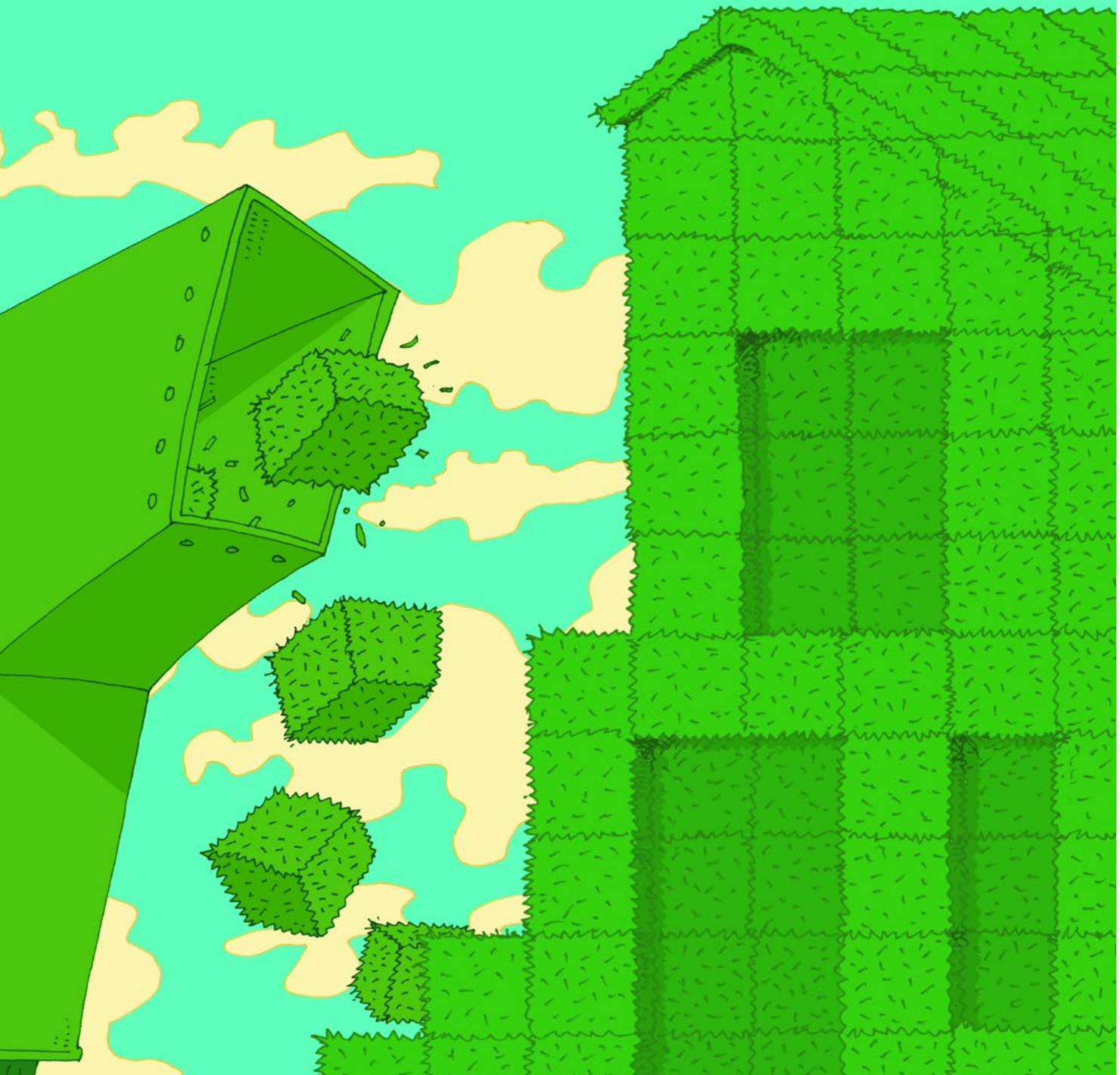


The latest building materials come from the farm



The construction industry is responsible for massive CO₂ emissions. Switching to biobased materials, such as insulating fibres made of elephant grass, can reduce its climate footprint substantially. And there are more opportunities for biobased construction on the horizon. In Wageningen, for instance, old cement is being made reusable with waste products from the food industry.

