

Wageningen University & Research presents

WUR Impact Portfolio

A selection of 100 years of research in Wageningen and its impact on the world

Wageningen University & Research presents

WUR Impact Portfolio

A selection of 100 years of research in
Wageningen and its impact on the world

100 Years WUR

An Impact Portfolio

Wageningen University & Research was founded 100 years ago. During this century, the organisation has shown itself to be a global expert in the field of healthy food and the environment. In 100 years, valuable knowledge has been acquired and high-value education has been developed. Research, education, and countless projects have led to products and valuable partnerships. In this portfolio, we highlight more than fifty of those research projects, products and partnerships that have had an impact on society.

Wageningen University has grown over the years, meeting the desires and demands of a rapidly changing society. At the same time, this society is also changing as a result of the insights and applications provided by WUR. The Wageningen domain used to look very different from what it looks like today. Some research areas were a university focus from the get-go, such as soil, dairy and plant sciences. Other fields of research, such as big data, healthy food, genetics and geo-information science, have been incorporated into the Wageningen portfolio in recent years.

WUR has developed multiple crop varieties, such as the Elstar apple or the Elsanta strawberry. These advances in plant breeding have, among other things, led to the modernisation of agriculture in the Netherlands. Nowadays, high technology greenhouses cover extensive areas in the Netherlands. They are equipped with innovative substrates for soilless cultivation and LED lights,

ensuring maximised yield and resource efficiency. Pesticides are no longer the norm in high-tech greenhouses; insects are used for biological control of pests. All these advancements have become reality thanks to WUR.

WUR research in animal science has led to the development of optimised animal feeds and new vaccines, which in turn led to improvements in animal welfare. Genetics and genomics are other fields in which WUR has contributed key discoveries. One of them is CRISPR-CPF-1, which shows enormous potential for gene therapy and genome editing. Another is the Dutch Milk Genomics Initiative for selective cow breeding.

WUR has engaged with political institutions and businesses to form partnerships that have led to its huge impact on society. The WUR impact portfolio contains examples of coastal infrastructure, climate change, forest protection, healthy food and food security.

This unique portfolio allows us to demonstrate how WUR has contributed to the quality of life over the past 100 years. We will be continuing that mission in the future. 'To explore the potential of nature to improve the quality of life'.

Enjoy reading!

Contents

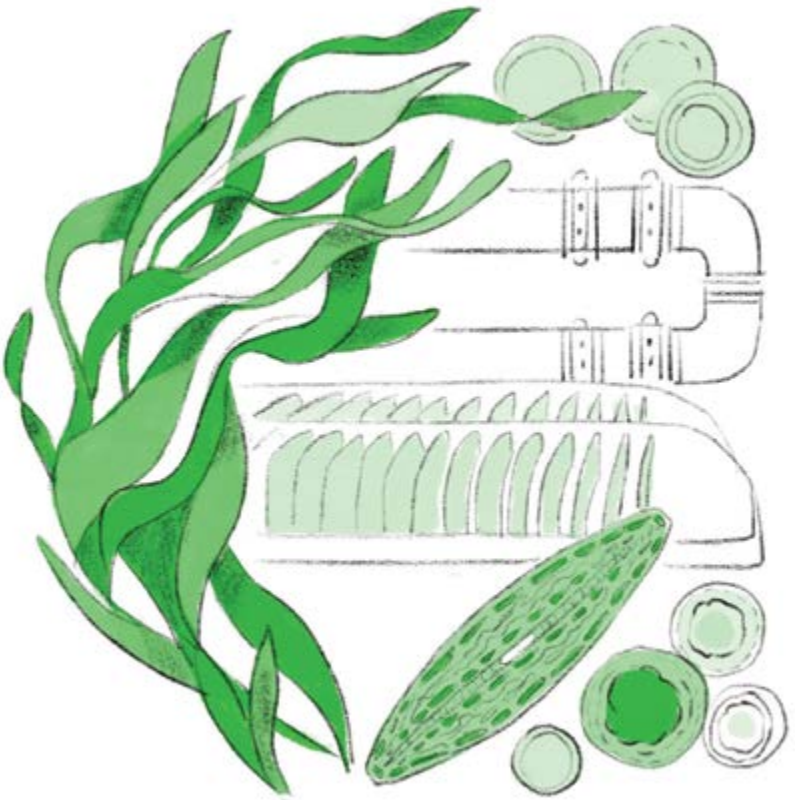
100 Years WUR: An Impact Portfolio	2
Green gold, WUR and the Algae PARC	6
At home and during harvest, WUR and Food waste	7
Curing people, WUR, Genome Editing, and Cpf1	8
Moulded crust, WUR and Cheese	10
Feedprint, WUR and Animal Feed Efficiency	10
Electricity from living plants, WUR and Plant-e	12
Sustainable cocoa shells, WUR and Cocoa Supply Chain Sustainability	13
Urban heat islands, WUR and Urban Climate Change Adaptation	14
Blue revolution, WUR and Aquaculture	16
Safe navigation in frozen water, WUR and Marine Climate Services in the Arctic	17
Renewable energy, WUR and Artificial Photosynthesis	19
Roots, plants and diseases, WUR and Avoiding food contamination	20
High-quality seeds in Ethiopia, WUR and the BENEFIT Partnership	22
Answering questions and solving problems, WUR and Big Data	23
A seasonal animation, WUR and Citizen science	24
Provide enough freshwater, WUR and Delta management	25
60 missions in 15 countries, WUR and Dutch Embassies on Development and Aid Programmes	26
Millions of insects per week, WUR and the Great Insect War	28
Need of a food policy WUR and the Common Agricultural Policy	29
Undernutrition in the elderly, WUR and Cater with Care	30
Forced departure, WUR and Climate migration	32
Scratch free, WUR and Soft Matter	33
Synthetic production will save the environment, WUR and High Valued Compounds	35
Cooperation of farmers, WUR and the dairy industry in East Africa	36
Climate-smart agriculture, WUR and Carbon Sequestration in Soil	38
One pipe for any kind of soil, WUR and Drainage Systems	39
Hyperspectral cameras, WUR and Drones	41
The right diet for Olympic athletes, WUR and Eat2Move	42

Discarded fish species, WUR and Good Fish Foundation	43
Food-based dietary guidelines for population, WUR and Nutrition in Africa	45
Lucrative breeding programmes, WUR and Plant Genomics	46
Less water for a kilogram of fresh tomatoes, WUR and Soilless Horticulture (Hydroponics)	48
Critical for human survival, WUR and the Insect Economy	49
Knowledge leads to motivated people, WUR and Integrated Farm Planning in Burundi	51
100% increase of vitamin C, WUR and Greenhouse LED Lighting	52
Solar energy and less mosquitoes, WUR and the fight against malaria	53
Sustainable cup of coffee, WUR and Manos Al Agua	55
Minerals as fertiliser, WUR and Nutrient Recovery from biomass	56
Vanilla in greenhouses, WUR and NetherCrops (NetherQuinoa and NetherVanilla)	58
Corn in space, WUR and Agriculture on Mars	59
Weather observations for a century, WUR and the History of Meteorological Observations	61
The milk-bio-bank, WUR and Dairy Science	62
700.000 African farmers, WUR and N2Africa	64
Switch off receptive genes, WUR and Potato blight	65
Pig Plateau 2.0, WUR and Animal Welfare	67
Imitation of texture, WUR and Plant Meat Matters	68
Improve plant growth, WUR and Plant Microbiome	69
Software distinguish crops, WUR and Plant Phenomics	70
Feeds, hatcheries and vaccines, WUR and Poultry in Ethiopia (Holland-Africa Poultry Partners)	72
Beyond the walls of Academia, WUR and knowledge transfer to the broader public	73
Sustainable toolkits, WUR and The Sustainability Consortium	74
Around the world, WUR and UASB Reactor	76
Useful wastewater, WUR and the Applications of the UASB Reactor	77
From animal to human, WUR and Veterinary Vaccines	78
Sand nourishment exported, WUR and the 'Zandmotor'	79

Green gold

WUR and the Algae PARC

The AlgaePARC is a research facility at WUR aiming to unleash the full potential of algae. This facility is the result of an investment made by a consortium of 19 companies interested in what is considered the “green gold of the future”. Much of the research of the Bioprocess Engineering Group takes place in this facility, aiming to produce high-value products from water, CO₂, and sunlight.



AlgaePARC scientists seek to advance the state-of-the-art by optimising algae cultivation, improving algae strains, and scaling up processes.

The advances in algae cultivation and strain development are sky-rocketing. Scientists at AlgaePARC have developed a strain that produced twice the amount of lipids than its wild counterpart. This strain improvement has been achieved in just two years by selecting the algae that had larger lipid bodies in its cellular matrix. Because of the microscopic size of the algae, the selection of the best algae has not been child's play and required a great deal of time and labour. However, the outcome is more than satisfactory and is a great leap towards sustainable algae lipid production.

The AlgaePARC has done an economic analysis to monitor the economic improvement in algae cultivation. According to this study, in 2010, the cost production ratio of algae production was 5 to 6 Euros, while in 2015, this ratio decreased to 2.5 Euros. This reduction is the result of scientific advances thanks to the efforts of scientists from the AlgaePARC. The aim is to reduce the cost production ratio to 1 to 0.5 Euros so that algae production can compete on the market.

Want to know more about the AlgaePARC?

Contact WUR's algae expert, Rene Wijffels, rene.wijffels@wur.nl

At home and during harvest

WUR and Food waste

One-third of all food in the world is wasted, entailing a loss of money, a waste of resources and negatively impacts the availability of food for others. The average Dutch person throws away 50 kg of perfectly edible food every year. This is the equivalent of 150 Euros per person, entailing a monetary loss of 4.4 billion in the Netherlands and 550 billion worldwide.

Food waste happens throughout the entire supply chain. The processes involved in harvesting, transportation, storage, catering, and finally domestic waste, lead to monumental food losses. Depending on the country, some parts of the supply chain are more sensitive than others to food waste. In developed countries, the hotspot of food waste is through home disposal, while in developing countries post-harvest losses register more food waste than consumer behaviour. WUR is actively working to reduce food waste throughout the entire supply chain.

WUR has engaged in international projects such as FUSIONS (Food Use for Social Innovation by Optimising waste prevention Strategies), a European project that involves 21 partners from 13 countries. FUSIONS aims to engage key actors across Europe to achieve a 50% reduction



in food waste, and a 20% reduction in resource input in the food chain by 2020. WUR, as the knowledge centrepiece of the food valley, is committed to providing knowledge that contributes to reducing food waste throughout the whole value chain.

Want to know more about the issue of food waste?
Contact the WUR expert on food waste, Toine Timmermans,
toine.timmermans@wur.nl

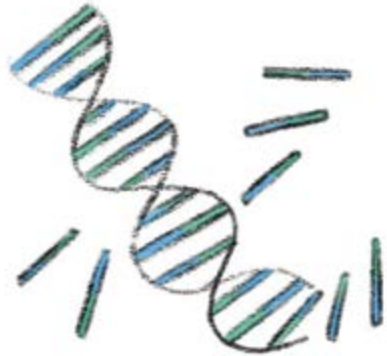
Curing people

WUR, Genome Editing, and Cpf1

CRISPR-Cas-based genome editing will lead to advances in society in terms of improved yields in agriculture, synthetic production of

high-value products and potentially curing certain genetic diseases. However, genome editing requires high precision and efficiency when changing, introducing or deleting genes in the genome.

Wageningen University and Research, and the Massachusetts Institute of Technology have developed a new approach for genome editing, based on a novel CRISPR-Cas nuclease called Cpf1. Both institutions hold a patent on this revolutionary technology, CRISPR-Cpf1, that allows precise and efficient genome editing.



Editas Medicine, a company specialised in CRISPR-Cas9 technology, is commercialising CRISPR-Cpf1 for treating a selection of human genetic diseases, including the rare inherited eye disease Leber Congenital Amaurosis 10 (LCA10). This genetic disorder affects one out of 40,000 newborns and entails severe vision loss or blindness. Editas Medicine is experimenting with eye droplets based on the CRISPR technology to aim for gene editing in the eye tissue.

