New director for ESG

Bram de Vos back on old stamping ground. | **p.4** |

Space farming

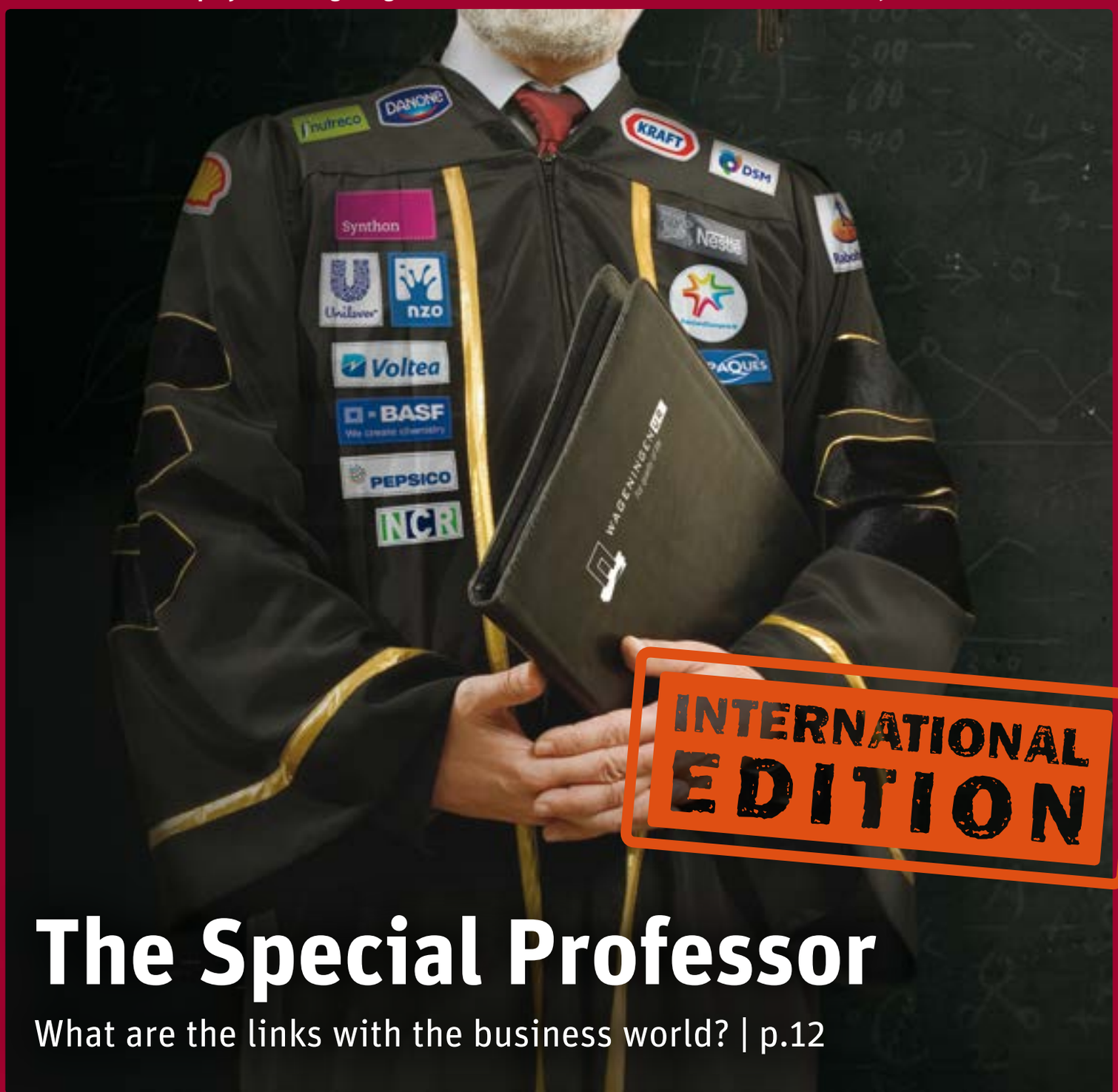
Research on dining in space. | **p.18** |

Making your hobby your sideline

These students took the plunge. | **p.24** |

RESOURCE [ENG]