TEXT RENÉ DIDDE ILLUSTRATION RHONALD BLOMMESTIJN





NATIONAL ENVIRONMENTAL DATABASE

One of the projects with which WUR is stimulating the market development of biobased building materials is aimed at including these materials in the National Environmental Database. 'We are collaborating on "product cards" which make the environmental benefits of 13 biobased materials clear to the construction industry. Architects and project developers can draw on this database to calculate the environmental score of their building,' says Martien van den Oever of Wageningen Food & Biobased Research. Work is also under way on a method of visualizing carbon storage in biobased building materials. This will help reduce the carbon footprint of buildings, hence increasing the use of bio-based building materials.

'Elephant grass is a fabulous crop with loads of applications,' says horticulturalist Joost Sterke from Haaren, Noord-Brabant. He has been growing this spectacular giant grass – which grows up to four metres in height – for seven years now. 'Miscanthus is suitable for use as fuel and as a substitute for peat in potting soil, and I sprinkle it in shredded form over my pots of seedlings. It stops weeds and moss from forming, and does it better than imported wood bark chips.'

Sterke notes an increase in interest in this fast-growing crop. 'I see it among horticulturalists who, like me, are looking for sustainable innovations, as well as among arable farmers on low-lying farms. Elephant grass copes well with wet conditions.' Sterke expects interest in growing the crop to increase further because the construction industry is sitting up and taking notice. 'A Belgian company visited us recently to explore the potential for a subfloor made of elephant grass for use in housing construction.'

In Wageningen, too, elephant grass is seen as a promising source of building materials. Wageningen Food & Biobased Research has been testing fibre-rich crops and waste streams for 30 years. For example, Richard Gosselink developed a rock-hard composite material for sheets shaped like the cor-

rugated iron sheets that were used in the past for roofing barns. 'This is made from coconut husk, without adding any synthetic glue,' Gosselink explains, 'but now we can also produce this material from wood chips and elephant grass.'

INSULATING WITH GRASS

And this is just for starters, the experts think. They foresee a boom in interest in growing miscanthus once homes are no longer being insulated with the familiar yellow rockwool mats, but with fibres made out of elephant grass. 'I am looking forward to the day when houses are grown in the fields,' commented Minister of Housing and Spatial Planning Hugo de Jonge in the Dutch construction sector magazine *Cobouw* at the end of March. Last December, the government told parliament in a memo that it intends to actively promote fibre crops for bio-based construction. In anticipation of this, three ministries and six of the Dutch provinces are funding the Building Balance programme, which aims at speeding up the adoption of bio-based materials in the building sector. WUR is involved in this programme too.

The initiator and head of the programme, Jan Willem van de Groep, regularly gets around the kitchen table with farmers, as well as visiting construction companies. They stand to benefit a lot from each other, argues Van de Groep, a freelance consultant. 'New crops give arable and livestock farmers an additional business model. And the construction industry can reduce its negative impact on the climate. At present, the manufacture of rockwool and glass wool consumes a lot of energy and emits a lot of CO₂ and nitrogen.'

European agricultural regulations are favourable for the cultivation of elephant grass. From this spring, it is compulsory to maintain a three- to five-metre-wide buffer strip

‘It helps if the agriculture and construction sectors get linked up quickly’

along watercourses, where manure and pesticides are taboo. This applies to both arable fields and grassland. Extensive crops that require little in the way of inputs and pesticides are especially useful for these buffer strips, as well as for stream valleys and marginal land. Crops like bulrushes and elephant grass thrive in swampy areas, making it possible for peat meadows and water retention zones to remain productive. And then there are other fibre crops such as sunflower and hemp that are drought-resistant and suited to dry sandy soils, says Van de Groep.

A further advantage of these crops is that the production chain is often short, he adds. ‘The farmer delivers the harvest dried and shredded to sheds in the region, where it is sieved and dusted. Then the loose fibres can be processed for blow-in insulation in roofs and prefabricated building components. If there’s a well-run production chain and a system of compensation for carbon capture, a miscanthus farmer can make 3000 euros per hectare. We are working hard to get these kinds of chains up and running.’

STORING CARBON

Farmers in such production chains would also be paid for the carbon stored in their crops. ‘CO₂ storage is crucial if the Netherlands is to meet the Paris targets. The construction industry contributes to this with biofibres and wood, and most of the credits from that ought to go to the farmer.’ In the short term, the Building Balance programme aims at 13 regions, each with 1000 new hectares of fibre cultivation. The idea is for that to go up to 50,000 hectares by 2030. It has been calculated that with 180,000 hectares of fibre crops, the construction industry could entirely replace mineral fibre with biofibre. ‘That is about 10 percent of Dutch agricultural land, so it would contribute to a reduction in CO₂ of 5.5 megatons annually,’

says Van de Groep. The Netherlands needs to reduce its CO₂ emissions by 110 megatons of CO₂ by 2030 compared to 1990. Of that amount, 22 megatons will require additional measures, showed an official report in mid-April. Fibre farming could provide a fair proportion of that.

