which are naturally less water permeable than sandy soils. We have also investigated the effect on the organic matter of adding extra manure or compost to the soil. It turns out that this has little effect on crop yields for soils that are already healthy. However, if the quantity of organic matter in the soil is too low, these additions can indeed lead to higher yields."

#### **Green manure**

Another part of this research is green manure: a crop that the farmer or grower sows after the main harvest to maintain or improve the soil fertility and combat leaching. De Haan: "Countless sorts of green manure are available, but which type is best for each purpose? In this research, we compared the various types. This led to the Green Manure Handbook, which contains an extensive summary of the pros and cons of the various types of green manure, their specific characteristics and cultivation information."

#### **Puzzle**

For Thea van Beers, a plant researcher at Agrifirm, that concrete transition from research to practical application was an important reason to take part in this research. This co-operative of livestock farmers and growers is always looking for useful tools to add to the toolbox of their 10,000 members. "Really concrete research is being carried out in this study into the natural potential of the soil. How can we get the most out of the soil? This type of large-scale research is beyond the capacity of individual farmers and growers. The soil is a complex puzzle that we need to complete together. With every report published, we can immediately see as a sector what the

"How can we keep diseases under control by promoting the naturally occurring defences against disease present in the soil?"

"With this research, it will be possible to increase production, to reduce environmental pollution and to enhance biodiversity and water management."

research has delivered and what you can do with it in practice. This creates really useful tools to increase the quality of the soil."

#### **Practice**

To transform all the results of this long-term soil study into practical communications about and recommendations for sustainable soil management, a follow-up study is being initiated. The partners have decided to continue the research via a new, two-year public-private partnership, which will focus on integrating and translating the knowledge acquired from this research.

*The Beter Bodembeheer (Better Soil Management) project is being implemented by the Brancheorganisatie Akkerbouw (Arable Sector Association), LTO Netherlands, ZLTO, LLTB, LTO-Noord, Agrifirm Plant, IRS, Cosun Beet Company, AVEBE, CZAV, NAO, the Branche Vereniging Organische Reststoffen (Organic Byproducts Sector Association), the Vereniging afvalbedrijven (Waste Processors Association), Biohuis, ERF, Zuivel-NL (Dairy NL), Eurofins-Agro, ForFarmers Netherlands, Stichting Veldleeuwerik, Cumela Netherlands, the Melkveestudieclub MORGEN (MORGEN Dairy Cow Study Club), the Stichting HAS Kennistransfer en Bedrijfsopleidingen (HAS Knowledge Transfer and Vocational Training Association), van Iperen, the Koninklijke Algemeene Vereeniging voor Bloembollencultuur (Royal General Association for Flower Bulb Cultivation), Waterman Onions, the Nutriënten Management Instituut (Nutrient Management Institute, NMI), the Stichting Teeltondersteuning Groenten (Vegetable Crop Support Foundation) and the Ministry of Agriculture, Nature and Food Quality. The research programme was carried out by Wageningen University & Research and the Louis Bolk Institute.*

# Rural energy generation is good for farmers, citizens and grid operators.

The Climate Agreement makes it clear: by 2050, the entire Netherlands will run on sustainable energy. Agriculture will play an important role in this, because around a third of that green energy must come from rural areas. There is a complication: the electricity grid was not designed to transport large quantities of electricity from the countryside back to the national high-voltage grid. A project financed by the Agri & Food Top Sector is working on a solution that will make farmers, citizens and grid operators happy.

“You see it immediately as you drive past the average farm: the roofs of most stalls and barns have plenty of space for extra solar panels, and there is often also space for a wind turbine on the farm”, says Andries Visser (Wageningen University & Research): “But the big question is: how can you use all that green energy if there is limited capacity to feed it into the high-voltage grid?” The answer is relatively simple: adapt your operations in such a way that you need the maximum amount of electricity on your own farm at times of peak production, while also looking for new, major consumers who can use your energy via the medium-voltage grid. If you also choose a user who can supply an agricultural service, you have a win-win situation.

