RESEARCH ON REDUCING GREENHOUSE GAS EMISSIONS

How farmers can

store CO_2

Dutch farmers and other land users are going to have to emit 3.5 million tons less CO_2 per year as their contribution to reaching the country's climate targets. Wageningen is studying the options. 'Technically, a great deal is possible. A lot depends on what farmers can put into practice.'

TEXT RENÉ DIDDE **ILLUSTRATION** RHONALD BLOMMESTIJN

> ‘Farmers must become more aware of the importance of organic matter in the soil’

Poultry farmer Johan Verbeek proudly displays the meadow where he has planted 200 walnut trees. The now still slender saplings fill part of the space over which 16,000 free-range chickens roam. ‘On hot summer days, the leaves will provide shade,’ says Verbeek. But on this snowy January afternoon in Renswoude, the white hens are wisely taking shelter under the overhanging roof of the barn.
The chicken was originally a forest bird, says the farmer. ‘Once there is a nut tree in the field, they will roam a couple of hundred metres further from the barn than they do at present,’ expects Verbeek. ‘They’ll move around more and spread the manure over a larger area.’ Planting trees is one of the proven ways of combatting climate change. In just over 10 years, the Netherlands aims to almost halve its CO_2 emissions from over 220 million tons per year (1990) to 113 million tons. The agriculture and land use sector – including forestry, nature management, livestock and horticulture – has cut its greenhouse gas emissions by at least 5 million tons in the past 25 years, and is required to cut a further 3.5 million tons in the next 10 years.
The project in Renswoude, small as it is, numbers among the many model projects in which Wageningen researchers work on reducing CO_2 emissions in the forestry, nature management, arable farming, livestock farming and horticulture sectors.

BUSINESS MODEL

Gert-Jan Nabuurs looks on with satisfaction throughout the guided tour of Verbeek’s poultry farm in Renswoude. The Wageningen professor of European forests explains that this little stand of nut trees will capture eight to nine tons of CO_2 per hectare. It is also a viable business model for the farmer, Martijn Boosten of the sustainable forest management institute Probos has calculated. ‘The farmer gains a good sideline. It is true that nut trees only start to bear sufficient quantities of fruit after 12 years, but then the farmer can earn 4000 to 6000 euros per hectare from them.’ And that is not all. ‘The trees absorb the chicken manure and in the long term the farmer gains some nice nut wood that is good material for furniture or veneer. And that can save on energy-guzzling materials such as plastics,’ adds Nabuurs.
The nut trees at the poultry farm are one of 16 trial projects Gert-Jan Nabuurs and Martijn Boosten are running in which ‘climate-smart’ forest and nature management approaches are being studied. They are going to monitor the development of the forest, the storage of CO_2 and the yields very carefully.
The Netherlands Environmental Assessment Agency calculated that Dutch nature captures and stores about 0.6 million tons of CO_2 per year, a negligible contribution to the over 100 million tons that the Netherlands needs to achieve by 2030. ‘We think that the CO_2 storage in forests in the Netherlands can be increased by half through active interventions,’ says Nabuurs. By rejuvenating forests at certain locations that absorb less CO_2, for instance, and by planting more robust species such as fluttering elm and aspen at locations with a lot of ash deaths.
The relative contribution of forests to CO_2 sequestration is much larger in Europe, and forests are already compensating for 10 per cent of the total CO_2 emissions. ‘We want to double that,’ says Nabuurs. ‘Large European countries with lots of forest can learn from the Dutch example.’
Besides storage of CO_2, Nabuurs is researching measures that contribute to the agreements on climate by producing sustainable energy, such as the cultivation of fast-growing trees like willows for biomass power stations, or turning pruned wood from landscape maintenance into compost and heat. Nabuurs: ‘All these measures and the knowledge we gain from them will be brought together in an online toolkit for Climate-smart Forest and Nature Policy for the benefit of practitioners.’