Other genetically inherited diseases could be cured using this gene editing technology as well. The applications of Cpf1 are not limited to medicine, but can be applied to multiple fields. The economic resources that WUR is obtaining from the commercialisation of this patent are destined to support other applications of this technology as well as other innovative microbiology-related research lines.

Curious to know more about the applications of CRISPR-Cpf1?

Contact the WUR expert, John van der Oost, john.vanderoost@wur.nl

Moulded crust

WUR and Cheese

The Netherlands is a cheese-producing country with various typical cheeses that are exported worldwide. Producing high-quality cheese to reach high-end consumers and restaurants requires constant innovation and scientific research.



WUR has collaborated with the producers of Remeker cheese to study how different cheese coatings affect the taste and quality of their Dutch cheese. Remeker uses non-heated milk from Jersey cows for its cheese production, and it does not have a traditional cheese coating. WUR has studied if the mould growing on the milk fat coating in the Remeker cheese would affect the quality of this premium cheese that targets Michelin-star restaurants.

WUR found out that mould on the coating affects the organoleptic qualities of this typical Dutch cheese. These results allowed Remeker to understand the impact of the ripening of their cheese by modifying the cheese coating. The outcomes of this research led to the publication of 5 to 6 articles in professional journals having a worldwide impact on cheese production.

Do you love cheese and you want to know more?

Contact our WUR cheese expert, Kasper Hettinga, kasper.hettinga@wur.nl

Feedprint

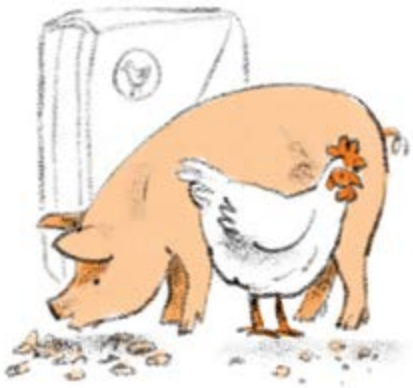
WUR and Animal Feed Efficiency

The industry of animal feed is a sector that strives for constant innovation to provide the best animal growth and welfare while

maximising resource efficiency. The feed conversion ratio that measures how efficient an animal feed is has been increasing 1 to 2 percent per year over the last decades. The Dutch animal feed industry has engaged with WUR in public-private partnerships, such as Breed&Feed4Food or Feed4Foodure.

The Dutch Animal Feed Research Federation (VDN) has established various objectives for the next years to upgrade animal feeds. Feed formulation can be customised to strengthen the immune system or modify the intestinal flora to promote animal welfare. Moreover, feeds can also influence animals' behaviour, leading to less feather picking in poultry or tail biting in pigs. Apart from animal welfare, improving protein and phosphate efficiency in animal feed while reducing its environmental footprint also lie within the objectives of VDN and WUR.

Regarding animal feed footprint, the FeedPrint tool is the jewel in the crown of WUR research in feed sustainability. This tool calculates the carbon footprint of feed raw materials during their complete life cycle. This tool is used by companies to assess the CO₂ emissions of feed throughout its value chain. As 95% of the CO₂ emissions are due to feed composition, this tool enables companies to consider the environmental impact of its feed formulation.



Improving animal feed efficiency and developing sustainable agriculture has been among WUR's core values since its inception 100 years ago.

Do you want to know more about animal feed efficiency?
Contact the animal feed expert, Leon Marchal, leon.marchal@wur.nl

Electricity from living plants

WUR and Plant-e

Plant-e is a spin-off from the sub-department of Environmental Technology of Wageningen University that produces electricity from living plants. This revolutionary technology is the first in the world to generate electricity with a negative carbon footprint. This technique uses the electrons released by the bacterial breakdown of plant roots exudates to produce environmentally friendly electricity.



Plant-e was founded in 2009 by Marjolein Helder and David Strik only half a year after the start of Marjolein's PhD project in energy production from living plants. The combination of a PhD and Plant-e led to the quick development and application of this pioneering technology. After the completion of her PhD, Marjolein decided to focus on the commercialisation of this technology as CEO of Plant-e, and David pursued his scientific career at WUR in related technologies.

Plant-e has commercialised modular gardens and DIY kits for offices and high schools. The company's activity allows employment of seven full-time professionals and 13 part-time jobs. The company plans to scale up and install the systems in plains, polders and/or mangroves to produce more electricity and maximise its positive environmental impact.

Want to know more about Plant-e? Looking forward to supporting them?

Contact Plant-e CEO, Marjolein Helder, office@plant-e.com

Sustainable cocoa shells

WUR and Cocoa Supply Chain Sustainability.

The Netherlands processes more cocoa than any other country in the world. The consumption of chocolate in Europe and the United States is increasing every year. On top of that, the chocolate demand of countries such as China, India and Brazil is also growing. Ensuring that cocoa production remains sufficient for the next decades, requires the intensification of cocoa cultivation, which includes improved service delivery, while extending and maintaining the focus on sustainability.

WUR cocoa research focuses on ways of increasing sustainability, often through measuring the outcomes of interventions, farm



management practices and technologies. WUR is working with the private sector, standard-setting bodies and NGOs to investigate the effect of integrated soil fertility management and service delivery on yields, profitability and incomes, the environment and society. In addition, WUR is researching the origin of cocoa beans in different products. This research reveals whether a product has been traded responsibly, or not, helping to combat food fraud.

WUR also contributes to the optimal use of side streams. During the processing of cocoa for instance, cocoa shells often end up as a waste product. WUR is studying the extraction of additional high-quality raw materials for manufacturing chemicals, diverse materials and fertilisers from cocoa shells. New value chains are being devised to develop fibre applications, lignin-natural oils, and other biobased products from cocoa shells. Getting the most out of biological resources is vital to ensure sustainability of supply chains and minimise the impact of human activities on the environment.

Want to know more about cocoa?

Contact the WUR expert, Yuca Waarts, yuca.waarts@wur.nl

Urban heat islands

WUR and Urban Climate Change Adaptation

Cities are warmer than their surroundings and climate change is further increasing urban temperatures. The centre of big metropolises can be up to 10 degrees Celsius warmer than the countryside. The heat waves that affected Europe in the summer of 2003 and 2006 resulted in thousands of heat-related deaths among the elderly. The heat wave that affected France in 2003 resulted in 14,802 deaths according to the French National Institute of Health. These terrifying numbers alarmed the population, demanding city climate change adaptation.

Bert Holtslag and his colleagues from the WUR Chair group of Meteorology and Air Quality found that urban heat islands affect not only big cities in warm areas but also small towns in the Netherlands. The centre of Wageningen during a nice summer evening can be 6 degrees warmer than the countryside.



To analyse the factors that contribute to this increase in temperature in cities, WUR has developed a bike equipped with a weather station that records radiation from the sun, reflected radiation from buildings, humidity, temperature, etc. Thanks to this data, gathered by a network of urban observations and model studies, an app has been developed to inform the public authorities and citizens about streets with a high risk of overheating, or the least polluted roads for a bike ride.

This information is also useful to determine what factors make an area more adapted to climate change. The Netherlands is not well adapted to hot summers, and cities should have more coverage to avoid radiation. Imitating nature is usually the best solution, and tree coverage is the best alternative to making our streets more livable. WUR keeps on monitoring the effects of climate change while proposing climate solutions to deal with this major challenge of the 21st century.

Want to know more about urban climate change and adaptation?

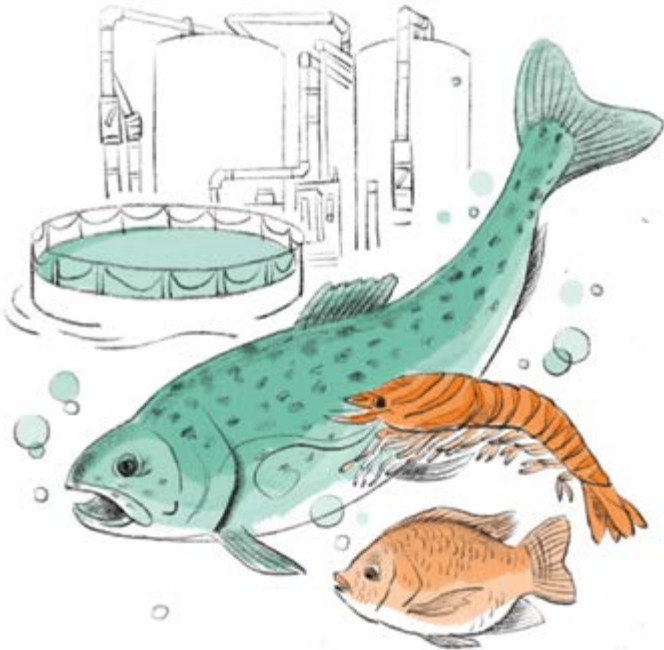
Contact WUR experts, Bert Heusinkveld, Bert.Heusinkveld@wur.nl or Gert-Jan Steenveld, Gert-Jan.Steenveld@wur.nl.

Blue revolution

WUR and Aquaculture

The demand for fish and seafood products is increasing while fisheries are becoming overexploited. Aquaculture is expected to meet the increasing consumer demand for fish while alleviating the pressure on fisheries. Sustainable fish feed and recirculating aquaculture systems are promising fields in which WUR is actively working.

Recirculating Aquaculture Systems (RAS) allows fish culture in controlled conditions and in high densities to maximise aquaculture production. These systems minimise water and nutrient discharges into the environment as more than 90% of the water is recirculated. During this recirculation, the water is mechanically and



biologically filtered to ensure optimal water quality. Temperature, pH, and oxygen levels are entirely controlled in recirculating systems to assure fish welfare. RAS avoids fish escapes and feed losses, making intensive aquaculture production a viable option.

Ep Eding has been working on recirculating systems at WUR since the conception of these technologies. He aims to develop this technology to reach minimum water discharge. Marc Verdegem is working alongside Ep on how to maximise nutrient efficiency in integrated aquaculture systems. These systems aim to use the waste streams of fish to culture molluscs and algae. Ep Eding and Marc Verdegem, along with their colleagues of the WUR Department of Aquaculture and Fisheries, are working to develop a sustainable Blue Revolution.

Interested to know more about aquaculture?

Contact the WUR experts Ep Eding and Marc Verdegem, ep.eding@wur.nl, marc.verdegem@wur.nl

Safe navigation in frozen water

WUR and Marine Climate Services in the Arctic

Ice coverage in the Arctic Ocean is retreating, leading to a more dynamic marine environment. Sailing in these waters is risky if there is not enough information about marine conditions. The weather and sea-ice forecasts provided by various meteorological agencies is continuously improving in accuracy as well as extending towards sub-seasonal to seasonal time horizons. This information is essential for strategic decision-making on Arctic marine operations and the safety of ships manoeuvring in these remote, frozen waters. Close to 50,000 cruise passengers currently visit the Svalbard archipelago (Norway) and remote indigenous communities, like Qaanaaq in Greenland, and need to be supplied seasonally with essential goods by boat. However, how, when and



in what form marine climate services should be made available for it to be useful and usable remains unclear.

WUR is working alongside the Danish and Norwegian Meteorological institutes to improve and co-produce marine climate services in the SALIENSEAS project coordinated by Machiel Lamers of the Environmental Policy Group. This project aims to improve the quality of Arctic marine climate services and make it accessible to end users. In co-producing these services, end users will obtain trustworthy marine climate services tailored to their strategic and operational decision-making. The Environmental Policy Group is working on this science/end users interface to increase the usefulness and usability of this emerging knowledge type in the dynamic Arctic ocean environment.

The outcome of this project will lead to a more secure supply of goods to remote communities in the Arctic. Besides, there are around 60 cruise vessel operations that also benefit from this meteorological data. Well-planned and safe operations would

benefit businesses and communities in the Arctic, improving their quality of life. WUR is working on projects like SALIENSEAS to make these visions a reality.

