

SPOTLIGHT ON THE NETHERLANDS

Green light for Netherlands' sustainability research

The Netherlands is using its expertise in tech and agriculture to punch above its weight in the clean-tech revolution.

"Our students want to work in professions that will help to build a more sustainable world."

Sascha Kersten, University of Twente

ONE DAY in the not-too-distant future you may be tucking into a worm burger, freshly grilled on a barbecue powered by pig manure-derived fuel. And if you do, there's a good chance that the technologies behind your sustainable meal will have been developed in the Netherlands.

The thought of chowing down on creepy crawlies may not sound too appealing, but seeing that worm burger as

an environmentally friendly version of your usual fast food snack might make it a little more palatable: it could be part of the solution to the planet's burgeoning population and declining availability of agricultural land.

Those are the hopes of researchers all over the Netherlands, where sustainability research is at the top of the agenda of universities, research institutes, companies and the government. Building on a strong history of high-tech industry and high-density agriculture, the Netherlands is rapidly applying its expertise and infrastructure to revolutionising the way we feed and power the planet.

"The Netherlands already has the world's highest productivity in the agrifood business in terms of production per acre," says Toine Timmermans, from Top Institute (TI) Food and Nutrition in Wageningen. The Netherlands may be one of the smallest countries in the European Union, but more than half of its four million hectares of land is used for agricultural purposes, and it is the world's second largest exporter of agricultural products, after the United States. "Our challenge now is how to do that in a more sustainable way," Timmermans says.

Making alternatives a reality

Scientists at Wageningen University and Research Centre (UR) are working on one innovative solution: plant- and insect-derived meat alternatives.

The town of Wageningen is situated at the heart of the country's 'Food Valley', an area dense in food companies and research organisations. This makes it ideal for testing out novel foodstuffs, with companies such as Nizo — which operates Europe's largest pilot plant for food production — on the doorstep.

In Driebergen in the middle of the country, researchers at the Louis Bolk Institute are also focused on less resource-intensive food production. They are showing Dutch farmers how techniques developed for organic farming can provide economically-viable options for conventional agriculture. "We're showing them that techniques like planting clover in fields to get extra nitrogen in plants and soil can be just as effective as using artificial fertilizers," says institute researcher Jan-Paul Wagenaar.

An inevitable byproduct of such a large agricultural sector is waste. "The Netherlands has more pigs than people," says Sascha Kersten, at the University of Twente. Kersten, who works on developing new biofuels, sees the waste as a resource to be tapped, rather than a problem. Most of the pig waste, and that derived from many other agricultural processes, is biomass — organic material such as manure and woodchips that can be converted into heat, fuel and chemicals. "Our research focuses on making products that are currently made from fossil fuels from biomass instead," he says.

Efforts don't stop with solid waste. Located in Leeuwarden



near the northeastern coast of the Netherlands, Wetsus, a centre of excellence for sustainable water technology, brings together universities and companies across Europe in order to develop sustainable ways to treat waste water.

Innovation through collaboration

Working with companies to put new technologies into practice is one of the draws of sustainability research, says Kersten. The University of Twente works in close collaboration with large companies such as Shell and DSM, a Dutch life science and materials sciences firm. "When we survey our first year students in chemistry or chemical engineering, often their primary reason for choosing these topics is that they want to work in professions that will help to build a more sustainable world," he says.

This goal is echoed by Hester Bijl, chair of the Delft Energy Initiative, at the Delft University of Technology (TU Delft) which stimulates interdisciplinary partnerships between the university's 700 energy researchers and business.

One such partnership is helping to build the reputation of the Netherlands as one of Europe's leaders in wind energy

production. TU Delft is engaged in FLOW, a large scale project to build wind farms far off the shore, in order to avoid shipping routes and other obstacles. The initiative is a collaboration with the Energy Research Centre of the Netherlands (ECN), the largest energy research institute in the country, and should help the Dutch government meet its target of 6000MW of offshore wind energy capacity to be installed in the Netherlands by 2020.

Fusion on many levels

The Netherlands' version of Silicon Valley, the so-called Brainport Eindhoven region — an area concentrated in high-technology research — is also turning its attention to sustainable technologies. The Netherlands Organisation for Applied Scientific Research (TNO), which employs around 4000 people in the area, is spearheading the Solliance research cluster, a cooperation which brings together 250 researchers in the Eindhoven area who are working on the development of thin-film photovoltaic cells for harnessing solar energy.