SECOND-HAND CEMENT

And there are plenty more opportunities for biobased construction on the horizon. A spectacular invention from Wageningen Food & Biobased Research’s lab is the reactivation of old cement. Cement is the main ingredient in concrete, and it accounts for seven per cent of global CO₂ emissions. Wageningen researchers have succeeded in making old cement reusable by adding certain biopolymers from waste products from the food industry to it. Which biopolymers these are, researcher Richard Gosselink declines to say. ‘Anyway, we have shown that this bio-additive can enable old cement to form new compounds. And then the cement sticks again, having been reactivated, as it were.’

This second-hand cement would be a major application in the valorization of waste products from the construction and food industries, and would cut CO₂ emissions at the same time. Wageningen Food & Biobased Research is collaborating on this with AMS Institute, TNO and several companies. ‘But the separation technology for construction and demolition waste needs some further fine-tuning, so that we can separate the cement from the bricks,’ says Gosselink. ‘We hope to make a paving stone as a demonstration product in 2024.’

Gosselink also shows us a block of ‘bio-asphalt’. He has been working for 10 years on how to replace the fossil product bitumen, which sticks together the stones and sand in asphalt, with lignin, the woody substance which gives plants their strength. ‘We have >



RICHARD GOSSELINK
Senior Biorefinery scientist,
Wageningen Food & Biobased
Research



MARTIEN VAN DEN OEVER
Scientist in Biorefinery and
Biobased Products, Wageningen
Food & Biobased Research

‘Biobased building products must be of impeccable quality’



ARJEN VAN KAMPEN
Business Development
Manager, Biobased Products,
Wageningen Food & Biobased
Research



EDWIN HAMOEN
Programme Manager, Nature
Based Materials, Wageningen
Food & Biobased Research

started more than 30 pilot projects in the Netherlands, from a cycle path here on the Wageningen campus to a ring road in Terneuzen. At all those locations, half of the fossil bitumen has been replaced by lignin,’ says Gosselink. Bitumen is left over after lighter and commercially attractive components such as paraffin, petrol, diesel and fuel oil have been extracted from oil. Lignin, on the other hand, is a renewable resource. Wood and pruning waste is full of it and it is produced by the paper industry, for example. Elephant grass is another potential source of lignin. Gosselink tells us of the interest being shown from abroad. Densely forested countries in Scandinavia, Canada and the Baltic states are particularly interested. ‘I expect that within a year we will be able to set up a test site where all the bitumen has been replaced by bio-based components.’

This research also brings lignin-based roofing closer to being a reality. The natural wood tissue can also replace the glue component phenol formaldehyde in things like chipboard or the widely used cladding panels known by the brand name Trespa. ‘We are investigating the feasibility of replacing all the conventional glue in such products with lignin and other bio-based components,’ says Gosselink.

PRESSING PLATES

Gosselink’s colleague Arjen van Kampen reaches into a large cardboard box and produces more intriguing new plant-based building materials discovered and developed in Wageningen. Such as insulation material made from hemp and 3-D printed material made from fibres from Japanese knotweed mixed with biobased plastic. And ‘binderless board’ –boards made from long fibres pressed into sheets using only high pressure and temperatures, without adding

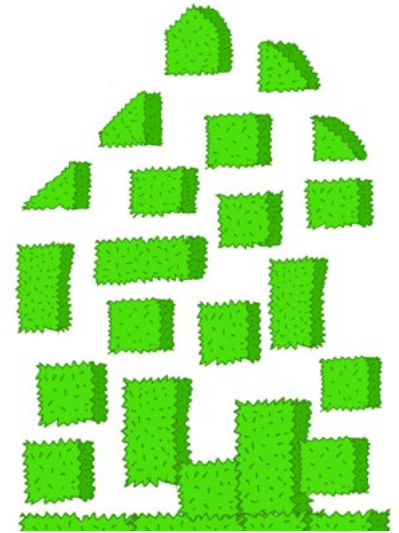
the traditionally fossil-based and non-recyclable binders. ‘The nice thing is that our research group started doing this around the year 2000 to process coconut waste in the Philippines, and now we are doing it here in the Netherlands using various local woody waste streams, such as reeds, straw and pruning waste. It is a good substitute for MDF board,’ says Van Kampen. ‘The great thing is, too, that this fibreboard withstands moisture well.’