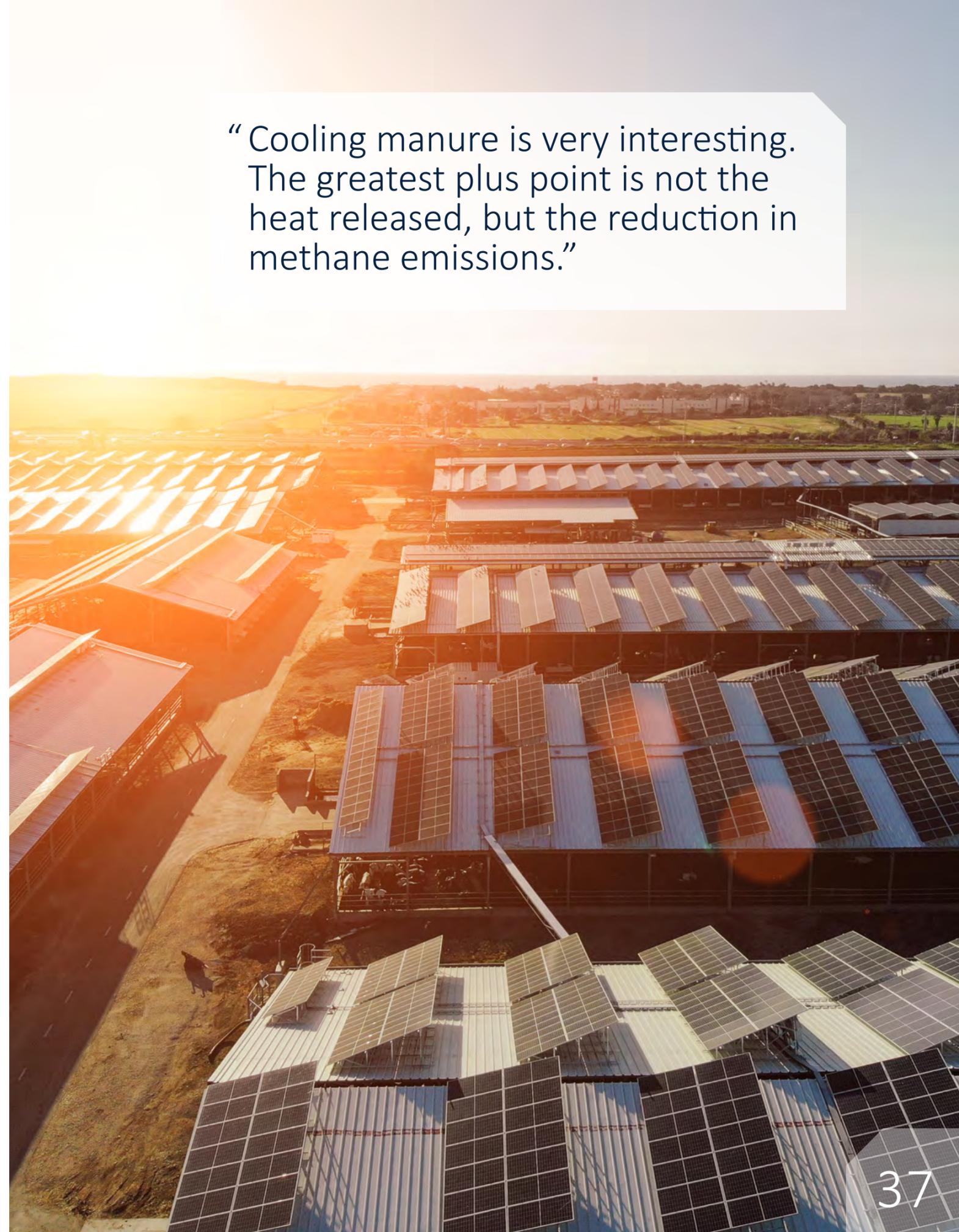
## What are the high-voltage and medium-voltage grids?

In the Netherlands, electricity is transported over large distances via a high-voltage grid. In the northern Netherlands, this is a 220,000 V grid, while the grid in the central and southern Netherlands is 380,000 V. The voltage is reduced to 25,000 V through regional transformer stations. An additional intermediate step reduces the voltage again for use in households.

## Dairy farmer saves and earns

In the Landbouw als Vliegwiel voor de Energietransitie (Agriculture as Flywheel for the Energy Transition) project, Visser is investigating the possibilities together with colleagues and agricultural entrepreneurs. The project focuses on dairy and arable farmers. Visser: “In terms of energy characteristics, these business types are very different, which means the solutions are too. In dairy farming, many processes already run on electricity and the demand for energy does not vary much throughout the year. For dairy farmers, there is a financial incentive to look for operational processes that consume energy during the peak periods. If this means you can stay under your connected load

“Cooling manure is very interesting. The greatest plus point is not the heat released, but the reduction in methane emissions.”