Wind and solar may be the most obvious options in alternative energy research, but TU Eindhoven is also thinking beyond these. The university,



The newly constructed Bernoulliborg building houses a section of the science department of the University of Groningen. The city is part of the 'Energy Valley' of the Netherlands.

which has named energy as one of its top three research foci, is using its technical prowess to

investigate the potential of nuclear fusion as an energy source.

Niek Lopes Cardozo, head of

Key figures of Dutch universities in 2011

| | Total income (education and research)* | | Research council income | | Research capacity** | |
|---|--|------------|-------------------------|------------|---------------------|------------|
| | M€ | in % | M€ | in % | fte | in % |
| Total | 6,005.0 | 100 | 450.3 | 100 | 19,700 | 100 |
| University of Utrecht | 767.4 | 12.8 | 69.2 | 15.4 | 2,531 | 12.8 |
| University of Amsterdam | 599.6 | 10.0 | 48.6 | 10.8 | 1,285 | 6.5 |
| University of Groningen | 594.2 | 9.9 | 40.7 | 9.0 | 1,721 | 8.7 |
| Delft University of Technology | 544.8 | 9.1 | 33.1 | 7.3 | 1,498 | 7.6 |
| Erasmus University Rotterdam | 542.3 | 9.0 | 20.9 | 4.6 | 1,396 | 7.1 |
| Leiden University | 514.7 | 8.6 | 55.8 | 12.4 | 2,192 | 11.1 |
| Radboud University Nijmegen | 506.5 | 8.4 | 54.2 | 12.0 | 2,258 | 11.5 |
| VU University of Amsterdam | 459.7 | 7.7 | 34.9 | 7.8 | 1,743 | 8.8 |
| Maastricht University | 343.4 | 5.7 | 16.5 | 3.7 | 1,481 | 7.5 |
| Eindhoven University of Technology | 317.1 | 5.3 | 24.0 | 5.3 | 1,122 | 5.7 |
| University of Twente | 313.5 | 5.2 | 21.0 | 4.7 | 1,068 | 5.4 |
| Wageningen University and Research Centre | 304.5 | 5.1 | 22.0 | 4.9 | 942 | 4.8 |
| Tilburg University | 197.4 | 3.3 | 9.4 | 2.1 | 463 | 2.4 |

Sources: Total income: based on the annual accounts of the universities, treatment DUO, an agency of the ministry of Education, Culture and Science. Research council income: research council NWO. Research capacity: Association of Dutch Universities. * current costs, without the government contribution to the eight academic medical centres for educational and research activities (which amounted € 586 million in 2011). The universities receive this money, but are obliged to transfer this to the academic medical centres. ** excluding health research of the University of Amsterdam.



Eindhoven University has named energy as one of its top three areas of focus for research.

the fusion science programme, wants to make the university an international centre for fusion education. The physics, mechanical engineering and electrical engineering departments have developed a new two-year Masters course in fusion science, which Lopes Cardozo describes as “unique in the world.”

The energy generation

In the far north of the country, the Groningen Energy and Sustainability Programme (GESP), part of the University of Groningen, also offers a cross-disciplinary educational environment, with the aim of educating highly-employable graduates. “Interdisciplinary research is what trains people well and makes them versatile,” says Harro Meijer, a greenhouse gas scientist at the University of Groningen.

Groningen is located in the ‘Energy Valley’ of the Netherlands, an area packed with infrastructure for natural gas exploitation — infrastructure which many scientists hope to see put into use for deriving and supplying renewable energy. Capitalising on the local set-up, the University of

Groningen has recently teamed up with the Hanze University of Applied Sciences to form the Energy Academy Europe, an international centre of excellence for energy education, research and innovation, which has just launched. “The energy industry is telling us that they want people with sound basic knowledge across the industry – even in their managerial streams,” says Meijer. “At the Energy Academy, we will educate everyone from skilled technicians to postdoctoral researchers to managers.”

Plastic from sugars

Businesses are also coming up with their own innovative clean-tech solutions. “We have a rule that each new product we develop should have a lower environmental footprint than the last,” says Maarten van de Graaf, a biotechnologist at DSM. For instance, his team is currently developing bio-based materials that are made by fermenting sugars. These can then be used to make polymers and other products that in turn can make the manufacture of items like shoes, paint and packaging more sustainable. “We can already

make similar materials from chemical sources,” he says, “but sugars are a renewable starting material.” This corporate attitude has secured the company top ranking on the international Dow Jones Sustainability Index for the chemical sector for six out of the past nine years.