Eager to find out more about navigation and ecotourism in the Arctic? Contact the WUR expert, Machiel Lamers, machiel.lamers@wur.nl

Renewable energy

WUR and Artificial Photosynthesis

Plants can produce high energy compounds from water, CO₂, and the energy they obtain from the sun. Artificial photosynthesis aims to emulate this process to synthesise high energy molecules (methanol or formic acid) from CO₂, water, and an artificial source of energy. Methanol and formic acid are used as energy storage when there is a surplus of energy production. There are already urban buses in the market running on these substances as a fuel.



The WUR Agrotechnology and Food Sciences Group, and Wageningen Food and Biobased Research, have been working alongside BIOMCN located in Delfzijl to develop artificial photosynthesis that relies on enzymes. The enzyme approach to artificial photosynthesis is preferred because it mimics nature better and the purity of the final product is higher. This method of artificial photosynthesis has already been successful at the millilitre scale, and the consortium is planning to scale it up to the litre.

The scaling up of this technology would have a positive environmental impact on the environment as this technology is

carbon neutral and allows the storage of a surplus of renewable energy. Artificial photosynthesis is a promising technology with the potential to change the renewable energy sector.

Curious about artificial photosynthesis?

Contact the WUR expert, Jules Beekwilder, jules.beekwilder@wur.nl

Roots, plants and diseases

WUR and avoiding food contamination

The food supply chain is becoming more complex in our western societies. A single salad we purchase in the supermarket has ingredients from all over the world. The chicken breasts in the supermarket have been processed according to standards that ensure food safety. Despite all the efforts that institutions make to ensure food safety, illness due to contaminated food still occur once in a while.

As the knowledge centrepiece of the Food Valley, WUR is working on the hotspots and new challenges of food safety throughout the supply chain. *Campylobacter* and *Salmonella* are among the most frequently reported food-borne bacterial diseases worldwide. *Campylobacter* is responsible for 80,000 new cases every year in the Netherlands, while the new cases worldwide tally in the millions. The EU has developed new regulations to reduce the consumer risks, and WUR is studying *Campylobacter* to determine infection risk factors in poultry and humans. However, the solution to these meat food safety issues is yet to be achieved.

Contamination of sprouts in salads by dangerous strains of *E. coli* alarmed the public in 2011 when an outbreak occurred in Germany affecting 3,950 people and killing 53. These rare events pose a new challenge to food safety as *E. coli* strains can be naturally found in

the intestines of cattle and, by extension, its manure, thus becoming part of the plant root microbiome. However, the presence of potentially harmful bacteria rarely affects people. WUR researchers are looking deeper into the microbiomes of plants and soils to understand the emergence of new diseases and to design new measures to control human pathogens in agro-production systems to avoid outbreaks and to improve food safety.

Curious to know more about food safety and the projects at WUR dealing with this problem?

Contact the WUR expert, Jaap Wagenaar, to learn more about meat contamination, Jaap.wagenaar@wur.nl or contact the WUR expert, Leo van Overbeek to learn more about food safety in vegetables, Leo.vanoverbeek@wur.nl



High-quality seeds in Ethiopia

WUR and the BENEFIT Partnership

The research that is undertaken at Wageningen University and Research has worldwide impact, sometimes with research focused on countries far away from the Netherlands. The BENEFIT (Bilateral Ethiopian Netherlands Effort for Food Income and Trade) Partnership includes various programmes to support the transformation of Ethiopia's agricultural sector. Developing the value chain of sesame, an integrated approach for the seed sector, or improving the yield of smallholder farmers by upscaling good practices, are some of the programme objectives.

The role of WUR is focused on providing technical assistance, agriculture innovation, and supporting the transformation of the agricultural sector. WUR has worked with two unions and four cooperatives in the supply chain of sesame, increasing the cost-benefit ratio in the last years by 5%. The partnership encourages finance literacy for farmers, enabling them to diversify their offer.



The BENEFIT Partnership also includes the Integrated Seed Sector Development (ISSD) in Ethiopia that aspires to provide smallholder farmers with access to high-quality seeds, improved varieties, and those in high demand, to increase productivity. Two years after the start of the partnership, the four embedded programmes jointly reached over 112,000 farmers directly through their activities, and over 1.6 million indirectly. WUR is committed to the development of African countries and has a high impact in Africa and worldwide.

Want to know more about the BENEFIT Partnership?

Contact the WUR expert, Irene Koomen, irene.koomen@wur.nl

Answering questions and solving problems

WUR and Big Data

Scientists have gathered enormous databases with scientific data over the last decades. These databases have usually been stored within university departments, inaccessible to other scientists. The increasing collaboration between institutions and the embrace of open innovation is changing this norm, unveiling enormous databases from different fields with potential to answer questions and solve problems.

Big data is gathering steam with the development of techniques to capture, process, analyse, interpret, and visualise large data sets in an increasingly, previously impossibly short time frame. These techniques aim to establish links between different fields whose relations have not been studied before. Big data benefits from parallel computing technology, new fast and cheap types of data storage, and is implemented by clustering data and making correlations through e.g. machine learning.



WUR has used big data in various projects in different fields. Smart farming matches animals' diets with their genotype for maximum resource efficiency. The EU Placard project aims to use big data for climate change adaptation and disaster risk reduction. The Optimove project aims to integrate algorithms for agricultural machinery in operational platforms. These are just some examples of big data with WUR involvement. WUR is giving big data a central place for the further development and application of life sciences and agricultural research.

Curious about big data?

Contact the WUR experts, Sander Janssen, Karin Andeweg, and Willem Jan Knibbe, sander.janssen@wur.nl, karin.andeweg@wur.nl, willemjan.knibbe@wur.nl

A seasonal animation

WUR and Citizen science

Citizen science is research which is wholly or partially carried out by amateurs or non-professional scientists. WUR has acknowledged the importance of citizen science projects, collaborating and gathering data from these people devoted to science. Data collected by citizens is used in 95% of Dutch EU reports on biodiversity and has an impact on policy-making.

The WUR biologist Arnold van Vliet has launched the GrowApp application that allows people to create a seasonal animation of their backyard and other natural places they choose by taking pictures on the same site throughout the year. Thanks to this gathered data, scientists can study the effects of climate change, while citizens get gorgeous set of images.



Another way citizens can participate in scientific projects is by monitoring air quality parameters with home-based stations designed to measure pollution or meteorological conditions. This data is then reported to scientific organisations for further analysis. Engaging citizens in data gathering contributes to a more educated society, aware of their natural environment, and committed to its protection. The contribution of citizens to scientific projects allows the performance of certain scientific projects that otherwise would not be possible because of financial constraints, or lack of staff.

Would you like to contribute to citizen science projects?

Contact the WUR expert in the field, Arnold van Vliet, arnold.vanvliet@wur.nl

Provide enough freshwater

WUR and Delta management

The Netherlands is located in the delta of the Nederrijn, and most of its territory is below sea level. Dutch expertise in terms of flood protection is world renowned. Dutch knowledge in delta management is exported to other countries through projects in which WUR collaborates with partners, such as Deltares, foreign governments and/or Dutch companies.

Safety in deltas and coastal zones is of paramount importance in the Netherlands, as 70% of the country's GDP is earned in areas prone to flooding and most people live in these areas. WUR experts in flood management are working in developing countries such as Bangladesh to protect those countries against flooding. In Bangladesh alone, 60 million



people live in flood-prone areas. The consequences of flood disasters in these areas are cataclysmic. WUR has developed future scenarios for Bangladesh and has proposed nature-based solutions to deal with erosion in Bangladesh while improving ecosystem services.

Besides Bangladesh, WUR has collaborated in the Delta plans of the Mekong River in Vietnam, and the Kapuas and Mahakam river in Indonesia. Each of these locations has its peculiarities and challenges. Delta management is not all about building dykes and fighting erosion, but also about water quality, natural environment, and local communities. WUR experts are studying how to avoid groundwater salinisation to provide freshwater to communities living in delta areas.

Interested in delta management?

Contact the WUR expert, Ivo Demmers, Ivo.demmers@wur.nl

60 missions in 15 countries

WUR and Dutch Embassies on Development and Aid Programmes

The Netherlands allocates 0.7 of its GDP to international development and aid. This capital corresponds to the Dutch contribution to fund international institutions like the UN and the World Bank. Besides that, part of this money is also spent in development programmes independently managed by Dutch embassies. These development programmes supported by the Netherlands require detailed monitoring of its outputs, expenditures, processes and partners involved.

The Wageningen Centre for Development Innovation cooperates with Dutch embassies to monitor development and aid programmes to maximise its efficiency and provide advice. The involvement of WUR ensures the application of state-of-the-art technology and

techniques in these plans. The WCDI was involved in a total of 60 missions in 15 countries, making up more than 2,000 consulting days. In these missions, Wageningen staff works alongside regional experts and locals to ensure success.

Dutch firms are usually involved in these programmes to provide products or technology unavailable in the region. This conglomerate of various institutions leads to the implementation of new technologies and changes in social processes in the area. Ultimately, this leads to the empowerment of local communities contributing to food security.

Interested in finding out about the role WUR plays in development and aid programmes?

Contact our expert, Herman Brouwer, herman.brouwer@wur.nl



Millions of insects per week

WUR and the Great Insect War

The use of insects for biological control of greenhouse pests is already a reality. Climate control, LED lightings, and robots share the same space along with insects that keep destructive organisms under control. Biological control leads to healthier plants and higher yields, does not have toxic implications for farm workers, does not lead to pest resistance, and no pesticide residues are left on the final product. That is why managers of high technology greenhouses in the Netherlands prefer to use biological control rather than chemical pesticides.

The entomologist Joop van Lenteren from WUR has been a pioneer in biological control, enabling companies to apply the concepts of insect population dynamics, whereby the release of a beneficial insect controls the population of a damaging insect. Van Lenteren and his colleagues from the WUR Department



of Entomology have developed the techniques necessary for insect rearing, shipping, and distribution of millions of insects per week. Wageningen knowledge played such a critical role in the upscale of this technology that a stamp was designed to commemorate its contribution to this game-changing technology.

Van Lenteren disciples work for companies such as Koppert Biological Systems, the biggest biological control company in the world. Koppert has its headquarters in the Netherlands, but has 25 offices worldwide, employing more than 1,400 full-time professionals. Koppert revenues have increased year on year and, in 2017, the company registered a turnover of more than 200 million Euros. The success of businesses like

Koppert is an indication that pest control has shifted towards biological control thanks to the Wageningen alumni that pioneered this change.

Interested to know more about biological control of pests?

Contact our expert, Joop van Lenteren, joop.vanlenteren@wur.nl

Need of food policy

WUR and the Common Agricultural Policy

Agriculture has been subject to governmental policy as long as Wageningen UR has existed. In the early days of Dutch agricultural policy, innovation was the main target, and the creation of Wageningen University was one of the instruments. In the crisis of the 1930s, the policy shifted to strong interventions in markets and, after the Second World War, food security dominated. This policy was highly successful to the extent that its successor, the European common agricultural policy had to cope with overproduction. Attention shifted to the reduction of negative effects of food production on the environment and rural development. Interventions in markets were replaced by direct payments to farmers, and annual price negotiations gave way to 5-year programmes.

Wageningen UR has long been involved in the development of the CAP. It is responsible for the Dutch contribution to the Farm Accountancy Data Network, which monitors income developments at the farm level; we are helping to innovate this instrument towards full sustainability monitoring. These and other data are used in several models for impact assessment by the CAP and proposals to change it. The outcome of such studies is not only useful for governments but also for industries affected by the CAP or NGOs that want to influence the decision-making.



We do not only investigate different aspects of the CAP on behalf of clients but also actively contribute to the debate on the CAP. Louise Fresco and Krijn Poppe have argued that the CAP should take a food systems approach and be developed into a Common Agriculture and Food Policy. With a strong emphasis on innovation, given the challenges for the future.