“In Hoeksche Waard, twenty arable farmers are exploring the possibilities of using this energy to produce hydrogen.”

value, you can supply twice as much energy to the grid outside the peak period, which means you can generate extra income. At the same time, you save on energy consumption as you use some of the generated energy yourself. For example, dairy farmers can charge batteries during peak periods or carry out process steps for the processing of milk and manure on the farm itself”.

#### Hydrogen producer

Jan Pieter van Tilburg, a dairy farmer from Hellum in Groningen, is involved with a sub-project that is investigating the effect of manure cooling: “I see important opportunities in terms of energy generation and consumption on my own farm. After first using the heat generated from cooling manure to heat our home, it was time for the next step. I realised that a great deal of heat can also be extracted from manure. In this project, we investigated how this can be realised and have since completed an initial pilot. I can’t yet give any exact figures, but it was clear that cooling manure is very interesting. The greatest plus point is not so much the heat released, but the reduction in methane emissions. It turns out that much less methane is emitted by colder manure. This could be a game changer for the way dairy farmers approach their

emission reduction targets. We will soon start a follow-up programme, in which we will reduce methane emissions even further while also tackling ammonia emissions.”

#### Electricity from farms

During the spring and summer, the vast majority of the energy consumed by arable farmers comes from diesel. In the autumn and winter, the refrigerated storage is turned on, which leads to an increase in the demand for electricity. Visser: “This means that the energy produced by the solar panels throughout the year can only be used to a limited extent on the farm itself. Of course you can electrify some of your vehicles, but you will still produce a surplus of electricity during a large part of the year. In Hoeksche Waard, we are working with twenty arable farmers to explore the possibilities of using this energy to produce hydrogen. This may be on a small scale behind the meter on the farm itself, or on a larger scale and connected to the medium-voltage grid. In time, this could replace diesel, which would lead to a considerable reduction in the carbon footprint.

#### Everyone wins with electricity from farms

A group of dairy farmers in Friesland is now also involved with the project. They are developing a regional energy supply. The idea is to use their surplus electricity to create a heat buffer for a district heat grid for the village of Kollum. Visser: “Here too, the initial calculations are promising. It is great to see that the concepts are good for everyone: farmers reduce their carbon footprint and gain extra income, citizens get sustainable energy and the grid operator does not need to make major investments.”

*LTO Noord, Jules Energy, Windunie, Alliander, ECN, Stedin and Wageningen University & Research are working together in the Landbouw als Vliegwiél voor de Energietransitie (Agriculture as Flywheel for the Energy Transition) project.*

# Data is the new gold in agriculture, but you need to dig it up.

**In the future, farmers will need more than intuition and common sense. They will need data: objective measurement data about their crops and animals. By linking this data together smartly, farmers can improve their production processes by detecting diseases at an early stage, using precision fertilising technologies and monitoring the health of their cows etc.**

Grain, dairy, eggs and meat: everyone knows the products that farmers produce. However, these businesses also have something else that isn’t visible, but which is important for farmers themselves: data. This data is collected by measurement equipment and sensors on the land, in milking robots, in greenhouses and in stalls. But all this information is only valuable if you link it together, as Sjaak Wolfert, senior researcher at Wageningen Economic Research, explains. At present, this only occurs sporadically. The DATA-FAIR project was initiated three years ago to change this. This project examines how the various data flows from farms – and in the supply chain – can be made easily accessible. Wolfert: “We want to expand existing applications with extra functions or modules, which will allow data on and around farms to be shared more effectively. The goal is to get more added value out of data, for both farmers and the sector.”

#### Concerns

The growing digitalisation is producing more and more data. This data can help farmers make the right decisions, so they can optimise their production processes. Farmers are increasingly interested in data and are using it more and more. However, there are concerns. Data is often stored separately and

processed by various parties. Farmers exchange their data with multiple data processors, and subsequently need to log in to various platforms to view and manage their data. As the various platforms and devices can’t yet ‘talk’ to one another, it is often impossible to combine and share data.