For students and employees of Wageningen UR **no 19 – 4 June 2015 – 9th Volume**



The Special Professor

What are the links with the business world? | p.12

Space farming: a growth market

If they are to be able to travel deeper into space, astronauts will have to start growing their own food. A topic which Wageningen UR is addressing is several ways. This year several projects have been started, and if it is up to the researchers, that is only the beginning.

text: Rob Ramaker

One day during Andre Kuipers' stay on the international space station ISS, a supply ship brought onions. 'I kept some to let them sprout later,' says Kuipers. 'Up there plants are so special, because you miss living nature. There is nothing but artificial materials, metal and the sound of machinery.' For Kuipers' successors as astronauts, planting in space will become increasingly normal. The further space travelers go, the more often they will want, or even need, to grow their own food.

So there is more and more research going on in Wageningen into 'space farming'. Two new projects started this year.

Tom Dueck hopes to make space station ISS greener. The DLO researcher at Wageningen UR Greenhouse Horticulture has recently started working with a European consortium of aerospace engineers on a mini-greenhouse in which crops such as tomatoes and radishes will be grown. An interesting challenge for somebody who is normally occupied with greenhouse horticulture, says Dueck. The limitations, in particular, require a good dose of creativity. In ISS, for instance, there is only room for a greenhouse of 70 by 40 by 40 centimetres. This tiny size

'The Wageningen space farmers think their work will create spinoffs on earth'

immediately creates some practical problems. Greenhouses are built metres high precisely in order to keep the climate – humidity and temperature – as constant as possible. 'Making it smaller,' says Dueck, 'only makes the problems bigger.'

The aim of the mini-greenhouse is to improve the quality of life for astronauts. Research has shown that people feel more at ease in a green environment. That rings a bell with André Kuipers. 'You miss nature; going outside for a breath of fresh air, hearing birds sing. I would very much have appreciated the chance to grow something myself.' He thinks a greenhouse like this can have a positive effect on the psychological wellbeing of astronauts, especially those on long journeys.

The fresh vegetables that are grown can also be a nice addition to the astronauts' diet. Space food is not nearly as bad nowadays as it was in the 1960s. The creators of the bars, powders and slushes of that period had all sorts of concerns, but flavour was not one of them (see box). 'Nowadays the food in itself is not bad,' says Kuipers. Astronauts get to put their own varied menu together. There are dishes such as chicken teriyaki, lasagna and even beefsteak. But typical Dutch dishes such as endive

PHOTOS: ESA/NASA

THE CUBE SANDWICH

Eating wasn't much fun for the first astronauts in the 1960s. Writer Mary Roach has some juicy (or not, actually) tales about this in her book *Packing for Mars*. Apparently some of the pioneers of space food were veterinary scientists. They seemed to take as little interest in the astronauts' taste buds as they did with animals. They looked for foodstuffs which packed maximum energy into minimum mass and volume. Every inch of space in a rocket was precious, after all. The food also had to contain all the key nutrients. This was the era of the cube sandwich, which could be eaten in one mouthful. That way there was less risk of crumbs, which are a big nuisance in a weightless environment.