Wageningen is also working on biorefinery to obtain better quality fibres, lignin and other components. ‘That often requires more sophisticated technology, but we try to keep the biorefinery processes simple so that they can be applied on a small scale in factories that provide added economic value regionally, and are located close to farms,’ Van Kampen explains.

REALIZING POTENTIAL

Researchers in Wageningen – about 150 of them by now – have been working on bio-based materials for 30 years. A lot of new technology has become available in that period. So why is the application of the innovations still only limited? What would it take to realize the potential that exists? ‘Get started with the simplest applications, such as fibres,’ says Van de Groep. ‘It helps if agriculture and construction get linked up quickly and if politicians and the government see the benefits. After all, they are at the helm when it comes to creating stimulating conditions through legislation and incentive programmes.’ He points out that farmers would need to be able to supply bio-based building materials all year round, not just at harvest time.

For farmers, yield is an important issue. We need to take a broader view of new revenue models for fibre crops, Van Kampen argues. ‘For agricultural crops, of course,



profits are based on yields per hectare minus costs per hectare. If the proportion of food per hectare has to be reduced, perhaps by having fewer cows or wider crop-free zones beside ditches, then the farmer's business model needs to be supplemented – with profits from biofibres, for example. And the ecosystem services provided by these crops, such as the positive impact on soil and water quality, biodiversity and CO₂ storage in building materials, should be counted too.'

IMPECCABLE QUALITY

Edwin Hamoen has been leading the Wageningen Nature Based Materials research programme which Gosselink and Van Kampen are involved in for three years. Besides a steady supply from the farm, all the technical specifications that apply in the construction industry are important too, says Hamoen. 'The new bio-based building products must be of impeccable quality, provide good insulation and be fireproof and dampproof.' But he raises another issue as well. 'We as a society, and therefore also as Wageningen researchers, need to take a more integral view of the issues surrounding the energy transition, a more circular economy, manure, nitrogen, water and nature. The positive impact of the use of biobased materials should be reflected more in the price so as to ensure a fair comparison with conventional materials.'

The problem is that in the construction industry, as in agriculture, it is hard to leave the beaten track and break new ground, Hamoen believes. 'We are wary of what we don't know. For example, some builders think that natural insulation material attracts mice and other vermin. The construction world will not change course until all the materials have proven themselves twice over. Rightly so, of course, because quality and safety must come first. But it does create a chicken-and-egg

situation, which will be over sooner if the government sets requirements for tenders to stipulate the use of bio-based materials.'

START NOW

Onno Dwars, director of Development at the major construction company Ballast Nedam, indicates that there is no time to lose if the construction and renovation work facing the Netherlands is to be done with more bio-based materials. 'Suppose this operation starts in 2030. Then the plans have to be ready in 2026, so you've got three years to get the bio-based chain up and running,' Dwars explains. That means as many building materials supply chains as possible need to become biobased, he says. 'Including insulation fibres, lignin in roofing bitumen and bio Trespas board. As well as laminated timber load-bearing beams and more timber-frame construction for ground-level housing. Don't choose some options, just do it all.'

If the government set a target that construction should reduce its CO₂ and nitrogen emissions to zero by 2035, the financiers would go into action, thinks Dwars. That would be an engine for change. 'The same thing happened with the energy transition in the construction industry. That was prompted by mortgage discounts and more generous mortgages for energy-efficient homes. And residents now have lower energy bills too.' Government and financiers could stimulate bio-based construction in a similar fashion, thinks Dwars.

'It would be great for WUR,' he says, 'if it could involve more parties in the agricultural chain in biobased construction and develop more new business models. Besides the construction sector, the packaging industry and clothing brands are also lining up to use plant-based raw materials.' ■

www.wur.eu/naturebasedmaterials

REGIONAL CHAINS

In the Regional Supply of Herbaceous Biomass project, Martien van den Oever of Wageningen Food & Biobased Research is doing a strengths and weaknesses analysis of biobased materials as an alternative to fossil-based materials. The study was commissioned by the Dutch ministry of Agriculture, Nature and Food Quality. 'With biobased raw materials like elephant grass, flax, hemp and straw, obviously you avoid using fossil resources, but you should also factor in things like the transport of large harvesters to numerous small plots of elephant grass,' he says to illustrate the pros and cons.

The aim of the study is to describe the 'value chains' – the chains of production and distribution from the raw material in the field to its application in an end-product. The study also analyses what it takes to create regional supply chains for biomass, and thereby to arrive at a clear national strategy. 'That is about demand, but also the location and scale of the farming and processing of the crop,' says Van den Oever. Construction materials and clothing come out as promising uses of biobased products. The research report will be published in summer 2023.