Wolfert and his fellow project leader, Peter Parea from ZLTO, believe this can be done better. Eight trials have been initiated in partnership with the sector through the DATA-FAIR project, supported by the Agri & Food Top Sector. Parea: “By simultaneously making data accessible and testing its use in partnership with the sector, this project can lead to rapid, well-founded and effective implementation. It is very important that farmers remain in control: they decide which data to share, with whom and under which conditions.”

#### Diversity

In all the trials, the researchers are working together intensively with the farmers and a wide range of companies, ranging from VION abattoir, insurer Achmea, financier Rabobank and sector organisations Cumela and ZLTO to the JoinData non-profit co-operative, which is responsible for the technical realisation of the data links and systems. According to Wolfert, this diverse group of parties is one of the most positive aspects of the project. “Some of the parties would otherwise never have come into contact with each other. There are many different interests at stake, including within the project, and you need to take these into account. The added value of the project is that you can share data and devise generic solutions that farmers can really use.”



“With farmers as smart data managers, the productivity, efficiency and sustainability of agriculture can improve enormously.”

“The added value of the project is that you can share data and devise solutions that farmers can really use.”

#### Slaughtered cattle

One of the trials involves exchanging data about slaughtered cattle. This trial involved the development of a Slaughter Data Dashboard in partnership with parties such as VION. This shows farmers slaughter data from the abattoir, including the weight, quality and animal health data of the cattle. Wolfert: “By combining data from the various agencies and sectors in the supply chain, we can contribute to improving quality, health and welfare throughout the entire cattle supply chain.”

#### Insurance

In another trial, Achmea was an important partner. This trial investigated reducing the administrative burden and risk analyses that insurers have to carry out using the farmer’s land and image data. “For the insurer, this was a whole new world. By exchanging data, the insurer can work with farmers to manage the risks on farms more effectively. This now goes beyond insurance: it is also about reducing farmers’ workload”, explains Parea.

According to Stefan van Harn at insurer Achmea, transforming the data into better risk management solutions for farmers and growers is a major challenge. “In practice, using data during daily operations on the farm and in the greenhouse turns out not to be so straightforward. Innovation is highly dependent on good infrastructure. It serves as the foundation for new applications and the creation of confidence among entrepreneurs. This is why it’s so important that we invest in this project together.”

#### Boundaries

The trials investigated practical applications for farmers and growers. “The project brought together clients, students, researchers and the insurer. In one of the trials, the market overtook us. Another trial led us to question whether technology will take over the role of insurers. The outcomes were surprising.” The research also gave the insurer access to a broad network of businesses and organisations that face the same challenges. Stefan has noticed that the traditional boundaries between sectors are blurring. “Within this project, everyone has used

their own specific expertise to contribute to the sustainability and continuity of farms and the safety of entrepreneurs and their employees.”

#### New solutions

In the short term, Achmea will launch a new generation of insurance solutions on the market, which will offer agricultural entrepreneurs the possibility of sharing data in exchange for more extensive guarantees and less paperwork. “We have incorporated the lessons learned from this research. With well-trained and interested entrepreneurs, our country is a fertile breeding ground for innovative data solutions. This will allow the sector, and us as an insurer, to retain our leading position internationally.”

#### Data manager

According to Wolfert and Parea, the developments in digitalisation are proceeding very rapidly. “With farmers as smart data managers, the productivity, efficiency and sustainability of agriculture can improve enormously. This means it’s not just about yields, but also about reducing raw material wastage, making more efficient use of fertilisers and the traceability of feed. Smart data use will make the Dutch agrifood sector even stronger.”

*The DATA-FAIR: Value Creation by Data Sharing in Agrifood Business project is co-ordinated by Wageningen University & Research. The participating commercial parties are ZLTO, Rabobank, VION, Fresh Info, Agriplace, Achmea, Cumela, Fedecom and AgroConnect.*



# Food forests are hip

“What are the effects of a food forest?”

**Food forests are being developed all across the Netherlands. These newly planted forests produce foods, such as berries and nuts, while simultaneously helping the soil recover and restoring biodiversity. While the practical experience gained so far is very promising, little scientific research into the real impact of food forests has been carried out. However, this is about to change.**

In recent years, food forests have attracted a lot of attention – and justifiably so, says researcher Jeroen Kruit from Wageningen Environmental Research. He believes that food forests can make an important contribution to supplying an effective solution to major problems in agriculture, from climate change to the nitrogen problem, restoring biodiversity, water capture and circular agriculture.