TWENTY MILLION

Nabuurs’ forest research comes under the four climate projects that Wageningen started in 2018 under the leadership of Saskia Visser, Sustainable Land Use programme leader at Wageningen Environmental Research. The ministry of Agriculture has allocated 20 million euros for research on measures that can get greenhouse gas emissions under control in the four areas of forest and nature management, greenhouse horticulture, livestock farming and land use. The projects must be implemented in close collaboration with partners such as the state forest service Staatsbosbeheer, the Centre for Agriculture and Environment (CLM), the Louis Bolk Institute and farmers’ own networks. ‘The funds come from the agreements made in the Climate Treaty,’ explains Visser. She mentions the example of the nut

PHOTO SVEN MENSCHEL

BRAM BREGMAN, CLIMATE AMBASSADOR

Slow-going, laborious, tough. That is how Bram Bregman, climate researcher at the Radboud University Nijmegen and since November, Wageningen University & Research's climate figurehead, describes the progress of the negotiations at the climate summit.
'The enthusiasm of the Paris agreement in 2015 has totally disappeared,' says the Wageningen-educated environmental scientist. 'A bloc of serious climate sceptics has emerged, with Trump in the lead of course, but don't forget Putin and the new president of Brazil, Bolsonaro, either. And it was already difficult to get all the countries in the world to pull together to limit global warming to 1.5 to 2 degrees. To do that we have to be emitting less CO_2 by 2050 – preferably 80 to 95 per cent less.'
As climate ambassador, Bregman is trying to specify for several ministries the knowledge that they still need in order to make the Netherlands climate-proof in future.
'I think we need to fundamentally change the way we look at climate resilience. Up to now it has primarily been seen as a water safety issue. But with increasing warming, an accelerating rise in sea levels, and increasing soil subsidence, our current spatial planning choices won't work. So we shall have to develop alternative scenarios for future land use in the Netherlands, going along with nature more and taking a different view of urbanization and infrastructure.'
'And we must keep our fingers on the pulse. Do all the measures work well? Measuring, checking, analysing and, where necessary, adjusting. That is what is often lacking. And that is what Wageningen is good at. I want to make that known in The Hague. The Netherlands says it wants to boost emissions reductions but in reality emissions are going up in the Netherlands and worldwide. At this rate we shall cross the 1.5 degree line in 2030 rather than in 2040. I find that alarming.'

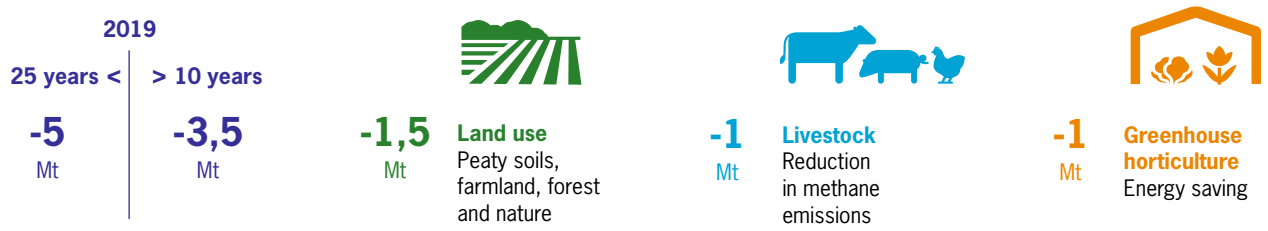
trees on the poultry farm, one third of which are paid for from a grant. 'It is a practical project, simple to execute and some secondary objectives are achieved along the way,' says Visser.
Along with such practical trials, there is also a need for a measuring and monitoring standard with which the various sectors can learn how to ascertain precise quantities of CO_2 or how to avoid emitting it, thinks Visser. 'Good monitoring will be important for the reporting and communication, including at the European level.' Visser has submitted a proposal for this to the EU, asking for 80 million euros to raise the level of knowledge about soil processes among farmers and policymakers in 24 member states, mainly under the leadership of Wageningen University & Research and the Institut National de la Recherche Agronomique (INRA) in France. 'Farmers must become more aware, for example, of the importance of keeping organic matter in the soil.'