Dutch renewable chemicals firm Avantium, which was this year listed in the Global Cleantech 100 list of the top 100 private companies in clean technology for the third year a row, is working in partnership with Coca-Cola and Danone to develop 100% plant-based soft drink bottles using PEF — the company’s innovative alternative to the chemically-derived plastic PET.

Helping hand

Sustainability research in academia and industry should also be given a boost by government initiatives. In September 2011 the Dutch government announced an overhaul of its research funding policy, with the aim of increasing the country’s spending on research and development. At 1.8% of GDP at the end of 2011, it is well below that of its northern European neighbours, but the

government wants it to rise to 2.5% of GDP by 2020. The scheme identified nine areas that are key to the Dutch economy – including energy, water, food agriculture, and high-technology materials and systems. As part of this plan, some government research subsidies will be channelled into tax breaks and incentives for businesses which invest in research and development in these areas.

Some Dutch scientists regard the scheme, which they say places industry in a strong position to set research agendas, somewhat cautiously. But the policy could be a promising one for the sustainability sector. “The Netherlands has historically lagged behind some of its European neighbours in terms of rolling out renewable energy technologies,” says solar-cell scientist Rene Janssen from TU Eindhoven. “Encouraging more industry involvement, if it is combined with a strong fundamental research program, could give the sector a real boost.”

Provincial governments are also putting a major focus on sustainability. The Overijssel province government, for example, recently announced a €250 million (US\$324 million) fund for low-interest loans and investments which might help the province to generate 20% of its energy from renewable sources by 2020.

“This sustainability push from local governments is a new direction for the Netherlands,” says Kersten from the University of Twente, which is in Overijssel province. “They want to create jobs in the region and help achieve local goals in reducing CO₂ emissions. They’re specific goals for small areas, but I’m very optimistic it will lead to good R&D outcomes too,” he says.

Timmermans is also optimistic that the push from government should be a boon for the agrifood industry. Whereas sustainability has gone from being an issue that companies used primarily for public image purposes a decade ago, it is now a genuine part of their business plans he says: “sustainability is now part of their licence to exist.”

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UMC UTRECHT AT UTRECHT SCIENCE PARK

From Network to Nature

Benefitting fully from the opportunities Utrecht Science Park has to offer, cell biologist Madelon Maurice, PhD from UMC Utrecht, teamed up with stem cell specialist Hans Clevers and proteomics expert Albert Heck to explain in great detail how mutations in intestinal stem cells may lead to cancer. *Nature* published the findings in August.

Mutations in the newly identified RNF43 stem-cell-specific gene turned out to disrupt the delicate fine-tuning of stem cell replication speed. But how? Maurice showed that the RNF43 protein interferes with the well-known Wnt pathway. RNF43 dampens the Wnt growth signal by targeting the Wnt surface receptor for destruction by ubiquitin labeling. When mutated, however, the RNF43 protein no longer

removes the Wnt receptor from the cell surface. This amplifies the growth signal, and stem cells grow too quickly. This leads to pre-cancerous adenomas.

Dr. Maurice explains the relevance: "RNF43 mutations have been found in patients with cancer of the pancreas, bile duct, ovary and colon," she says. "These findings open up the possibility to treat

cancers caused by RNF43 mutations with inhibitors for Wnt-molecules and their receptors. This is not just a theoretical option, as the first Wnt pathway inhibitors are currently being tested in Phase I clinical trials."

The results show the collaborative strength of Utrecht Science Park. Dr. Maurice, who works in the department of Cell Biology, UMC Utrecht, closely collaborated with stem cell specialist Prof. Hans Clevers from the neighboring Hubrecht Institute. Just as valuable was the contribution of proteomics expert Prof. Albert Heck from the (also neighboring) Faculty of Science of Utrecht University.

"At Utrecht Science Park, it's easy to bring together expertise from highly regarded, international researchers, who are located at walking distance. This makes doing research at UMC Utrecht fun and inspiring", Maurice says.