In the Wetenschappelijke Bodemvorming onder de Voedselbosbouw (A Scientific Foundation for Food Forests) project, financed by the Agri & Food and Horticulture & Plant Propagation Materials Top Sectors, the impact of food forests will be investigated over a period of four years: what are the effects of food forests?

#### **Sustainability**

Jeroen Kruit is the project leader of this new study. He first learned about food forests in 2016 as a participant in the group that initiated the realisation of a Green Deal for Food Forests. At that time, governments, policy makers, research and education institutes, pioneers and other parties agreed to work to expand the total area of food forests in the Netherlands.

The principle behind a food forest is simple: it is a forest ecosystem, planted by humans, which produces food. A successful food forest takes care of fighting pests itself, accumulates fertility, is resistant to climate change and produces food for human consumption. The forest ecosystem is self-sustaining, i.e. it operates without the need for fertiliser, pesticides, irrigation or drainage. These forests are highly biodiverse and contribute to restoring soil fertility. Kruit: “The practical experience gained with food forests is very positive. However, we are now initiating fundamental research into food forests for the first time. In this study, we will test whether a well-designed food forest can contribute to effectively tackling the sustainability challenges we face.”

#### **Carbon storage**

Within this project, two food forests that are being developed by the Stichting Voedselbosbouw Nederland (Dutch Food Forest Foundation) will be used: in Almere (30 hectares) and Schijndel (20 hectares). These two food forests will be “living labs” for the practical research. In this project, Isabelle van der Zanden, a PhD Student at the Nederlands Instituut voor Ecologie (Netherlands Institute of Ecology, NIOO-KNAW), is researching the impact of food forests on the climate and soil biodiversity. “Here and at several other locations, I will study the soil life under food forests, and most of all accumulate knowledge about the nutrient cycle and carbon storage.”

“Can food forests retain more water and improve soil quality?”

The research project started only four months ago. Late last year, the first samples were taken from the soil in the food forest in Almere. In Schijndel, samples were already taken for a baseline measurement in 2018. “In the analysis of the soil samples from the forest, we will primarily focus on carbon storage in the soil and the role of the soil life in that process”, explains Isabelle van der Zanden. The monitoring data from the field study will be compared with conventional observations used in the Bodemindicatoren voor Landbouwgronden in Nederland (Soil Indicators for Agricultural Land in the Netherlands, BLN).

#### Cultivation systems

Gerard Korthals, a research co-ordinator at the Centre for Soil Ecology at Wageningen University and NIOO-KNAW: “For example, data from BLN maize fields can serve as a reference. That way, we can compare our own observations with the available data from existing cultivation systems. By combining this data, you can see how the soil in a food forest develops compared to the previous period. By doing so, we expect to be able to see whether this deviates from an intensively cultivated field, for example.” Van der Zanden: “Compared to intensive agricultural systems, food forests offer promising perspectives for biodiversity, as the soil is not disturbed every year and natural succession is used.”

#### Water management

De Dommel water authority is one of the project partners. Ineke Barten is an ecologist at the water authority. She hopes the study will provide more insights into how the nutrient and water cycles function in a well-managed agricultural system. “We hope to find out whether food forests can retain more water, improve the soil quality and reduce leaching. We are also curious about the influence these trees and bushes have on the soil life. It would be great if the study produces a number of indicators that will allow us to quantify how much water food forests can retain throughout the seasons, for example.”

#### Labour

Kruit hopes that the business community will also join in the research. “At present, food forests are mostly run by pioneers. However, farmers are increasingly approaching us. They want to know what the revenue model is, but this is still problematic. You can reduce costs because heavy machinery, pesticides and other inputs are unnecessary. However, it takes around ten years before you achieve optimal production. Another important point is labour: at present, harvesting is often done by volunteers. If we want to roll out food forests on a larger scale, we need to find an answer to this.”