Interested to find out more about the Common Agricultural Policy?
Ask the WUR expert, Krijn Poppe, krijn.poppe@wur.nl

Undernutrition in the elderly

WUR and Cater with Care

The risk of undernutrition in developed countries is increasing. One in five patients in hospitals and care homes is undernourished, and one in three is at risk of becoming undernourished. Older

adults tend to lose their appetite and often develop a preference for soft and sweet foods and drinks, such as soups, juices, bread, porridges, etc. The advice of doctors to eat more, or eat differently, is rarely followed because elderly tend to stick to their habits. Consequently, the risk of undernutrition increases because their preferred diet results in a low-protein intake.

The WUR Department of Human Nutrition along with the 'Gelderse Vallei' hospital in Ede have developed a programme to tackle undernutrition in the elderly. The programme, baptised as *Cater with Care*, fortifies favourite food products among the elderly with added protein without changing taste or texture. The programme has been a success, as 71% of the elderly were able to reach the recommended protein intake, compared with 31% of the patients that followed a regular protein-rich programme.

Implementing this programme required the involvement of WUR, the 'Gelderse Vallei' hospital, the NIZO institute for food research,



and private companies such as Heinz, Carezzo, and local providers. The outcome of this collaboration has been very welcomed by the population. The concept 'Cater with Care' could be easily extended to other needs, such as diets low in salt, or diets aimed at hospitalised children.

Interested in improving nutrition without changing eating habits?
Contact the WUR expert, Nicole de Roos, nicole.deroos@wur.nl

Forced departure

WUR and Climate migration

The consequences of climate change will affect all segments of our society. However, the severity of these effects will largely depend on where the communities are located and the wealth of its members. Several WUR departments are working on climate change topics. Ingrid Boas from the Environmental Policy Group is studying how environmental change, including climate change, affects the migration patterns of people affected by disasters and long-term environmental changes.



Multiple factors affect people's decision to move. Factors such as distance, connections and information, possibilities for work, or cultural and political factors, influence where people will and can settle after a forced departure from their homes, and whether they can or want to leave in the first place. Most affected communities move short distances and within national borders, often maintaining a close link with their hometown or region.

This more nuanced picture of the relationship between environmental change and migration contrasts with the apocalyptic view of climate migration often mentioned in the news and depicted in movies. In this context, Ingrid Boas and her colleagues regularly highlight the complex and everyday empirical realities of the issue when offering expert advice to the Dutch Government, the United Nations, the European Commission, NGOs and the media on this subject. This to ensure that newly designed policies properly address the problems at hand and help those in greatest need in an appropriate manner. It is also intended to avoid stigmatising migrants, and the places from which migration originates, as dangerous.

Interested to find out more about climate migrations?

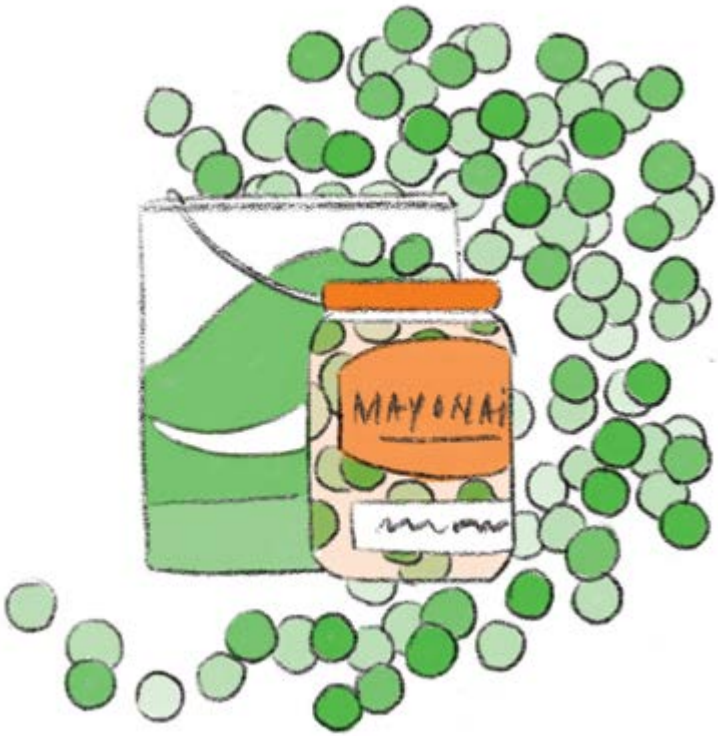
Ask the WUR expert, Ingrid Boas, ingrid.boas@wur.nl

Scratch free

WUR and Soft Matter

Colloids, polymers, foams, liquid crystals, ... these materials are now categorised under the general name 'soft matter'. You can find these materials everywhere even without realising it. They are present in foods like yoghurt, mayonnaise, puree, butter and jelly. Apart from food, the paint of your house, or the fog you see in the mornings, are colloids.

The WUR Department of Physical Chemistry and Soft Matter is researching the properties of these materials. The focus of the group is on fundamental science, but they collaborate with various companies dealing with colloids in different industrial fields. Businesses like AkzoNobel, DSM and OCE (Canon) work with WUR to develop inks and paints with improved characteristics and a lower impact on the environment and workers' health. Unilever is researching how light mayonnaise with fewer calories and a different composition can have the same properties as regular mayonnaise.



WUR also collaborates with other universities to develop new soft matter applications. TU Delft material scientists collaborated with WUR to gain fundamental knowledge on self-healing materials. These materials have futuristic applications as they can recover from scratches and fractures to recoup its initial form. These applications that seem to be only possible in science-fiction movies are already a reality in our lives thanks to WUR's collaboration with other universities and companies.

Fascinated by the applications of Soft Matter? Want to know more?
Contact the WUR expert, Joris Sprakel, joris.sprakel@wur.nl

Synthetic production will save the environment

WUR and High Valued Compounds

The commodities you use on a daily basis like your shampoo or food flavourings are composed of many different compounds. The industries that produce them demand a steady and reliable supply of specific natural compounds at a stable price. However, outsourcing these compounds might be difficult, expensive or unsustainable.

The WUR Department of Agrotechnology and Food Science is studying the production pathways of these natural compounds in order to produce them synthetically. WUR has developed the synthetic production of artemisinin or taxol. These compounds



have a medical use; artemisinin is used to fight malaria, while taxol is used against cancer. Stable production of these substances is essential to supply medicines to the population.

Valencene is another compound whose production pathway has also been developed at WUR. This natural compound is found on oranges, and can be extracted from them. However, disease outbreaks and climate conditions can affect orange production and valencene extraction, jeopardising industries that rely on this compound. The pathway developed by WUR is currently used by the company Isobionics that produces valencene in a bioreactor. Isobionics offers a product to the other industries with stable purity, quality, and price.

Other compounds developed at WUR that have economic interest include santalol and bisabolol. These compounds are used in the cosmetic industry. The synthetic production of santalol would reduce demand for sandalwood, from where it is currently extracted, and have a positive environmental impact.

Interested in knowing more?

Contact Jules Beekwilder, the WUR expert on synthetic production, jules.beekwilder@wur.nl

Cooperation of farmers

WUR and the dairy industry in East Africa

The demand for milk and dairy products in East Africa is expected to increase sharply over the coming years. But the dairy sector is not ready to cater to that demand in all countries. While the Kenyan dairy sector has been developing for over a century with much private and public investment, in a country like Burundi, the milk supply chain suffers from lack of public support and productivity. WUR is studying how dairy sector development can be fostered in

countries with very different economic and socio-political conditions.

Kenya leads the East African pack with milk production and consumption of over 110 litres per capita per annum, followed by Uganda, Rwanda, Tanzania, Ethiopia, and Burundi. The milk consumption per capita of the latter is even

below 20 litres per annum. Milk production in these countries is less effectively spurred by market demand and more constrained by a range of issues. Reasons for low productivity may be varied: land pressures, unproductive cattle breeds, low feed supply, high disease loads, inadequate farmer training, or low adoption of dairy industry technologies, to name a few.

Jan van der Lee is part of a Wageningen Livestock Research team that works in these East African countries on improving the milk supply chain. Alongside local institutions and development partners, Jan is researching viable entrepreneurship options, such as private advisory services and quality-based milk payment, to increase milk production and quality. The idea is to move the sector towards a well-functioning system in which farmers work together, the processing industry is focused, and consumer demand is effectively met. While the dairy industry in East Africa is facing many challenges, the WUR team is confident it can contribute to overcoming these, together with African entrepreneurs and partners.

Curious to know more about the development of the East African dairy sector?

Contact the WUR expert, Jan van der Lee, jan.vanderlee@wur.nl



Climate-smart agriculture

WUR and Carbon Sequestration in Soil

“Terras Pretas de Índio”, also known as Amazonian Dark Earths, are fertile anthropogenic soils found in the Amazon region. These soils are remnants of ancient, pre-Columbian societies arising between 3,000 and 500 years BP*. The high contents of organic soil matter and nutrients and hence the extraordinary fertility of these soils have led to extensive studies on its composition, origin, uses and possible future applications in climate-smart agriculture. The extraordinary properties of these soils, to a large extent, are derived from charcoal that originated from the burning or charring of organic matter (household waste) by pre-Columbian communities. The presence of this charred material improves soil quality, enabling agriculture in these non-fertile Amazonian soils.

The study of these soils, which also occur in other parts of the globe, has led to the popularisation of biochar technology as a win-win solution. Biochar, which is charcoal intended for soil application, is a high-carbon residue produced through pyrolysis (burning in the absence of oxygen). Biochar technologies provide a mixture of solids (biochar), liquid (oils), and gas products with different uses. Biochar is a promising product with potential for carbon sequestration in soils, as it remains in the soil for thousands of years. Biochar application to soils also reduces the emissions of greenhouse gases such as nitrous oxide and methane into the atmosphere.



**BP stands for Before Present. This time scale used in geology uses 1 January 1950 as the commencement date of the age scale due to the commencement of practical radiocarbon dating.*

WUR has foreseen the potential of this new technology and has therefore funded the interdisciplinary research and education programme on Terra Preta. This programme engaged organisations from the Netherlands, Brazil, Bolivia, and Colombia to study the technical, anthropological, economic, agronomic and climate aspects of the exploitation of Terras Pretas. The technologies derived from these studies can address climate change while enhancing ecological intensification of agriculture, making the Terra Preta programme and biochar a topic in which WUR is a major player.

Curious to know more about Terra Preta, biochar, climate-smart agriculture and carbon soil sequestration?

Contact the Terra Programme Secretariat, terrapreta.inref@wur.nl or the WUR expert, Thom Kuyper, thom.kuyper@wur.nl

One pipe for any kind of soil

WUR and Drainage Systems

Drainage is an essential component of agricultural water management. In humid regions, drainage is needed to control soil water for better aeration, higher temperatures, and easier workability. By contrast, in arid and semi-arid regions its primary function is to prevent irrigation-induced waterlogging and salinization of the soil.

Subsurface drainage systems, consisting of perforated plastic pipes are used to drain both agricultural lands as well urban areas. To prevent entry of sediments into drainpipes, these pipes are wrapped with envelopes made from graded gravel or pre-wrapped synthetic materials. One of the biggest disadvantages of these materials is that they have to be matched with the characteristics of the soil in which they will be installed. A Turkish entrepreneur has outsourced WUR knowledge from the drainage expert Henk Ritzema to develop a universal drain pipe-envelope system that can be used in any type of soil.

The new concept, Hydroluis, consists of an inner pipe with three rows of perforations at the top and an unperforated outer-pipe that leaves only the unperforated bottom part of the inner-pipe in contact with the soil. This innovative pipe coverage works for a wide range of soil textures and there is better protection against root growth inside the pipe. Wageningen University is involved in testing the Hydroluis concept in several countries with different soil types and climate zones. Dutch and WUR knowledge on drainage is usually outsourced by international companies working in water management, as the Netherlands has traditionally a rich history in drainage and flood protection in delta areas.

Intrigued to learn more about drainage systems?