The University Medical Center Utrecht (UMC Utrecht) in the Netherlands

A vibrant science community

UMC Utrecht is in the center of a vibrant biomedical research community: Utrecht Life Sciences at the Utrecht Science Park in the heart of the Netherlands. More than 300 hectares is shared between knowledge institutions, top institutes and companies. It's a perfect starting point for top performances in research, development and innovation. Other Science Park residents include Utrecht University, the Hubrecht Institute, the HU University of Applied Sciences Utrecht, the National Institute for Public Health and the Environment, and companies like Genmab and Danone. For the past ten years, Utrecht University has been rated the best Dutch research university, by the Shanghai Ranking. Utrecht University offers an international

environment with 130 nationalities working and studying together.

Size matters

With more than 1,000 beds, 11,000 employees and 340,000 visits to outpatient clinics, UMC Utrecht is one of the largest academic centers in the Netherlands. Research focuses on six research programs: brain, infection & immunity, circulatory health, personalized cancer care, regenerative medicine and stem cells, and child health. Patient care and education are integrated into these programs. A relentless multidisciplinary approach guarantees that patients benefit from the latest available expertise and innovative technological solutions. Interaction with patients and society creates an 'innovation loop' where societal issues guide scientific

research and where scientific results quickly move from bench to bedside.

More than science

An attractive living environment with a lively city center, cultural life, all kinds of facilities and recreational opportunities characterizes Utrecht. The city borders the 'green heart' of the Netherlands. Utrecht is also one of the most accessible cities in the country. Traveling to Amsterdam Schiphol Airport or Amsterdam city center takes just 30 minutes by train.

Job opportunities

UMC Utrecht is always looking for new, enthusiastic colleagues with innovative ideas. For more information on research and job opportunities, visit our website: www.umcutrecht.nl/research



Breeding excel

Diverse approaches to research stimulate the dynamics of a study and can lead to pioneering results. This concept is firmly embedded in the infrastructure at Leiden University Medical Center (LUMC) where clinicians, researchers and technicians share their expertise in a set of research profile areas that span the organisation.

The research profile areas enable researchers to jointly study a single topic, each of them on the basis of their own disciplines. In the department of Molecular Cell Biology, Professor Peter ten Dijke heads a team studying the protein TGF β . “TGF β is involved in many different processes. Its misregulation has been implicated in cancer, auto-immune diseases, cardiovascular diseases, and osteoporosis, and it plays a major role in vascular biology and regenerative medicine. This means we get questions from numerous different clinics – and we work with different

expertise and departments in order to find answers.” Although ten Dijke’s work is spread across many areas, there is a particular focus on two of the research profile areas, namely Cancer Pathogenesis and Therapy and Vascular and Regenerative Medicine.

Professor Tom Huizinga at the Department of Rheumatology is convinced of this need for cross-discipline collaboration: “You cannot do modern medical research by yourself. You need people with different skills in order to

carry out the whole research process.

For our work on rheumatoid arthritis, we need our clinicians, the biobank, the DNA analysts and radiologists. These excellent people and resources form the basis of our research”

Drawing on resources

The resources at LUMC excel on a variety of fronts. “We have a talented multi-disciplinary team,” says ten Dijke. “It not only comprises molecular cell biologists, but also people with a background in pharmacology, chemistry, even veterinary medicine. And we use genomics, high throughput sequencing, proteomics, and so on. We need it all for our research and it’s all available within the LUMC.” Huizinga: “We benefit from LUMC having a long tradition of being at the forefront of technological developments, and being willing to invest in good equipment to further research. But that’s not all. I feel LUMC has a healthy approach to its financial organisation. There’s no internal billing, so there’s no need for concessions in terms of budgets. And it means there’s a better sense of everyone working towards the same goal.”



“Each stage of the process demands a different combination of expertise.” Peter ten Dijke



“You need people with different skills in order to carry out the whole research process.” Tom Huizinga

Spanning a disease spectrum

The LUMC has extensive biobanks and the collaboration with clinics and international networks means there are many

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patient groups to draw from. “We want to learn from our patient care,” says Huizinga. “We have a tracking system in place and our analysis of this data has resulted in a number of insights into arthritis that have helped us further improve our medical care, including in the early diagnosis of lung cancer, which can have arthritis as its presenting syndrome.” “What’s more,” adds ten Dijke, “as a university hospital, we get to see both common and rare diseases. The very special cases we get at the LUMC give us the opportunity to look at the opposite end of the spectrum and gain insights into both the rare disease and the common disorder.” For instance, as part of his work on osteoporosis, ten Dijke referred to a patient group with a rare disease characterised by the production of excess bone. With the gene that causes that disease now identified, ten Dijke’s research team can use the information to work on developing an effective therapy that increases bone density for osteoporosis. And as the same cells that induce bone loss in osteoporosis mediate bone destruction in rheumatoid arthritis, a therapy can also be developed for stopping joint destruction in rheumatoid arthritis.