CAPTURING CO_2

The soil is a vast storehouse to which carbon is added as organic matter through plant remains, dead roots, compost and manure.
'Some of that carbon escapes in the form of CO_2, because micro-organisms break down the stocks. To some extent that is unavoidable and even useful, because it also makes nutrients such as nitrogen and phosphate available to the plant,' says soil specialist Peter Kuikman of Wageningen Environmental Research. But the unnecessary breakdown of carbon should be avoided. Kuikman is researching the potential: >

AGRICULTURE AND LAND USE

Targets for reduction in greenhouse gas emissions by 2030
In CO_2 equivalents per year



SOURCE: SER, DRAFT CLIMATE AGREEMENT

'There is no single solution to this; it has to be approached case by case. We still need to do a lot of observing to find out what works best.' He reckons that one million tons of CO_2 can be captured and stored through improved land use: about one per cent of the contribution agreed by the Netherlands.
On higher sandy and clay soils, arable farmers can already make a contribution by ploughing less often and less deep, so that less organic matter is exposed to oxygen and therefore less CO_2 is formed, says Kuikman. 'Farmers can also return crop remains and manure to the soil more often and use green fertilizers such as lupins.' This is not just good for capturing CO_2 and preventing emissions, it also makes the soil more resistant to drought and pests, and makes for a more diverse soil life.

WETTER PEAT

It's quite another story in the low-lying peat land which accounts for about 10 per cent of Dutch farmland – mainly for dairy – and from which four to five million tons of CO_2 escape every year. This would seem to offer a promising project for capturing CO_2 but it has far-reaching consequences for livestock farming, says Kuikman. 'Farmers have to raise groundwater levels there, which makes the peat wetter and reduces the oxidation, so less CO_2 is released. But that leads to fewer cows, wetter fields and ultimately to a less open landscape.' At various places in Friesland and in the 'green heart' between the big Dutch cities, farmers are cautiously experimenting with a higher groundwater level.
It would be good if we encouraged better land use in the peat meadows, but equally on sandy and clay soils, thinks Kuikman. 'A financial incentive to store CO_2 and work on the quality of the soil could be added to the European agricultural subsidies. Our research should soon produce a set of measures that are the most effective for each soil type and branch of the sector.'

BREATHING OUT METHANE

There is another climate-wrecking factor at work on the peaty soils besides CO_2 emissions through oxidation. 'By breathing out methane, cows themselves are responsible for over 65 per cent of the contribution of livestock farming to climate gases,' says Leon Šebek, animal nutrition project leader at Wageningen Livestock Research.
Methane is a very strong greenhouse gas – 25 times as strong as CO_2 – and is released during digestion in the rumen. The methane of all the cows in the world causes roughly the same climate damage as all transport, show FAO figures.
About 20 per cent of the methane that escapes from the cow does so through the manure, while 80 per cent exits through the animal's mouth and nose, show measurements taken in Wageningen measuring chambers. Researchers have measured the metabolism and the manure and urine production over five years, in relation to different kinds of livestock feed. 'This contributed to our expansion of the Annual Nutrients Cycling Assessment - an instrument that shows the nitrogen and phosphate cycles on a farm – to include carbon. That enables farmers to steer their business towards a reduction in methane emissions,' says Šebek.
He thinks methane emissions from stored manure can be reduced to almost zero by further improving the way the manure is stored, covering it and then digesting it to form biogas. Emissions via nose and mouth are a trickier question. 'Technically speaking, those emissions can be almost halved by adapting feed, but in practice we shall have to be content with a reduction of 20 to 25 per cent for now,' thinks the feed researcher. 'The quality of raw feed is important here. If dairy farmers feed cows on young grass, the micro-organisms in the rumen make less methane. They do that too if the cow is fed on starchy feed such as maize,' says Šebek. That means mowing more frequently and using young grass to make silage for the winter feed stocks too.