*The Wetenschappelijke Bodemvorming onder de Voedselbosbouw (A Scientific Foundation for Food Forests) project is implemented by Wageningen University & Research, the Stichting Voedselbosbouw Nederland (Dutch Food Forest Foundation), the Centrum voor Bodemecologie (Soil Ecology Centre), the Nederlands Instituut voor Ecologie (Netherlands Institute of Ecology), the Province of Flevoland, Aeres University of Applied Sciences, HAS Den Bosch, the Groen Ontwikkelfonds Brabant (Brabant Green Development Fund), the North-East Brabant Region and De Dommel and Aa en Maas water*



Healthier eating with tailor-made advice and rapid feedback

**What major campaigns appear unable to achieve, a smart advice tool seems to do much better: teaching people to adopt healthier eating patterns. The trick is to combine individual health and nutrition data with social and psychological data. The project has demonstrated that this is a much better way of motivating consumers to adopt a healthier diet.**

Almost everyone knows it: healthy eating can reduce the risks of diabetes, obesity and cardiovascular diseases. However, general guidelines, such as eating 250 g of vegetables or two pieces of fruit, fail to convince large numbers of consumers to change their eating habits. The Personalised Nutrition & Health project, financed by the Agri & Food Top Sector, investigated whether you can convince more consumers to change their behaviour with tailor-made advice that also takes account of personal circumstances and eating habits.

#### Biomedical data

“There are numerous ways of giving patients personalised dietary advice”, explains researcher Mariëlle Timmer from Wageningen. “In the future, alongside blood analyses, blood pressure, BMI and waist size, scientific research will increasingly allow patients to be given tailor-made dietary advice based on the patient’s biomedical data. To ensure people don’t regress into old habits, it can help if the advice

takes account not only of biomedical data, but also of personal data”. Machiel Reinders, a consumer behaviour researcher at Wageningen Economic Research, explains how this project has done this: “There are considerable differences in how individual consumers can best be helped to accept dietary advice and follow it up.” For example, it turns out that individual consumers have very different information needs. Reinders: “While some consumers simply want a list of healthy products, others need comprehensive information about how a particular diet can help them. And to make it even more complex: these information needs also differ at specific moments. For example, if you’re standing in the supermarket, you want to know what is healthy quickly, while you may want more in-depth information when you have more time. To give effective advice, you must take this into account”.

#### Personal strategy

It’s not only the information needs that differ per person: everyone has their own healthy eating strategy. Some consumers choose to simply eat less, while others prefer to switch to light products and still others swap unhealthy products for healthy ones. Reinders: “If you know this, you can adapt your advice to consumers’ preferred strategy, which increases their chance of success.”

#### Smart algorithm

Timmer: “Based on these results, we use not just patients’ health and dietary information in the digital tool, but also individual social and psychological aspects. For example, as well as their information needs and personal strategy for adopting a healthier diet, we also included their personal dietary preferences. How many changes can you make at one time and still be effective, and to which eating moments does someone want to make changes?” A smart algorithm takes all factors into account to produce tailor-made advice. It’s also made as easy as

“A smart algorithm takes all factors into account to produce tailor-made advice.”

“Almost half the participants continued using the tool after the project.”

possible for patients: “For example, the advice is not ‘eat a certain number of grammes of fibre’, but instead a recommendation of which products will help the patient reach their goals. So patients themselves are given the tools to decide how they want to reach their end goal.”

#### Brown rice and croissants

Together with the Maag Lever Darm Stichting (Dutch Digestive Foundation), the digital tool was tested in the Vezel-Up (Fibre-Up) project. The project focused on encouraging people to eat more fibre, and successfully: “Almost half the participants continued using the tool after the project”, explains Zoë Verdaasdonk from the Stomach, Liver and Intestine Foundation. “The fact that we avoided compelling people to change helped. Using the tool, they can make their own decisions. If they can’t live without a croissant in the morning, they can choose to eat brown rice instead of white rice in the evening. This freedom of choice makes it easier to change your eating habits.”

#### Privacy

“The more you know about your patient, the more personal the advice can be”, says Reinders: “However, this also means you are asking your patient to give up some of their privacy. As the supplier of the advice, you must understand that there are limits to this. Our research has shown that it matters to patients who is requesting the information. A dietician or healthcare

organisation can ask a lot more than a supermarket, for example.”

#### New opportunities

A large group of companies took part in the project. They all understand the opportunities offered by personal dietary advice.