Working towards common goals

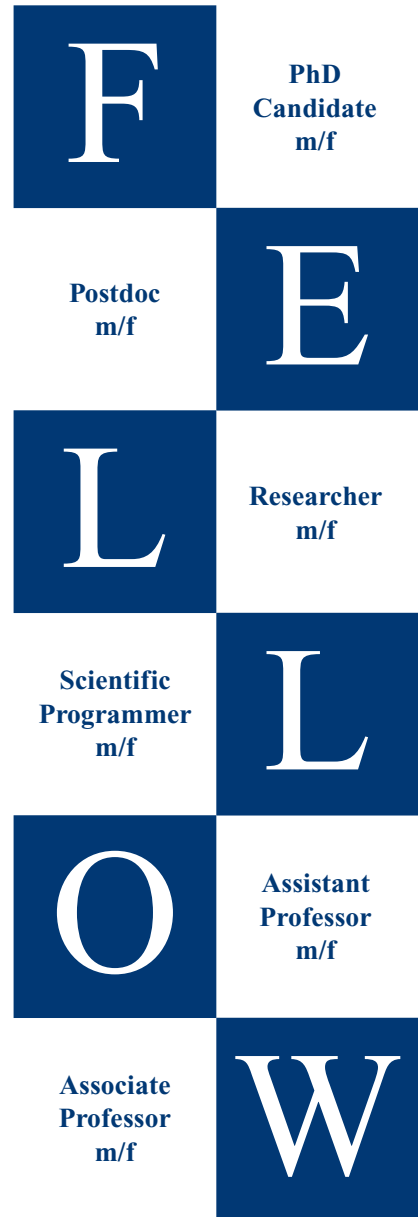
The aim of the medical research at LUMC is to contribute to the prevention and solution of health problems. “We really try to understand how a disease works,” explains Huizinga. “If we can understand a disease, we can improve the care for patients and make diagnoses earlier.” It’s a long process that requires time and dedication.

“Each stage of the process demands a different combination of expertise,” says ten Dijke. “The research profile areas enable us to get the best out of everyone at the right time. We all have the same goal, the same drive, and the same commitment, but different roles to play depending on the department we represent. Working together drives research forward, so that it can get out of the lab, through the testing phases and ultimately into the clinics as a form of therapy.” “Throughout the process,” says Huizinga, “your work is constantly being evaluated from different fronts. It’s an essential form of input in a team. This well-founded criticism enhances quality at the end of the day, so that the work we do can be truly excellent.”

About the LUMC

The LUMC is a centre for medical innovation and embraces and develops new technologies. The more than 7000 staff members of the LUMC are passionate about improving patient care through scientific research. With patient care and research labs under one roof, patients, doctors and researchers collaborate to develop new treatment methods.

The LUMC comprises the Leiden University Hospital and the Faculty of Medicine at Leiden University. It is part of the Bio Science Park, one of the top five most successful science parks in Europe, and maintains its position amongst the international elite through its centres of excellence and research focuses.



The Leiden University Medical Center offers young talented scientists the opportunity of obtaining the LUMC Research Fellowship. The Fellowship aims to enable the scientists to develop as innovators of the LUMC research portfolio. The Research Fellowship may lead to a tenure ship providing certain criteria have been met, and provides excellent prospects for furthering an academic career.

Interested? Please visit our website at www.lumc.nl/workingforus to find more information. There you will also find the current vacancies available.



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Utrecht University's Ecology & Biodiversity Group

investigates the mechanisms that regulate biodiversity and allow for the maintenance of ecosystem functioning such as carbon sequestration and biogeochemical cycling in our changing world. We pay special attention to above- and below ground interactions, spatial processes in the landscape and community assembly following dispersal and colonization. We seek to obtain process-based, mechanistic understanding of species interactions and functional responses to predict future impacts of climate and land-use changes on biodiversity and ecosystem functioning.

On the 1st of January 2013, Prof. George Kowalchuk will be installed as the new head of this research group. Coinciding with this appointment, the group seeks to intensify its focus of "understanding and predicting biodiversity and ecosystem functioning in a changing world".

The Ecology & Biodiversity research group is therefore currently seeking enthusiastic and dedicated people to expand its research team, including:

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