HIGHER MILK PRICE

To get this message across to dairy farmers requires extension services and communication, but Šebek has high expectations of price incentives as well. 'If their Annual Nutrients Cycling Assessment is good, the dairy farmer qualifies for a higher milk price,' says Šebek. The dairy sector is starting to pay more attention to milk's 'footprint', and will increasingly use prices as an incentive for environmental measures, just as there is already a higher price for milk from cows that are put out to pasture.
Šebek expects results from another quarter within five years, too. He is doing research on the still unexplained differences in methane production between cows. 'We suspect this has to do with differences in the micro-organisms in the cow's stomach. If

> ‘Theoretically, methane emissions can be almost halved by adapting feed’

PHOTO GETTY

The exhalation of methane causes two thirds of climate gas emissions from livestock.

we can discover which of the dozen or so species of micro-organism in the cow’s stomach produce the least methane, and get them to work for us by, for example, changing the feed composition, methane emissions will go down. Another question is whether the animal can adapt. If it can, that could pave the way for a breeding programme for a “low-methane cow”’.
The research on restricting methane emissions from cows is one of the 12 climate research projects at Wageningen Livestock Research, coordinated by Karin Groenestein. They range from the development of new barn systems, installing filters with micro-organisms that break down methane in the stored manure, to the further development of sensor technology for measuring the cow’s emissions in the barn 24/7. ‘Farmers still don’t know much about the climate problem. It’s yet another thing for them to have to think about, on top of manure, ammonia, stink and fine particles,’ says Groenestein. Even more book-keeping, even more regulations. So the research coordinator has allocated some money to communication about the research results. ‘Technically, a great deal is possible. A lot depends on what aspects of the climate solutions farmers can put into practice – apart from the measures for conventional issues such as ammonia emissions. As well as whether they can make a good living, and whether consumers are prepared to pay for it.’

GREENHOUSES AS AN ENERGY SOURCE

Unlike the dairy industry, in greenhouse horticulture, saving energy and reducing CO_2 emissions has already been a topic for 45 years, says Frank Kempkes, a horticulture technology researcher at Wageningen Plant Research in Bleiswijk. Greenhouses used to be massive natural-gas guzzlers, but little by little, the greenhouse as a source of energy (the name of a 2008 Ministry of Agriculture research programme) is coming closer. Horticulturalists started closing the curtains at night back during the energy crisis of 1973, just like householders. Kempkes sums up the trends: ‘In standard greenhouses there are now two or three curtains, which help keep a lot of heat in. Heat is also extracted from the escaping ventilation air, and heat pumps are being introduced as gas-free heat sources.’ Emissions have gone down by one third to 4.4 million tons of CO_2 per year, in spite of a doubling of production per surface area.
The sector is also experimenting a lot with new, sustainable energy sources such as geothermal energy, in which heat is brought from up to three kilometres below the earth’s surface. Kempkes thinks a gas-free greenhouse is feasible and will be affordable. But there is a major stumbling block, he warns. ‘For year-round cultivation of flowers and greenhouse vegetables, the availability of light in the winter months is the limiting factor for production. Of course we work with energy-saving LED lights, but electricity will always be needed, for the heat pump as well. And the green sources for that are still limited.’
Electricity from solar energy seems an obvious answer, given the vast surface of greenhouse roofs. But there is one problem, says Kempkes. The solar cells compete with the plants, even if the cells of the future are no longer in blue-black panels but can allow sunlight through selectively. To grow, plants need the wavelength of 400 to 700 nanometres. And that is precisely the wavelength required to produce electricity. ‘Maybe breeding will make it possible to produce tomatoes, for example, that can grow in slightly different light. But it might be easier to find out whether the greenhouse area can be provided with storage capacity for the large amounts of electricity produced by wind farms at sea at night.’ ■

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