The more technically oriented participants see opportunities for developing wearables to make more personal readings possible. The supermarkets want to use the knowledge acquired to help their customers find the right products in their range, while the food manufacturers want to know which standards their products must meet to be included in that healthy range.

*TNO, Philips, Jumbo, FrieslandCampina, Albron, the Maag Lever Darm Stichting (Dutch Digestive Foundation), Menzis, Habit LLC, PS in Food Service, Noldus Information Technology, SmartWithFood, Marks & Spencer, NIPED, Vital 10, BASF, ONE Health, Albert Heijn, Google Food, Kellogg, Bolletje, Sonneveld, Sensus, the Nederlands Bakkerij Centrum (Dutch Bakery Centre), Roquette and Wageningen University & Research worked together in the Personalized Health & Nutrition project.*

# The vegetarian steak is on the way

“Restaurants can put dishes with locally-grown field beans on the menu.”

Replacing some of the animal products on our plates with vegetarian alternatives brings a sustainable world much closer. Thanks to the Plant Meat Matters Top Sector Project, the vegetarian steak, the holy grail for producers of meat substitutes, is much closer to appearing on supermarket shelves.

The average Dutch person eats more meat than is good for the planet. If we all avoided meat now and then, we would produce fewer greenhouse gases, consume less water and help tackle the nitrogen problem. Nevertheless, many consumers have yet to be persuaded to try meat substitutes. This is partly because they are unfamiliar with them, and partly because they are dissatisfied with the quality. “However, the quality has improved enormously in recent years”, explains Atze Jan van der Goot, professor of Sustainable Protein Technology at Wageningen University: “You can already buy products that closely resemble chicken. But this project will bring the ultimate goal within reach: the vegetarian steak.”

#### It starts with knowledge

In this project, Van der Goot and his colleague Ariette Matser from Wageningen Food & Biobased Research collaborated with a group of companies to analyse what happens when you transform vegetable proteins into a meat substitute: “It has taken four years of experiment and research, but we now know how the ingredients work together and what the effect is of adapting the various processing conditions. With this knowledge, manufacturers are able to produce the next generation of meat substitutes.”

#### Local proteins

With these improved meat substitutes, a larger group of consumers will be won over. And that is even better news for the planet than it first seems. Matser: “Alongside soya, we use products such as field beans as raw materials in our project. Soya cultivation has several sustainability issues. By making meat substitutes from raw materials that are less harmful to the environment, you create a win-win situation. This is certainly the case with field beans. Another benefit is that they can be grown very efficiently in north-western Europe.” Van der Goot emphasises that this win-win situation is actually a win-win-win situation: “The current generation of meat substitutes are often made from raw materials that have been intensively processed. While the field beans must be separated into fractions in our process, these don’t

“With this knowledge, manufacturers are able to produce the next generation of meat substitutes.”

need to be so pure. That means this production method requires much less energy and water.”

#### Locally processed

The arrival of this new technology also creates new opportunities for the production chain. Matser: “We are investigating whether it is possible to use these crops to produce meat substitutes with minimal pre-processing, using shear cell technology. It is conceivable that an enterprising arable farmer or a group of arable farmers may decide to start producing it themselves. Instead of advertising their dishes with local meat, restaurants can put local field beans on the menu.”

#### New products

The scientific results were presented at a scientific conference organised by Plant Meat Matters. Matser: “We have spent four years working together intensively with the industry. The interaction between applied research and scientific research was very fruitful: together, we really discovered how to take meat substitutes to a higher level. The test products we were able to make really had the structure and juiciness you would expect from a tasty piece of beef. This means the pre-competitive part of the work is done. It’s now up to the industry to take the final step.”

*The Plant Meat Matters project was implemented by Meyn, Avril, Givaudan, saturn petcare, Nutrition & Santé, De Vegetarische Slager (The Vegetarian Butcher), Unilever, Ingredion, Rival Foods and Wageningen University & Research.*

# A healthy old age thanks to a good diet and exercise programme

**We all want to grow old in good health and continue living independently for as long as possible. A project financed by the Agri & Food Top Sector investigated if one age-related problem, reduced mobility, can be prevented. And successfully: in a special programme that combined high-protein nutrition with a programme of strength training, the participants were able to regain a large part of their independence.**

While it differs from one individual to another, we lose an average of around 3-8% of our muscle mass every ten years from the age of fifty. This slowly but surely reduces our muscle strength and leads to problems in old age: moving becomes increasingly difficult and we eventually become more and more dependent on the help of others.