Contact the WUR expert, Henk Ritzema. henk.ritzema@wur.nl



Hyperspectral cameras

WUR and Drones

New technologies that come to the market such as drones can have tremendous potential for scientific developments. WUR foresaw the impact of these technologies and set up an Unmanned Aerial Remote Sensing Facility (UARSF) in 2012. The drones can be equipped with the latest sensing technology such as hyperspectral, thermal and LiDAR cameras.



WUR has developed techniques for the application of these technologies in real cases. Several projects that benefit from WUR participation have been developed using this technology. The SPECTORS project monitors agricultural fields, while Natura 2000 monitors protected areas in the Netherlands and Germany. This technique can also be applied to coastal regions. The coral reefs of Bonaire have been monitored using a hyperspectral camera alongside diving in selected areas. Another example of a coastal application of this technology is the NatureCoast project that aims to track dune formation in the Zandmotor.

The application possibilities for unmanned aerial systems and the technology that they hold are unlimited, especially when combined with satellite imagery and in-situ measurements. The information we gather with these new technologies enables new and innovative research that leads to quality of life improvements. Wageningen University and Research is using the latest technology to unravel the secrets of the Earth.

Curious to know more about these technologies?

Contact our experts, Sander Mucher, sander.mucher@wur.nl or Lammert Kooistra, lammert.kooistra@wur.nl

The right diet for Olympic athletes

WUR and Eat2Move

Olympic athletes are sport professionals with a commitment to reach their physical limits. Trainers oversee their performance, and nutritionists consider their dietary intake. WUR scientists are evaluating their performance to assess and give advice on their boundaries. WUR is part of Eat2Move, an innovation hub that includes the Gelderse Vallei hospital, the University of Applied Sciences Arnhem-Nijmegen, the Dutch Olympic sports centre Papendal, and various companies aiming to promote performance



and recovery in (elite) sport and care by means of optimal nutrition.

One of the themes of Eat2Move is centred around optimising performance of Dutch Olympic athletes using nutrition. For example, WUR is studying how to test the physical limits of professional athletes using metabolic cues to optimize performance and limit the risk of injuries. WUR is the knowledge centre of Eat2Move, providing the fundamental knowledge necessary to maximise exercise performance. The companies within the Eat2Move consortia have, together with Sports centre Papendal, developed new food products specifically designed for professional athletes like the Sportsquark, a quark enriched in protein which accelerates recovery.

However, Eat2Move is not only focusing on professional athletes. WUR is collaborating with the Gelderse Vallei hospital to study how nutrition can be tailored to patients' needs. Changing dietary intake and physical activity before surgery will improve patients' mobility during recovery. The goal of this collaboration is to provide evidence-based advice for quick recovery and reduce hospital stays. Nutrition and physical activity is everyone's concern. Wageningen University is unravelling the secrets behind well-being.

Want to know more about nutrition and physical activity?

Contact the WUR expert, Marco Mensink, marco.mensink@wur.nl

Discarded fish species

WUR and Good Fish Foundation

Fishing is an activity with an economic, social, and environmental impact. The pressure on a fishery depends on the economic value of the fish species and the legislation and quota to which it is subjected. WUR is researching various aspects of this complex activity to minimise environmental impact and maximise economic profit.

WUR collaborates with NGOs like Good Fish Foundation to steer fisheries in fields such as consumer demand, policy making, and stakeholder engagement. The Good Fish Foundation has created the fish guide Viswijzer that informs consumers about good fish choices.



This guide aims to steer consumer demand towards sustainable fish to trigger changes in the market and ultimately fish captures and culture. Good Fish Foundation has also been developing programmes to increase the economic value of relatively unknown and therefore underutilised fish species that are often discarded. Promoting undervalued fish among consumers leads to its valorisation in the market while increasing fishermen income.

Good Fish Foundation headquarters are located in Veenendaal, in the surroundings of Wageningen. The NGO has collaboration agreements with WUR and many alumni work for the organisation. Along with Good Fish Foundation and other partners, WUR is working to develop sustainable fisheries not only in the Netherlands but also in remote places such as Vietnam or Indonesia.

Want to know more about Fisheries and Good Fish Foundation?

Download Viswijzer at www.goedevis.nl

Contact the Good Fish Foundation Secretariat, secretariat@goodfish.guide

Contact the WUR experts, Simon Bush, simon.bush@wur.nl and Paul van Zwieten, paul.vanzwieten@wur.nl

Food-based dietary guidelines for population

WUR and Nutrition in Africa

Food and nutrition security is a well-known problem in Africa, especially for women and children. Fortifying foods, improving access to food, or providing healthy dietary guidelines are amongst actions that would lead to better nutrition in Africa. WUR has contributed to many of these measures to improve the quality of life on this continent. The Human Nutrition Division has had an impact on many African countries, thanks to the research of Inge Brouwer and her team.

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) located in Mali, has been developing new varieties of fonio, also known as the hungry rice for its growth characteristics and potential for food security. ICRISAT selected the varieties that



had higher productivity. However, these species contained less zinc and iron compared to the traditional variety, and its introduction in the market would have consequences for human nutrition. WUR worked with ICRISAT to select the ones with higher productivity and the best nutritional characteristics.

WUR's involvement in Africa is well-known, and along with the FAO, Inge Brouwer and her colleagues are developing food-based dietary guidelines for African countries to help consumers, policymakers and the food industry. However, such guidelines only exist in 7 of the 54 African countries. As the guidelines are county-specific, developing them is labour intensive, requiring data on nutrient intake, food access, and other socio-economic aspects. WUR and FAO are closely collaborating with local institutes to make dietary guidelines a reality to improve quality of life for millions of people.

Curious about nutrition in Africa?

Contact the WUR expert, Inge Brouwer, inge.brouwer@wur.nl

Lucrative breeding programmes

WUR and Plant Genomics

The Centre for BioSystem Genomics (CBSG) was a consortium of 15 companies and seven knowledge institutes that, between 2002 and 2013, worked on genome sequencing, primarily of potato and tomato. The first genome of the potato was completed in 2011, and the tomato genome was finished in 2012, leading to two publications in Nature. Sequencing these first genomes required the involvement of multiple institutions and their completion took many years. Nowadays, the rapid advancements in genome technologies permits the sequencing of 150 tomato genomes at WUR facilities in a few months.

The CBSG focus on tomato and potato was the result of a strong strategic choice driven by the private partners, as the Netherlands is responsible for approx. 70% of the worldwide seed production of

both species. Dutch breeding companies still partner with WUR for genomic projects at the pre-competitive stage enabling all companies to benefit from genome data generation, annotation and mining. The WUR research valorisation in plant genomics is outstanding; this can reduce the breeding time for a new variety by 30-40%, and save 5 to 25% of the economic costs of breeding programmes (Source: CBSG).

Tomato varieties with fruits of different colours, shapes, sizes and taste are now being developed faster thanks to the information that genomics provides to breeding companies. Companies such as Syngenta, KeyGene, RijkSwaan, or Enza Seeds engage in such projects together with WUR, and this should ultimately lead to more and better crop varieties. Genome technologies are available at WUR and the industry is already actively implementing such



approaches in their plant breeding programmes. Public-private partnerships are flourishing and helping us advance more rapidly towards a revolution in plant breeding.

Fascinated by these new technologies? Meet the expert behind Plant genomics at WUR.

Contact the WUR expert on genomics, Robert Hall, robert.hall@wur.nl

Less water for a kilogram of fresh tomatoes

WUR and Soilless Horticulture (Hydroponics)

Traditional agriculture relies on soil to grow crops. Growing vegetables on substrates such as stone wool, coconut fibres or gravel have already been implemented in Dutch greenhouses. 98% of the tomatoes, sweet peppers and cucumbers in the Netherlands are grown on substrates. Hydroponic systems optimise the use of water and nutrients while permitting full control of temperature, root oxygenation, electrical conductivity, etc. Besides, hydroponics avoids most soil-borne diseases, which are the cause of yield losses in soil between 10 and 50%.

WUR is researching the improvement and implementation of this technology, with its goal being to reach zero water emissions containing plant nutrients and plant protection products by recovering the drain water and, in the next stage, transpiration water. High-tech Dutch greenhouses have already implemented this technology that allows the cultivation of one kg of fresh tomatoes with only 16L of water. Researchers reduced the energy spent on growing tomatoes in Dutch greenhouses by up to 75%, and commercial growers have already



achieved more than a 50% improvement compared to production in the 90s.

Apart from improving the efficiency of this technology, WUR researchers are working on implementing low-cost systems in developing countries such as Jordan, Algeria and Rwanda, among others. Investment for a high-tech Dutch greenhouse is recovered in ten years, while the investment spent in a conventional tunnel greenhouse can be recovered in two. WUR seeks maximum impact of its research in hydroponics by implementing them in low-tech greenhouses along with the development of low-cost hydroponic systems to achieve higher production levels using less water per kg of fresh product.

Curious about hydroponics? Want to know more about soilless horticulture?

Contact the WUR expert, Erik van Os, erik.vanos@wur.nl

Critical for human survival

WUR and the Insect Economy

Insects are the most diverse group of organisms on this planet, and they are critical for our survival as they provide important ecosystem services: they ensure reproduction of two thirds of all plant species, remove organic waste, and provide food for 80% of bird species. There are 6 million species of insects on Earth, making up 80% of all animal species on Earth. In addition, insects may provide the sustainable source of protein required to feed the rapidly growing human population. Currently, 2 billion people already eat insects as a delicacy. Even if you don't realise it, you eat approximately 500 grams of insects per year as stowaways in processed food.

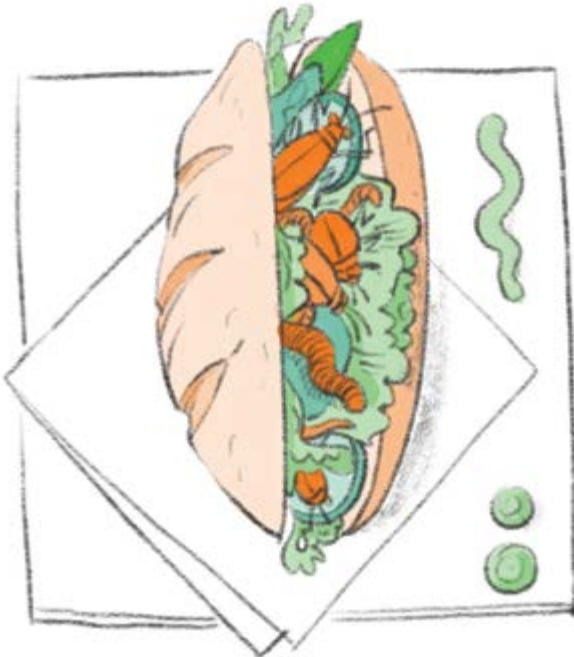
Carmine, a food colourant highly valued and used in food industry is derived from scale insects such as cochineal. Insects provide important contributions to the economy. For instance, a

conservative estimation in the US calculated that insects in the natural environment contribute 57 billion US\$ to the economy of the USA.

Insect farming is more sustainable than the farming of traditional livestock such as cattle, as insects have high feed-to-meat conversion rates. Twenty-five kilograms of feed is required to produce one kilogram of beef, while only 2.2 kg is needed to produce one kg of locusts, the so-called "land shrimp". Moreover, insect production has a lower greenhouse warming potential than production of traditional livestock, making insect farming highly sustainable. WUR has played an active role, in collaboration with FAO, in putting insects as human food and animal feed on the international agenda in the context of food security.

Want to know more about the insect economy

Contact the WUR expert, Marcel Dicke, marcel.dicke@wur.nl



Knowledge leads to motivated people

WUR and Integrated Farm Planning in Burundi.

Despite fertile soils and a beneficent climate, farming in Burundi hardly generates any income. This is not farming by choice, but a consequence of fate: farmers have no other options. Farmers are therefore often not motivated to invest in their farm, as they lack agricultural knowledge and resources to increase their yields. As a result of continuous productivity



decline, many farmers want to leave the rural areas. The Integrated Farm Planning approach, shortly called PIP approach, developed by Aad Kessler from Wageningen Environmental Research, aims to reverse this situation and convert these farmers into sustainable entrepreneurs.

