RESEARCH ON PIXEL AGRICULTURE

Harvesting by the square decimetre

There is a field on the Velhorst estate in the eastern Netherlands that looks like a colourful kitchen garden full of different crops. But this is a serious trial with a novel farming system and part of a Wageningen experiment with 'pixel agriculture'. The aim of this approach is to promote biodiversity and reduce pest pressure.

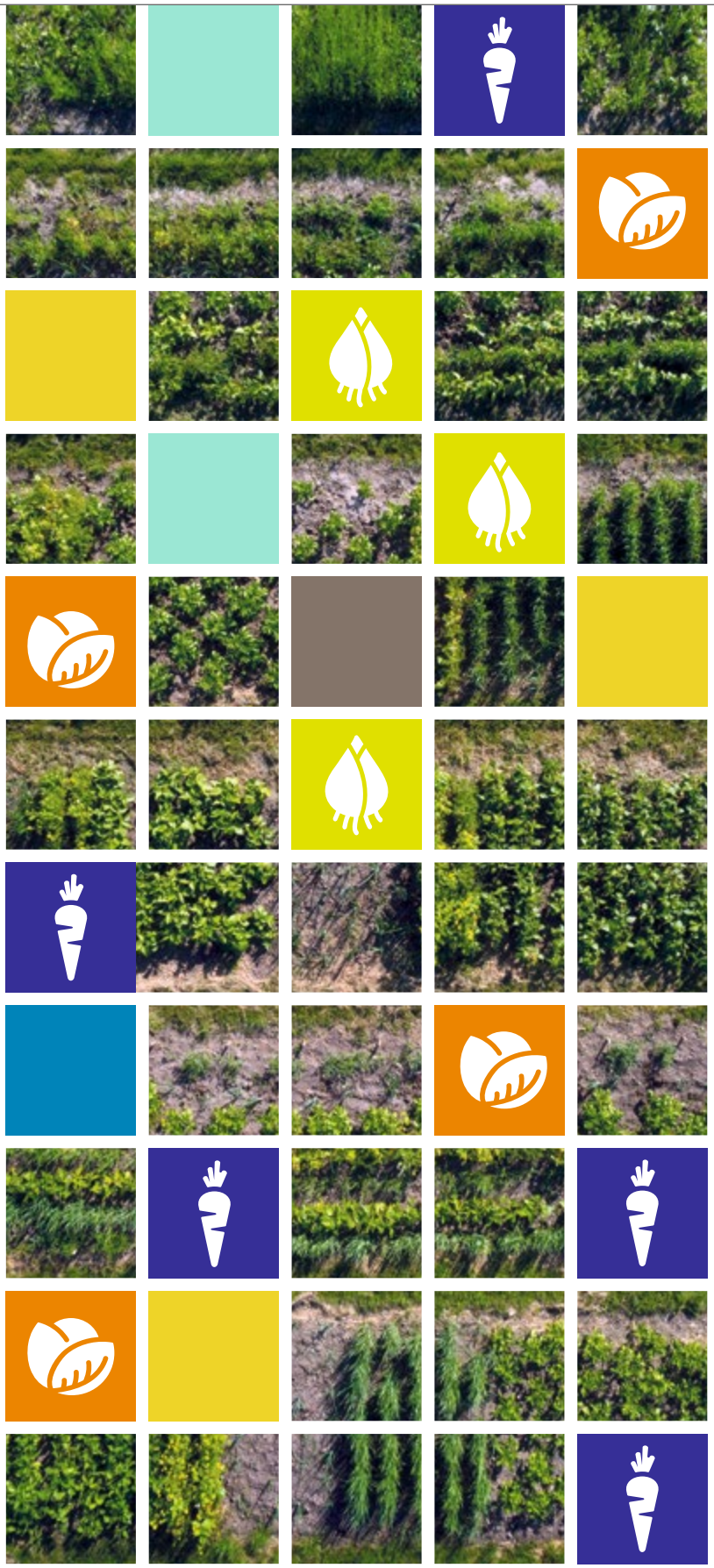
TEXT RENÉ DIDDE **ILLUSTRATION** WUR **PHOTO** GETTY

An extraordinary patchwork of cabbages, leeks and celeriac catches the eye on the Velhorst estate near Lochem in the east of the Netherlands. It is not so much the crops or the harvest that jump out at you, as the pattern they form – a bit like a chessboard, with the different winter vegetables growing in the squares. Each crop has its own bed measuring 1.5 by 1.5 metres, with a few beds of sage and parsley dotted among them.