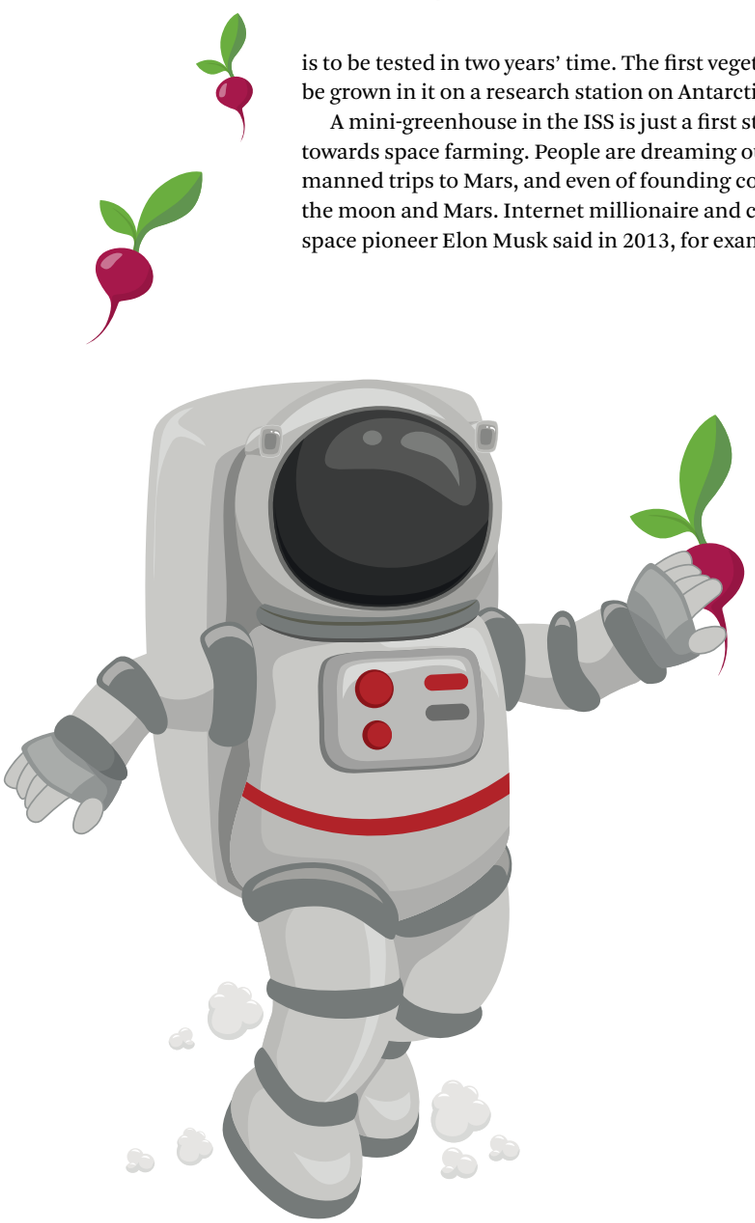
'stamppot' are not on offer. 'And the food is almost always processed, zapped, freeze-dried and comes out of a packet or a tin.' Fresh fruit from the local market near the space centre at Baikonur only comes now and then on a supply ship.

Dueck hopes to be able to offer astronauts a more regular supply of fresh vegetables, preferably with some real bite to them. Processed food tends to lose much of its texture. He is currently studying which crop would be the most suitable. The plants need to be small enough for the mini-greenhouse, create as little waste as possible, and be able to thrive under artificial light. The project has only just got going, but Dueck is already having a great time. 'This is just so nice and I am extremely curious to see what will come out of it.' There is a lot of work ahead because the project has a hard deadline. The greenhouse

'The first space radishes have already been harvested'

is to be tested in two years' time. The first vegetables will be grown in it on a research station on Antarctica.

A mini-greenhouse in the ISS is just a first step towards space farming. People are dreaming out loud of manned trips to Mars, and even of founding colonies on the moon and Mars. Internet millionaire and commercial space pioneer Elon Musk said in 2013, for example, that he would like to die on Mars, and preferably not on landing. And the Dutch Mars One, a media hit in recent years but controversial among the experts, wants to sell people one-way tickets to the red planet (see box). And Wageningen scientists are doing their bit by thinking through what is needed for successful agriculture on the moon or on Mars.



Farming on other planets poses huge challenges. Take Mars. The planet is continuously bombarded with harmful radiation, the atmosphere is extremely thin and it is bitterly cold. The temperature ranges between minus 143 and plus 35 degrees Celsius. So any growing of crops will have to be done in a closed environment, says Leo Marcelis, professor of Horticulture and Product Physiology. Then radiation, temperature and the lack of an atmosphere are less problematic. Moreover, it enables the colonists to use all kinds of techniques which were developed for terrestrial horticulture, such as the most efficient LED lighting.

Marcelis himself is doing research – also in a European collaboration – on the effects of reduced gravity. Gravity on Mars is only one third as powerful as that on earth. And that difference influences plants in several different ways. Scientific research in space has already demonstrated that plants need gravity as well as other things to grow in the right direction: the stems grow towards the source of light, and the roots towards water and nutrients. If there is no gravity and no clear single source of light, plants grow in all directions. Kuipers repeated an experiment on this on his first flight, to show schoolchildren how scientific research works.