The PIP approach focuses on two crucial issues: motivated people and healthy land. Farmers learn how to plan their farm, and integrate better soil and crop management practices. With these practices, they can often triple their yield. Agricultural knowledge from experts further spurs farmers' investments in healthy land, as such assuring a sustainable increase in production. These motivated farmers become farmers by choice, good stewards of their land, and they inspire other farmers to do the same.

In Burundi, more than 30,000 households have been reached over the past years with the PIP approach. With WUR being responsible for sustainable farming, the plan has restored farmers' intrinsic motivation to invest in their farm. This renewed confidence that their farm is the basis for a sustainable living encourages them

to stay in their villages. Farmers now collaborate in entrepreneurial activities, they form cooperatives, and they have become more food secure. This change is sustainable because it is based on ownership, with motivated farmers leading the way towards sustainable farming.

Intrigued to find out more about how WUR changes farmers' lives?
Contact the WUR expert, Aad Kessler, aad.kessler@wur.nl

100% increase of Vitamin C

WUR and Greenhouse LED Lighting

The market introduction of LED lights entailed a revolution in the lighting industry. This energy-efficient technology can be used in



multiple settings, including greenhouse illumination for crop culture. This technology allows the customisation of light wavelength and intensity while saving 40% of the electricity compared with the traditional high-pressure sodium lamps.

WUR is working together with lighting companies, growers and breeders to improve the percentage of light use by plants up to 30%. This increase in light efficiency would lead to higher yield productivity and efficiency. The use of LED lights in greenhouses allows the stable production of high-quality vegetables year-round. Greenhouse LED lighting enables the vertical production of crops that are stacked in shelves inside buildings in urban areas. These vertical farms are proliferating in many urban areas with demand for locally grown vegetables.

Along with higher yields, LED lights allows the culture of crops with higher nutritional values. WUR research has found that intense LED lighting provided to tomato plants lead to a 100% increase in the content of vitamin C compared with traditional farming. This increase in vitamin C content has also been acknowledged in lettuce. WUR researchers are studying how LED lights affect the plant composition to improve the flavour of aromatic plants such as basil.

Thrilled about the applications of LED lighting in crop culture?

Contact the WUR expert on lighting in Greenhouses and Vertical Farms, Leo Marcelis. leo.marcelis@wur.nl

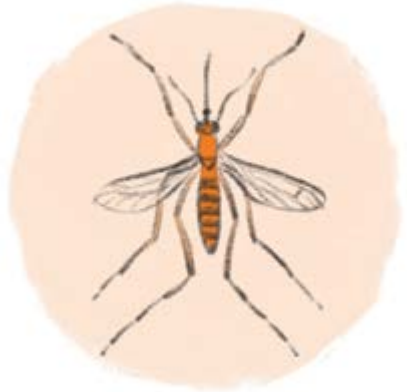
Solar energy and less mosquitoes

WUR and the Fight Against Malaria

Malaria is the most prevalent infectious disease transmitted by insects, causing more than 200 million new cases of malaria each year. Half a million young children die of malaria every year. They are most vulnerable, as their immunological systems have not yet developed resistance.

Malaria infections have a high social and economic impact in many African countries. On average, 10% of an African household's income is spent on the medical treatment of malaria. This expenditure on malaria treatment along with the incapacitation to work while being infected with malaria negatively affects the economy of countries in which malaria infections are an everyday issue.

WUR's efforts to fight malaria are focused on mosquito control, as this has proven to be most effective for control of the disease. Willem Takken has studied which human scents mosquitoes detect to recognise their victims. He has spent 25 years researching this topic until his research group found the answer. These days, these scents are mimicked to trick mosquitoes into traps rather than them biting humans.



Willem Takken has recently led the project SolarMal that combined the introduction of solar-powered light in African regions with electric odour-baited traps for mosquitoes. The implementation of this plan resulted in the reduction of malaria from Rusinga Island (western Kenya) while providing households with solar energy. As part of the SolarMal project, Willem has collaborated with different companies to develop efficient mosquito traps, such as the Biogents AG in Regensburg and Vecotech Ltd in London.

The translation of WUR knowledge into projects and products that control mosquito populations is expected to have a huge impact on malaria, contributing to its eventual eradication.

Want to know more about malaria?

Contact the WUR expert, Willem Takken, willem.takken@wur.nl

Sustainable cup of coffee

WUR and Manos Al Agua

Coffee is an essential beverage for many people. The increasing demand for coffee and consequent increase in production is sure to lead to negative environmental and social impacts if its production is not managed sustainably. To tackle coffee sustainability challenges, the Colombian Coffee Growers Federation (FNC), together with Nestle and Nespresso, Wageningen University and Research, as well as the Colombian and Dutch governments, has founded Manos al Agua. This public-private partnership focuses on the environmental, social and economic conditions of coffee farming



families through inter-sectoral cooperation for sustainable coffee farming.

The partnership has developed a set of good practices regarding saving water and implemented e-learning programmes for coffee growers that have led to a 35% reduction in water consumption. This programme has reached more than 3,500 coffee plantations in Colombia. The project covers five regions along The Andes, reaching 11,000 coffee farmers. Manos Al Agua is supporting the shift towards resistant coffee varieties (e.g. against plagues such as coffee rust and berry borer) with more than 4.6 million new coffee trees planted. Alongside that, 330 hectares were reforested with more than 260,000 trees, and other bioengineering activities were undertaken, such as landslide prevention.

The ecological implications of these actions are closely monitored by the partnership to ensure positive results and impact. The social impact created by the project is represented in the altered mindset of Manos al Agua's participants, such as community groups, extension service, coffee departments and local authorities, and will be key to the lasting success of the project.

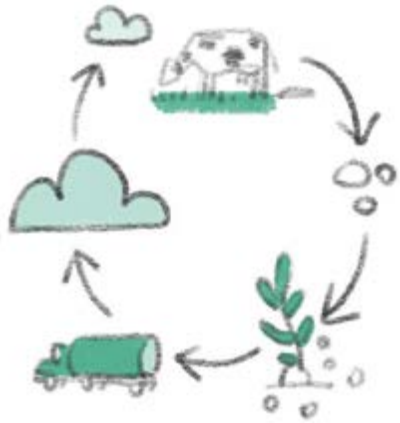
Are you a coffee lover and want to know more about Manos al Agua?
Contact the WUR expert, Laura Miguel Ayala, laura.miguelayala@wur.nl

Minerals as fertiliser

WUR and Nutrient Recovery from biomass

The intensification of the husbandry in the Netherlands in the early 70s has led to higher agriculture production but also to environmental problems and new challenges. The increase in manure production and manure applications on agricultural land caused nutrient losses by leaching and runoff, and resulted in nitrate pollution of drinking water and eutrophication of surface

waters. In the past, it was common to apply 350 kg or more each year of phosphate (P_2O_5) per hectare as manure, while only 60 (arable land) or 110 kg (grassland) per hectare is exported with the harvest. The surplus of phosphate led to high phosphate accumulation on agricultural land. Over the last decades, WUR scientists have been working on measures to



deal with this challenge, as the leaching of about 1 kg of P_2O_5 per hectare leads to an exceedance of environmental standards for surface waters. WUR solutions focused on phosphorous removal by crops and changing the water flows from field to surface water which measures are both still of interest in current policymaking and watershed management.

In the mid-eighties, the government of the Netherlands, and later the European Union, implemented new legislation regarding the maximum amounts of nutrients applied to the fields with manure and fertilisers, which became more stringent over time. To date, a large amount of the produced manure cannot be applied on agricultural land and livestock farms have to pay high costs for the disposal of their manure, even though it contains very valuable components, like organic matter, nitrogen, phosphate, potassium and micro nutrients. New challenges arise that need innovative solutions. Oscar Schoumans of WUR coordinates the EU SYSTEMIC project. This large-scale demonstration project aims to close the nutrient cycles by extraction of the minerals from organic waste streams, like manure, sludge and bio-waste, and reuse the recovered products as substitute for synthetic fertilisers and/or as resources for producing chemical fertilisers. This approach will reduce the energy and CO₂ production associated with synthetic nitrogen fertiliser production, reduce Europe's dependency on

external and finite phosphate reserves, reduce CO₂-emissions of bio-waste transport and reduce the nutrient losses to water and air due to an increased nutrient utilisation of available nutrients recovered from organic waste streams.

Interested in biowaste and nutrient recovery?

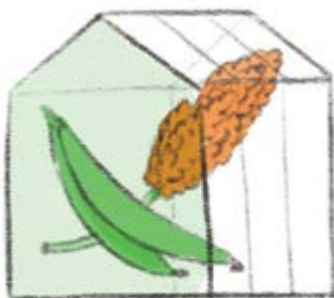
Contact the WUR expert, Oscar Schoumans, oscar.schoumans@wur.nl

Vanilla in greenhouses

WUR and NetherCrops (NetherQuinoa and NetherVanilla)

Before the discovery of the Americas, there were no potatoes, tomatoes, or corn fields in Europe as these are American species. Varieties of these crops have been selected, and nowadays they are commonly grown all over the world. However, there are many crops whose

consumption requires long-distance transportation as they are not locally produced. WUR is researching how to grow exotic species in the Netherlands, such as quinoa or vanilla.



Wageningen scientists are working on the development of new quinoa cultivars suitable for cultivation in Europe. These species can grow in cold climates with poor soil quality and give a significant yield. Quinoa demands high prices on the market and is considered a superfood. Companies are interested in evaluating the possible cultivation of quinoa in the Netherlands, while WUR scientists focus on testing new varieties to maximise production.

Vanilla is another exotic species whose production WUR scientists are researching. Vanilla is grown in greenhouses, where they flower and are artificially pollinated to produce the fruit. WUR has found the balance between humidity and temperature to allow the development of aerial roots in vanilla without mould growing on them. The result of this innovation is a stable product with standardised quality and an expected volume when compared with the traditional supply chain.

Curious to know more about the new NetherCrops?

Contact Ruud Timmer to know more about NetherQuinoa, ruud.timmer@wur.nl

Contact Filip van Noort to know more about NetherVanilla, filip.vannoort@wur.nl

Corn in space

WUR and Agriculture on Mars

We, as the human species, have already been to the Moon, but have not yet arrived on Mars. The idea of interplanetary travel to Mars is high on the list of many spatial agencies. However, going to Mars requires more effort than going to the Moon. Settling a self-sustainable base with human beings operating it will be a necessity. To feed the (human) Martians, it is essential to produce food on Mars.

WUR is a pioneer in agricultural research on Mars (and the moon) as a result of Wieger Wamelink's innovative research. Wieger got a research fund from Wageningen Environmental Research to start the study on the challenges and opportunities in Martian and Moon soils. Knowledge about the optimal conditions to grow plants is extensively present at Wageningen University and Research, but experiments with crops grown in Mars and moon soils were non-existent. The lack of sufficient nitrate in the ground is a challenge for Martian agriculture. On the bright side, the sterile Martian environment allows the introduction of only beneficial bacteria, avoiding pathogens and thus potentially resulting in higher yields.



Spirited debates about Mars agriculture are held at WUR departments, especially regarding the feasibility of a sustainable agricultural ecosystem on Mars, indoors and underground and whether it should be hydroponics or tissue culture, including the use of Martian soil. Alongside WUR, NASA is also experimenting with potatoes, and ESA is carrying out experiments on artificial substrates. China and Russia are focusing their research on other fields. Consequently, WUR is one of the frontrunners in agriculture beyond Earth. WUR is celebrating its centennial this year; in a hundred years' time, we hope to have a WUR department on Mars*.

Thrilled about Martian agriculture?