'At the start of this season, there were 30 crops on this plot, including fennel, courgettes, pumpkins, endive, Savoy cabbages, cucumbers, beans and pak choi,' says farmer Arjen van Buuren as we survey this spectacular-looking experiment. Van Buuren is fascinated by this new form of agriculture, with a huge variety of crops grown in what looks like a vegetable patch. Pumpkins and courgettes are growing in individual squares, cabbage in clusters of four squares, onions in eight and leeks in ten squares. Van Buuren and his wife Winny have only been farming here in the Achterhoek region since the end of 2018, when they had the chance to lease 85 hectares of land designated for extensive farming from nature conservation organization Natuurmonumenten. Fifty hectares is grassland for cows, sheep and Bentheim black pied pigs, a rare breed that 'look like Dalmatians,' says Van Buuren.

STRIP-CROPPING

About 35 hectares of the land is used for arable and vegetable farming. On five hectares, the Van Buurens are practising strip cultivation, a relatively new phenomenon in the Netherlands, with different crops grown side by side in strips of between a few metres and 25 metres wide. The aim is to promote biodiversity and reduce pest pressure. Strip cultivation was developed on a large scale in the United States in the 1960s in response to eroding dust storms. Farmers in China have been practising strip cultivation for centuries. And on their last farm, the Van Buurens themselves got bigger yields from this form of cultivation. They saw an increase in the biodiversity on their farm and a decrease in crop damage by pest insects and mould. They also noted that spending less on pesticides improved not only the environmental balance on the farm but also the bank balance.



This year, on half a hectare, they are going a step further and experimenting with growing the crops in small patches in a chessboard pattern. Van Buuren heard about the 'chessboard concept' in November 2019 when he attended a study day about diversified cropping systems in Wageningen. 'We looked at a small trial plot in Wageningen. The researchers wanted to get some experience on a working farm so I offered a field,' says Van Buuren.

GOOD NEIGHBOURS

Thanks to his experience with strip cultivation, Van Buuren knew that grains and beans make good neighbours, for example, and so do oilseed rape and clover. This kind of helpful interaction that increases yields and biodiversity intrigues him. 'Scientists

> 'It was a joy to walk through the field this year'

don't know exactly what causes it.' The Van Buurens wanted to see what happens when crops have a lot more neighbours.
The Wageningen study day was led by agronomist Dirk van Apeldoorn and PhD researcher Lenora Ditzler. In the Farming Systems Ecology chair group, Van Apeldoorn is looking for farming systems that prioritize ecological concerns. 'From strip cultivation on about 40 farms in the Netherlands, as well as trials in Wageningen and the literature, we known that more biodiversity leads to fewer pests and higher yields.' And that can be explained: 'The roots of crops grown side by side work together to increase the resilience against soil diseases. With better root systems, the capacity to retain moisture improves and so does the nutrient uptake from the ground.'
With a view to further increasing biodiversity and studying the neighbourly >

‘The robot works overtime in order to learn’

PHOTO VRIENDEN VAN VELHORST

PHOTO ROBIN BRITSTRA

Arjen and Winnie van Buuren experiment with pixel agriculture on their estate, Velhorst, near Lochem. They have been testing a prototype weeding robot.

collaboration between crops, the researchers came up with the chessboard idea – or ‘pixel cropping’, as Van Apeldoorn calls it.

PERPLEXED

The name refers to the dots that make up a digital image. Different sizes of the patches in the field are being experimented with. They vary from over two square metres on Van Buuren’s farm to a quarter of a square metre on the Wageningen trial plots or patches of 10 by 10 centimetres on a farm in Almkerk – the scale of a pot of basil from the supermarket.

The choice of the pattern for the crops in Lochem was based on Arjen van Buuren’s experience. He knows from practising strip-cropping, for example, that onions and carrots make good neighbours. ‘The destructive carrot fly can’t stand the smell of onions, and the onion fly avoids the smell of carrots.’ Clover and white cabbage are good friends too. ‘Cabbage white butterflies were quite bewildered this year by the diversity of plants and the smell of the pixels with flowers.’

On the Wageningen trial plot, the planting and sowing of the pixels was done at random in order to see which crops benefitted the most from each other’s proximity. The Wageningen researchers count the moulds and pest insects in the pixels, as well as their natural enemies. They measure the harvest and its quality, looking at pest damage, dry matter volume and nutrients. They are going to compare the results of the Wageningen trial plot and the Van Buurens’ farm in Lochem. The other pixel farm, in Almkerk, will participate in the study too.