Besides the direction of growth, the plant is affected in other ways too. Marcelis wants to understand, for instance, how the flow of nutrients and water through the plant changes. For the time being he is only studying this on earth. He and postdoc Sander van Delden are going to grow plants on rotating discs. By adjusting the rotation speed, pressure is exerted on the plant that equals that of Martian gravity, for example. Of course that does not get rid of the earth's gravity, so eventually they want to do tests in space. 'But you only get permission for research in the ISS,' says Marcelis, 'when it has been so well prepared that the chance of success is almost 100 percent.' They will now first improve their growing system, so as to be able to take more precise measurements.

MARS ONE

The Dutch organization Mars One wants to send astronauts to the red planet on a one-way ticket. They think colonizing Mars would be more straightforward than organizing a manned landing and a return flight. Those colonists will probably need to learn to grow their own food. Leo Marcelis, professor of Horticulture and Product Physiology, advises the organization on how to achieve this. Wieger Wamelink has no official links with Mars One, but writes a blog on the site detailing the progress of his field trial.

https://community.mars-one.com/blog

Another thing that is not yet clear is what kinds of substance space vegetables should be grown on. There is a lot of experience in horticulture with growing plants on substances such as steel wool, or water with a solution of minerals in it. Alterra ecologist Wieger Wamelijk is looking at whether crops cannot grow in the usual way in the soil on Mars or the moon. Two years ago he bought soil from NASA which strongly resembled soils on this planet. He grew 12 terrestrial plants on this soil, with reasonable success. On the Martian soil everything grew and on the moon soil at least the plants germinated.

'We learned a lot from this experiment,' says Wamelink. The soils turned out to be extremely poor, for instance, and lacked nitrogen especially. They also dried out extremely fast. Wamelink fancied taking the adventure in space farming further and started an adapted

> **'Perhaps in future bees should be taken into space'**

follow-up experiment this spring. This involved fertilizing the soil with organic material - grass – to make it richer. The plants were also kept wet. And this produced a result. The first space radishes have already been harvested. The scientific results have not yet been processed, but it appears to be clear that space-grown crops still do not do nearly as well as they do on superior terrestrial soils. 'Martian soil performs at an estimated 20 percent,' says Wamelink, 'and that is better than the moon soil.' The research is still at such an early stage that there are many questions yet to be answered. A good soil structure and soil life, for example, are important for an optimal harvest. Microbiologists need to find out what combination of moulds and bacteria should be taken along to Mars. Another big question is how will the crops on Mars be pollinated. Perhaps in future bees should be taken into space.

Wamelijk hopes that the new research field will become a fixture on the Wageningen scene. 'There is a future in this,' he says. The main obstacle at the moment is the lack of funding. Wamelink's recent application for a Vidi grant was turned down because the project was not considered feasible. That frustrated him, as he did not agree with the reasons given. 'I want to take a different route now,' he says. 'Maybe crowd funding, a rich patron who sponsors us or an auction of the first space radishes and rocket.'

The relevance of this sort of research may not always be clear to us earthlings. But the Wageningen space farmers think their work will create spinoffs on earth. For example, Marcelis and Van Delden hope to discover in detail how plants absorb and distribute calcium. 'In Dutch horticulture that is an important quality issue.' The development of a closed cultivation system on Mars also has parallels with the ambitions for more sustainability in agriculture and the economy. If you can efficiently reuse waste and fertilizer and manage to close the cycle in the colony, you can of course use that knowledge on earth as well. Tom Dueck, too, expects results for horticulture. 'Just like in fundamental research, you have no idea what, beforehand, but you know that things are sure to come out of this. You can learn a lot from this in practical terms.' Ⓡ

WAGENINGEN'S SPACE FARMERS

LEO MARCELIS

professor of Horticulture and Product Physiology and advisor for Mars One

Works in the 3-year EU project Timescale, worth 3.9 million euros, together with the Norwegian Centre for Interdisciplinary Research in Space and the University of Gent.

Aim
To find out how powerful gravity affects the transport of water and nutrients in a plant.

TOM DUECK

DLO researcher at Wageningen UR Greenhouse Horticulture

Together with the German space institute and 12 other partners, received 4.5 million euros for the EDEN ISS project.

Aim
To create a mini-greenhouse with which astronauts in the ISS can grow their own vegetables.

WIEGER WAMELINK

ecologist at Alterra

Set up a greenhouse experiment in space farming, on his own initiative and so far in his own spare time. Researching the options for alternative funding sources.

Aim
To find out to what extent the soils on Mars and the moon are suitable for growing crops.