Contact the WUR expert, Wieger Wamelink, wieger.wamelink@wur.nl

** As spoken by Thijs Breuking during his farewell speech.*

weather observations for a century

WUR and the History of Meteorological Observations

Wageningen University and Research (WUR) is celebrating its centennial in 2018. Even before WUR was founded as an academic institution, the first weather observations were already being recorded such as precipitation since 1914. Soon after, solar radiation and standard meteorological observations were also recorded. Thanks to the link between agriculture and climate conditions, Wageningen University has one of the longest records of solar radiation observations in Europe.

The WUR Meteorology and Air Quality Group runs the weather station 'De Veenkampen', where state-of-the-art technologies and novel instruments monitor current weather and air quality conditions. In addition, unique observations of soil properties are also monitored. All these measurements are available to the public via their website. This data is widely used within WUR and used by public institutions and private weather companies like the Wageningen based



MeteoGroup as well. Anticipating the weather and providing sound advice to companies so they can react in time to harsh conditions is at the core of Meteorology and state-of-the-art observations are indispensable.

The meteorological observations and facilities are obviously also used for education, and students learn to set up and run their own weather station, for example. Besides this, the observations are

used for diagnosing weather trends and analysing climate change. Bert Holtslag and his chair group connect the local weather and air quality observations with the larger atmospheric picture for their research to unravel the ongoing mysteries of over-land atmosphere, including radiation processes and atmospheric turbulence. Wageningen University is leading in this field thanks to the early adoption of meteorological observations that were maintained and intensified over the last 100 years in combination with fine-scale atmospheric modelling studies in the last decade. In the future, these observations are also expected to play an important role in solar and wind energy resources.

Want to know more about the WUR meteorological observations and research?

Contact the WUR experts, Bert Holtslag, bert.holtslag@wur.nl and Bert Heusinkveld, bert.heusinkveld@wur.nl.

The milk-bio-bank

WUR and Dairy Science

Dairy science at WUR is as old as the university itself. Since its very beginning, WUR has studied how to improve milk production and its quality. The sector has changed drastically over the last 100 years, just as WUR's research focus on dairy. WUR has extensively studied dairy processing and related industrial processes. Nowadays, dairy companies like FrieslandCampina undertake their own R&D regarding dairy products and production processes. In the meantime, at WUR, the focus of the dairy department has shifted towards more fundamental insights into milk composition and functionality.

A major example of this approach is the Milk Genomics Initiative of Wageningen University that studies which genes are responsible for milk composition. Thanks to this project, it is possible to breed cows that produce the best milk composition for cheese production, or cows that produce milk with specific healthy fatty acids. The Milk

Genomics Initiative gathered the data of more than 2,000 cows from 400 different farms, constituting the first biobank and database of this kind worldwide.

The Milk Genomics Initiative involved three different WUR departments and had led to the publication of 12 PhD theses and more than 60 scientific papers. Breakthroughs in fundamental research like this initiative set the foundation for developing products at a later stage. Thanks to this WUR project, farmers will be able to specialise their production and dairy companies will be able to select the best milk for each product.

Interested in the latest insights into milk composition?

Contact the WUR expert on dairy science, Kasper Hettinga, kasper.hettinga@wur.nl



700.000 African farmers

WUR and N2Africa

Nitrogen is an essential nutrient for plant growth. Although almost 80% of the atmosphere is nitrogen, plants cannot assimilate it unless it is fixed in the form of ammonium in the soil. Rhizobia are bacteria that colonise the roots of legumes crops and fix nitrogen. The inoculation of grain legumes - beans, cowpea, groundnut and soybean - with these bacteria leads to yield increases while fertiliser requirements are decreased, giving an enormous boost to agricultural production.

The project N2Africa aims to introduce Rhizobium inoculants to African agriculture. Together with the use of improved varieties of the crops and good agronomic management, the inoculants enhance the yield of grain legumes and get more fixed nitrogen into farmers' fields. The potential of Rhizobium has been recognised by the



Bill & Melinda Gates Foundation which has funded this project. Professor Ken Giller and his WUR colleagues have been closely involved in the project, with Wageningen providing expertise to the project. N2Africa activities led to the implementation of a known technology that was not used before by developing new products and the market for Rhizobium inoculants.

N2Africa has reached more than 700,000 farmers located across 11 African countries. Reaching such high numbers has only been possible thanks to national partners, NGOs and various African

entrepreneurs. The increase in yield depends on multiple factors, such as the crop species and variety, the climate and soil conditions and, above all, good agronomic management, including Rhizobium inoculation. N2Africa is involved in monitoring and evaluating the yield increases and understanding where, when and for which farmers the technologies work best. The deeper understanding gained allows N2Africa to enhance the targeting of technologies in demonstration and the dissemination campaigns throughout Africa, in order to maximise its economic and societal impact.

Curious about the N2Africa project?

Ask Ken Giller, WUR Professor and N2Africa Project Leader, ken.giller@wur.nl
N2Africa Putting nitrogen fixation to work for smallholder farmers in Africa – www.N2Africa.org

Switch off receptive genes

WUR and Potato blight.

Phytophthora infestans is the pathogen that causes late potato blight. This disease caused the Great Irish Famine between 1845 and 1849. During this period, a million people died of hunger, and another million emigrated from Ireland. Late blight can be controlled using chemical biocides and by natural resistance of the potato host. However, Phytophthora mutates very fast, thereby evolving biocide resistance and host resistance breakdown.

The WUR Department of Plant Sciences is working to develop potato varieties that are resistant to Phytophthora. The traditional breeding of potato is time and resource-intensive. Because of the heterozygosity in the genome, it is impossible to reproduce improved versions of established varieties, forcing agriculturists to find alternative solutions.

Novel breeding techniques, such as cisgenesis and CRISPR-Cas9, are currently being used at WUR to improve disease resistance of potato varieties. These technologies allow the introduction of active

copies of natural resistance genes. The other way around, studying the genes responsible for the susceptibility of a plant to a given pathogen, allows the identification of unwanted genes. In this case, WUR uses CRISPR-Cas9 technology to eliminate the susceptibility genes so that plants can become unattractive to pathogens.

The impact of these developments on business and society are enormous as potato is a popular crop with high demand. WUR research on plant pathogen resistance is essential to ensure sustainable agriculture and food security while avoiding new episodes of the Great Famine.

Curious about WUR efforts to fight potato pathogens?

Ask our expert, Jack Vossen, jack.vossen@wur.nl



Pig-Plateau 2.0

WUR and Animal Welfare

Pigs are intelligent animals whose husbandry requires innovation to ensure pig welfare in indoor farms. Aggressive behaviour such as pig tail biting is a recurrent problem in indoor farming. New machinery and pig entertainment devices need to be designed to improve pig welfare. Wageningen Livestock Research has been part of a consortium that has developed an elevated platform for indoor farms that increases the liveable area and pig welfare, the Pig Plateau 2.0.



The split-level design of a pig plateau for growing/finishing pigs that was introduced in 2002, increases the liveable area by 25 to 40%. The platform provides room for a variety of pen enrichments while reducing pig aggressiveness and tail biting. The more extensive living area, plus pen enrichments, significantly improve the pigs' welfare compared to the traditional pen versions. The pigs seem to enjoy this new platform as 95% of them visit the elevated area.

As innovations are a constant process, the evaluation of practice experiences led to an improved design, the Plateau 2.0 with a collapsible plateau to facilitate easy cleaning and other enhanced features. The plateau 2.0 was created in close collaboration with the business community, pig farmers, Wageningen Livestock Research, the government and the Animal Protection Association. WUR keeps on innovating in the field of animal welfare to address the challenges and the societal demands of this new century.

Want to know more about this innovation?

Contact WUR expert, Anita Hoofs, anita.hoofs@wur.nl

Imitation of texture

WUR and Plant Meat Matters

The demand for animal protein is increasing with its consequent higher environmental impact when compared with plant-based diets. Meat replacements offer the possibility to shift towards a vegetarian diet without giving up meat taste. Despite the good quality of these meat replacements, we need innovation to make more structured, versatile, and cost-effective products.

Atze Jan van der Goot, along with his team from Food Processing Engineering, Wageningen Food and Biobased Research and TU Delft, has developed the formulation and machinery necessary to perfectly imitate meat texture through innovative shear technology. Thanks to the machinery developed based on the expertise developed by WUR scientists, plant proteins adopt a disposition



similar to the one found in meat muscles, imitating meat texture. These developments have attracted the interest of the food industry.

A consortium coined as Plant Meat Matters merges the efforts of eight companies with WUR to develop the new generation of meat substitutes. The meat texture is the unique selling proposition of this WUR plant meat. Flavouring this meat substitute, making it juicier, and improve its nutritional characteristics are currently being researched in the consortium. The ambition of the Plant Meat Matter consortium is to commercialise in the following years.

Want to know more about shear technology for the development of the Plant Meat Matters?

Contact the expert behind this invention, Atze Jan van der Goot, atzejan.vandergoot@wur.nl

Improve plant growth

WUR and Plant Microbiome

Plants live in association with communities of bacteria and fungi, which is named the plant microbiome. These communities have a positive impact on plant health; often being referred as the “natural biotic resilience of a plant” or the “second genome of plants”.

WUR researchers have analysed the composition of the microbiomes of various plant species and discovered new groups of microorganisms that cannot easily be cultured under laboratory conditions. The focus for research is on analysing which microorganism improve plant growth under natural conditions. It is known that seeds already have their own microbiome and, by enhancing the seed microbiome, it is possible to stimulate plant growth and development, which is the most direct way to benefit agriculture.

The agricultural industry is very interested in the potential of the plant microbiome. WUR works with companies, such as Incotec,

Koppert, Enza Zaden, Bejo, Beekenkamp and individual growers organised under LTO Glaskracht to advance the state-of-the-art of microbiome research while developing new applications. Some microorganisms that promote plant growth have already been commercialised by others, yet more fundamental research is necessary to unleash the full potential of the plant microbiome. WUR scientists are studying these fascinating microbial communities to understand their roles and possible applications better.



Want to know more about the plant microbiome?

Contact the WUR expert on plant microbiome, Leo Van Overbeek, leo.vanoverbeek@wur.nl

Software distinguish crops

WUR and Plant Phenomics

Plant phenotyping aims to measure the growth, architecture, and composition of a plant. Thanks to new technologies, this process of analysing the phenotype is automated with high-tech tools. The data gathered through state-of-the-art robots can be interpreted through various advanced software tools developed within WUR.

WUR collaborates with machine builders such as the ISO group and Steketee to develop commercial applications to automate tasks in which phenotyping software tools are integrated. The ISO group has developed the ISO PlantSampler that allows the mechanisation of plant sampling for DNA analysis, reducing time and labour required for research and contributing to faster discoveries of novel

varieties within breeding companies. Steketee has developed an automated weeding machine for agriculture fields thanks to WUR software that distinguishes crops from other objects and undesired plants.

WUR is leading in plant phenotyping and agro-food robotics. In the upcoming years, WUR is going to build a large-scale phenotyping facility, called The Netherlands Plant Eco-Phenotyping Centre (NPEC) together with Utrecht University, with climate chambers, automated greenhouse chambers, and field phenotyping systems with drones and mobile platforms. This new facility will boost plant research on a national scale.

Amazed by these revolutionary technologies?

Contact the WUR expert in plant phenotyping, Rick van de Zedde, rick.vandezedde@wur.nl

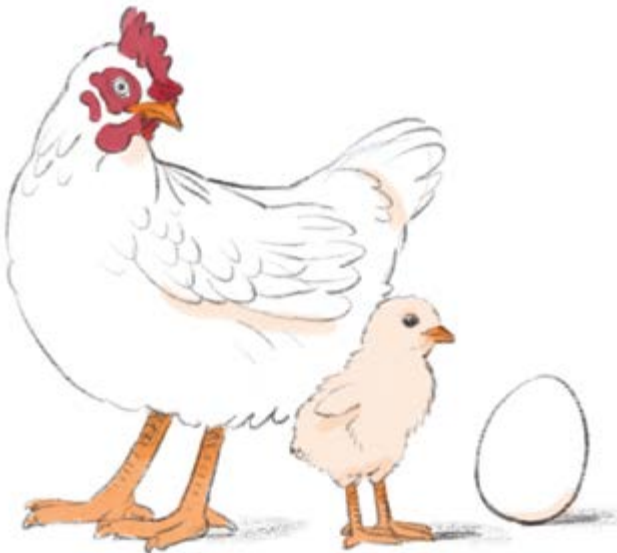


Feeds, hatcheries and vaccines

WUR and Poultry in Ethiopia (Holland-Africa Poultry Partners)

The Dutch animal husbandry sector is specialised in cow, pig, and poultry. The success of this animal farming in the Netherlands is world renowned, with Dutch knowledge being exported to other countries. The Holland-Africa Poultry Partners is a partnership of professional, committed companies, NGOs and knowledge institutes from the Netherlands, specialised in solutions and knowledge transfer for the international poultry sector.