To get a broader perspective on the biodiversity at Velhorst than just the pest insects such as aphids and their natural enemies (such as ladybirds), researchers from the EIS research centre and Naturalis natural history museum in Leiden are also keeping a tally of the moths and wild bees. The local birdwatchers of Lochem are counting the meadow birds every week, while the soil life is a research topic for Wageningen students.

CHOOSING WHEN TO HARVEST

That yields are higher in the pixels comes as no surprise, actually. ‘One reason for that is that the crops are harvested at the most optimal moment, a bit like the way you work in your vegetable garden, taking the ripest tomatoes or the best potatoes for tonight’s supper,’ says Van Apeldoorn. On a large field with a monoculture of wheat, at some point the farmer just has to decide to get out the combine harvester and harvest it all at once. ‘But in such monocultures, about 20 per cent is not ripe yet at the point of harvest,’ says Van Apeldoorn. The farmers in Lochem confirm that. The Van Buurens say it has been ‘a joy’ to walk through the pixel field this year. ‘We are harvesting to order for restaurants and greengrocers, and we are gradually getting to know where we will find the ripest crops,’ says Arjen van Buuren.

But there is one major disadvantage to the kaleidoscopic chessboard of crops with different harvest times. In a hotchpotch of pixels, planting and sowing, weeding and harvesting become labour-intensive jobs that cannot be done by a machine.

If pixel farming is to break through to the mainstream, technical aids will be needed

to support the farmer and the ecology, says Van Apeldoorn. 'We could use drones,' he suggests, 'which monitor how the crops are doing using photos and films.' But the manual labour can only be replaced by intelligent machines. Wageningen is working with the farmers in Lochem and Almkerk on what is called 'soft robotics'. 'We are developing robots that can do both 'hard' and 'soft' work,' says Van Apeldoorn. 'They have to be able to lift potatoes and then pick raspberries.' They also have to be able to sow and plant and – above all – weed.

WEEDING ROBOT

A prototype could be seen in Lochem this year of a robot called Robotone, which weeded with its five arms around the edges of the pixels and cautiously inside them too, among the cabbages, pumpkins and cucumbers.

It was not a success, though, says Van Buuren. 'The machine had difficulty keeping on track, and was five centimetres off-target by the end of the field, so it started pulling out cabbages. But that is part of the development costs of the technology. The robot has to work overtime in order to learn.'

Van Apeldoorn, who collaborates with researchers from the Wageningen Farm Technology Group, has no idea when an all-round robot will be available. What is certain is that the robot's camera will have to store at least 50,000 images in its memory in order to be able to distinguish plants from each other and from weeds, and to recognize their growth stage and the moment of optimum ripeness.

Arjen van Buuren's chief hope is that robots will be able to sow and plant. 'This spring it took three of us a month to plant half a hectare of pixels. It was so much work that we didn't do the other half.'

But for now, pixel farming on that half a hectare is proving an interesting business model. This year 500 people are leasing one pixel for 10 euros. 'We harvest onions or courgettes from their beds for them all year,' says Van Buuren. And there were 2000 pixels left for selling to local restaurants and greengrocers. 'Okay, it's a niche market, but it is a lucrative business model. I don't think there's a farmer in the Netherlands who gets more than 5000 euros a year from half a hectare.' ■

www.wur.eu/pixel-agriculture

SEBASTIAN BERNARDY

Clemens Driessen (Cultural Geography) and Lenora Ditzler (Farming Systems Ecology) collaborated on the *Countryside, the Future exhibition* at the Guggenheim Museum in New York. The exhibition was curated by the architect Rem Koolhaas and featured pixel farming among its topics.

MATCHING NEIGHBOURS ON THE SCREEN

In order to develop pixel agriculture, scientists look for positive interactions between different crops with a view to getting a bigger and better harvest using as little pesticide and fertilizer as possible. This search for successful combinations takes place not just on trial plots, but also on Jochem Evers' computer. A researcher at the Centre for Crop Systems Analysis at Wageningen University, Evers develops models that simulate the growth of crops. 'We recreate crops in 3D, complete with their root architecture, stalks, branches and leaves. We place them at a given distance to each other, and we can create growing conditions with different parameters such as light, water and nutrients. The role of pest insects and – however limited – of moulds is also calculated into the model.' Evers hopes to discover combinations of plants that flower in succession, need water at different times, or can reuse each other's decomposition products.

This has not yet delivered specific results for pixel farming, but in the case of strip cultivation it has thrown up insights into the optimal width of the strips for grains such as wheat or maize and for legumes such as field beans and soya.