The ProMuscle in de Praktijk (ProMuscle in Practice) project investigated whether this process of deterioration of muscle mass can be reversed. The project developed a programme that combines high-protein nutrition with a training programme of strength exercises. Project Leader Esmée Doets (Wageningen University & Research): "As people grow older, their appetites diminish, while their bodies in fact need more protein. For many older people, this makes it difficult to consume sufficient protein to maintain their muscle strength. In addition, around 60% of those over the age of 65 do not exercise intensively enough to maintain their strength."

## Programme

The programme was developed together with several companies and a health insurer. Guided by a physiotherapist, the test subjects underwent two hours of training for a period of twelve weeks to strengthen their muscles. A dietician simultaneously helped the individual participants consume 25 g of protein at breakfast and lunch. During the twelve weeks after that, the participants took part in sports lessons at fitness centres or physiotherapy practices and were given practical lessons about high-protein breakfasts, lunches and dinners. 200 elderly people from Gelderland between the ages of 65 and 93 took part in the study.

## More muscle mass

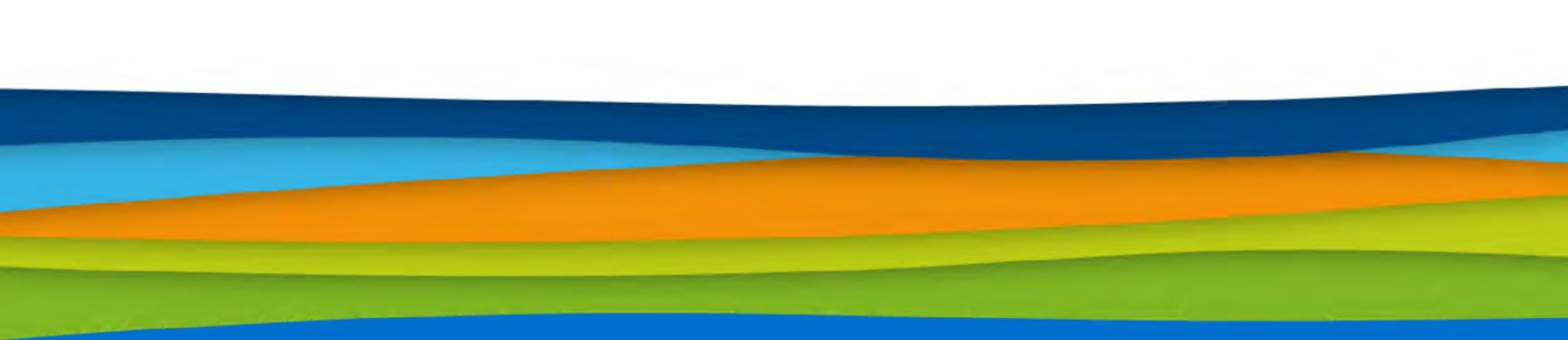
"The combination of high-protein nutrition and strength training proved to be an effective way of tackling loss of muscle mass and muscle strength in older people", explains Doets: "By following the programme, our participants were able to build up more than half a kilo of additional muscle mass within three months, which resulted in a 40% increase in muscle strength." These are astonishing results, which project partner Sjors Verlaan from FrieslandCampina is also enthusiastic about: "The figures are really fantastic, but what this renewed fitness led to is just as important: the participants felt stronger, were able to function again more easily, were able to climb the stairs again and had enough energy to take part in public life. Ultimately, that's what it's all about: better quality of life. It's fantastic that we as

"The programme helps older people gain more than half a kilo of extra muscle mass within three months."

a dairy manufacturer can contribute to this with our products." Looking back on the programme, Doets concludes that the professional guidance focused on individual circumstances was an important success factor: "You can go a long way by taking account of individual circumstances." At present, plans are being made for a larger roll-out in the Netherlands in partnership with healthcare institutions and fitness centres, and variants for different target groups are also being developed.

"The participants have enough energy to take part in public life again."

*The ProMuscle in de Praktijk (ProMuscle in Practice) project was implemented by Zilveren Kruis, FrieslandCampina, Innopastry, the Alliantie Voeding in de Zorg (Nutrition in Healthcare Alliance) and Wageningen University & Research.*



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