Ethiopia has been one of the fastest growing economies in Africa in recent years, with an agriculture sector that represents 44% of its GDP and 61% of Ethiopian exports. WUR, as part of Holland-Africa Poultry Partners, has spotted the potential of the Ethiopian poultry sector and is committed to its development. WUR has contributed to the integration of the value chain for eggs and meat production.



WUR has been training Ethiopian farmers in the fields of feeds, hatcheries, vaccines, drugs, and entrepreneurial practices.

Cooperation is necessary for growth. WUR has collaborated with companies like VDL Agro, Vencomatic, ISA Hendrix, PasReform, and de Heus Feed to bring Dutch knowledge on poultry to African countries. The Ethiopian poultry industry has benefited from this knowledge exchange and it is now better prepared to face the challenges of poultry farming and its commercialisation.

Curious to know more about the Holland-Africa Poultry Partners?

Contact the WUR expert on poultry, Adriaan Vernooij, adriaan.vernooij@wur.nl

Beyond the walls of Academia

WUR and knowledge transfer to the broader public

A university's ultimate goal is to create new knowledge and disseminate it to society. Wageningen University and Research can be proud of having a structure that transfers knowledge efficiently from WUR towards the industry. Alongside that, WUR has transferred knowledge over a numerous generations in its 100 years of existence. However, WUR has transferred knowledge not only to WUR students but also to a broader public not directly linked with the university.

The common idea of knowledge transfer in universities is that a teacher gives a lecture to undergraduate students. However, WUR goes beyond that stereotypical image of scientific institutions. To increase the acceptance of science among the general public, WUR has brought its laboratories to high



schools to showcase how they perform genetic analysis. The Mobile DNA labs allow school children to perform a DNA-based experiment in their school classrooms, reaching between 4,000 to 5,000 children each year. Teachers also benefit from these initiatives as they get first-hand training from experts in the field of genomics. Apart from that, WUR also offers specific training for teachers to update and inspire them in the field of healthy food and living environment.

WUR is reaching beyond the walls of academia to communicate their scientific findings to everyone interested in their activities. WUR opens the doors of its facilities so everyone can get an impression of what is done at the campus as first-hand witnesses. On top of that, accompanying the emergence of information technologies, WUR has created various Massive Online Open Courses (MOOCs) to reach everyone in the world that has Internet access. WUR has never been so close to the general public than on its 100th anniversary.

Want to know more about WUR knowledge transfer? Contact WUR by writing to the following e-mail addresses.

For the DNA labs project write to dnalabs@wur.nl

Interested in the FoodValley? Contact foodvalleynetwerk@wur.nl

Questions regarding MOOCs? Write to mooc@wur.nl

Sustainable toolkits

WUR and The Sustainability Consortium

In 2009, a group of companies, NGOs and universities came together to develop a system for measuring the sustainability of consumer products. This new system would create a benchmark for companies to work on continuous improvement of sustainability with their supply chain partners. This conglomerate of institutions working on this sustainability benchmark was named The Sustainability Consortium.



Wageningen University is one of the universities that leads the consortium, along with the University of Arkansas and the Arizona State University. The consortium has developed 128 toolkits to assess the sustainability of different consumer products. The toolkits identify the most important sustainability issues for the product category (hotspots), lists a set of indicators to measure the sustainability of products within this product category and includes a set of opportunities to improve the sustainability performance. Nowadays, there are more than 2,500 suppliers in the database that altogether have a total of 200 billion dollars revenues in sales. The Sustainability Consortium aims to stimulate competition between suppliers to appear first in the database.

The impact of The Sustainability Consortium on business is enormous as the group includes about 100 companies, NGOs and universities, including Unilever, Cargill and the WWF. The consortium is a multi-stakeholder non-profit organisation, so the members share responsibility and undertake activities to keep the consortium activity ongoing.

Intrigued to learn more about The Sustainability Consortium?

Contact the WUR expert, Koen Boone, koen.boone@wur.nl

Around the world

WUR and UASB Reactor.

The acronym for this technique for wastewater treatment stands for Upflow Anaerobic Sludge Bed (UASB) reactor. The UASB reactor was developed in Wageningen by Gatze Lettinga, a professor from WUR. Gatze realised the potential of this technology and did not patent it because he wanted it to be spread as fast as possible to have the greatest impact on society. The technology spread quickly and, today, there are UASB reactors in every corner of the world and in different industry sectors.

The Dutch industry sector welcomed the development of the UASB reactor. The Dutch companies Paques BV and Biothane-Veolia have developed the market for UASB reactors, entailing the commercialisation of this technology.

Despite the lack of a patent, WUR is leading the research into UASB reactors, with ongoing projects focusing on saline wastewater treatment and nutrient recovery. There are various Wageningen spin-offs regarding UASB reactors, such as LeAF. LeAF is a spin-off that offers laboratory services, feasibility studies and training to private enterprises and public institutions regarding the UASB reactor.



The UASB reactor is a WUR invention that has had a massive impact on business, society and the environment. WUR scientists are working to increase the applicability of this technology to other industries, regions, and applications to have an even greater impact.

Want to know more about the UASB Reactor?

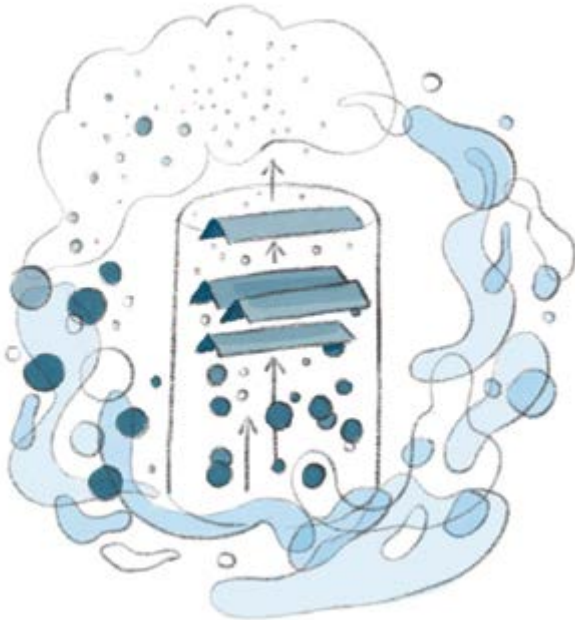
Contact the WUR expert, Miriam Van Eekert, miriam.vaneeekert@wur.nl

Useful wastewater

WUR and the applications of the UASB Reactor

The commercialisation of the UASB reactor has led to a revolution in water treatment and contributes to a more circular economy. Thanks to Gatzte Lettinga, WUR is the frontrunner in UASB technology. Nowadays there are UASB reactor “ambassadors” all over the world, much as Lettinga’s department in the 80s was already very international.

This WUR-born technology is used in different industrial sectors to treat wastewater. Heineken, Shell, COSUN and other companies have UASB reactors at their facilities. Recently, the first UASBs were installed in a housing estate and three office buildings in the Netherlands to treat domestic wastewater, collected with vacuum



toilets. This invention allows the treatment of high volumes of water in a small reactor volume, requires little energy as aeration is unnecessary, and produces energy in the form of biogas.

Besides water treatment, the primary purpose of this technology, the UASB reactor transforms between 80 to 90 % of the organic pollutants into biogas. Households can use this biogas for cooking or for building acclimatisation. There is also research underway to produce fatty acids, bioplastics, and electricity using the anaerobic processes in the reactor. The success of such research projects would entail a revolution in the circular economy, as a wide variety of products could be produced from waste.

Wageningen University is a pioneer in the circular economy that is being developed around the UASB reactor.

Want to know more about all the possibilities of the UASB reactor?
Contact the WUR expert, Miriam Van Eekert, miriam.vaneekert@wur.nl

From animal to human

WUR and Veterinary Vaccines

Wageningen Bioveterinary Research (WBVR) is the national reference laboratory for notifiable veterinary diseases in the Netherlands. Veterinary diseases are monitored in their facilities with 250.000 tests per year performed on horses, livestock, wild fauna, and fish. Wageningen Bioveterinary Research role in society becomes of paramount importance when emerging zoonosis, such as bird flu and Q-fever, alarm the population. However, WUR researches work all year round to avoid and control animal diseases outbreaks.

Besides monitoring livestock health, Wageningen Bioveterinary Research has developed various veterinary vaccines. The DIVA principle that allows the differentiation of vaccinated and infected animals, was developed at WBVR. This differentiation of infected animals from vaccinated ones is critical in the control of disease outbreaks. New prototypes of vaccines were developed for Avian

Influenza, Bluetongue, Rift valley fever and African Horse sickness.

Furthermore, new technology has been developed making use of RNA replicon particles as safe vaccines. The insertion of genes of emerging pathogens in these RNA replicon particles enables the rapid production of vaccines against new emerging pathogens.



Wageningen Bioveterinary Research keeps on developing new vaccines while monitoring disease outbreaks that could endanger animal welfare.

Interested in the vaccines developed at WUR?

Contact the WUR expert on animal vaccination, Riks Maas, riks.maas@wur.nl

Sand nourishment exported WUR and The ‘Zandmotor’

The Zandmotor is a mega-engineering coastal infrastructure located in South Holland was constructed as a pilot project for the long-term sand nourishment of the Dutch coast. The construction of the Zandmotor entailed the relocation of 22 million m³ of sand, creating a peninsula that extends 2 km along the coast and protrudes 1 km into the sea. This process was undertaken by dredging companies and supervised by universities, political institutions and consultancy companies.

Wageningen Marine Research studied the effect of the Zandmotor on the development of the marine benthic fauna, while Wageningen Environmental Research analysed dune plant colonisation.

Engineering consultancy companies like Witteveen+Bos developed measurement plans and databases for monitoring dune dynamics in coordination with WUR and Deltares. The Zandmotor is the result of collaboration between various institutions of different nature.

The Zandmotor created new habitats and attracted new fauna, flora and tourists to the area, especially kite surfing enthusiasts and nature lovers. This innovative idea for sand nourishment is already being exported to other parts of the world. WUR is proud for being part of the Zandmotor consortium and for becoming a knowledge exporter.

Want to know more about the Zandmotor?

Contact our expert Jeroen Wijsman, jeroen.wijsman@wur.nl.



Colophon

Title WUR impact portfolio, a selection of 100 years of research in Wageningen and its impact on the world

Published by

Wageningen University & Research
www.wur.eu

September 2018

This portfolio is composed for the 100th anniversary of Wageningen University & Research. It contains a selection of 100 years of Wageningen research. The portfolio has been created with the cooperation of a large number of researchers and employees from WUR. The portfolio has been ranked in random order.

Composed and written by

Francisco Presas Basalo

(Final) editing

Simon Vink
Edwin van Laar
Door van der Sloot

Illustrations Steffie Padmos
Design Communication Services,
Wageningen University and Research



Wageningen University & Research was founded 100 years ago. During this century, the organisation has shown itself to be a global expert in the field of healthy food and the environment. In 100 years, valuable knowledge has been acquired and high-value education has been developed. Research, education, and countless projects have led to products and valuable partnerships. In this impact portfolio, we highlight more than fifty of those research projects, products and partnerships that have had an impact on society.