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BAN ON DISPOSABLE PLASTICS

What are the alternatives?

The European Union has banned the use of plastics for single-use products such as bowls and drinking straws. The ban includes biodegradable plastics. 'But we think some of these materials should be exempt', says Christiaan Bolck, programme manager for renewable materials in Wageningen.

TEXT KARST OOSTERHUIS **PHOTO** ANP

WOUTER POST,
Sustainable Plastics Technology researcher

‘Biodegradable plastics are also banned, which I find very strange’

The phenomenon of plastic soup will not have escaped anyone's attention. Images of a sea turtle entangled in plastic are etched into many people's retinas. And the plastic objects found in the oceans are just the tip of the iceberg. The majority of plastics never make it to the sea but end up in the soil and river sludge, sometimes in the form of tiny microplastic particles. These plastics are less visible, and we know little about their impact.

How can we tackle these problems? Can we stop using fossil-based plastics that accumulate in the environment, and what are the alternatives? Researcher Wouter Post of Wageningen Food & Biobased Research is involved in developing new materials for various applications: 'You want plastics to be endlessly recyclable and to biodegrade when they do end up in the wider environment. My utopian dream is that a plastic that is at risk of ending up in the sea, for example, will trigger a mechanism on contact with seawater that causes the material to biodegrade quickly and fully. That is still a long way off, but it is what we are striving for in our projects.'

Post is working in the Sustainable Plastic Technology expert group on a project that has outlined a future scenario for plastic use in 2050. This resulted in a roadmap of alternatives to fossil plastics. Most products and packaging can already be replaced by bio-based materials with good biodegradability, but this is still difficult for food films with strongly protective properties for preventing spoilage.

'Technically speaking, there are lots of possibilities,' says Post. 'But you also have to deal with an existing infrastructure of waste collection and recycling, and with political considerations. For that reason, our future scenario still seems unrealistic.'

The European Union has chosen a different path. The Single-Use Plastic Directive, which came into force in July 2021, bans the use of all plastics for a number of common products made for single use, such as food containers, drinking cups and straws. Alternatives made of plant-based materials such as cardboard are allowed. Post's colleague Christiaan Bolck, programme manager for renewable materials, is glad the EU is taking a stricter stance, but he still sees room for improvement. 'The current dogma is: all plastics are bad and materials made by nature are good. There is no room for truly biodegradable manmade plastics, which we think it's all right to use too. The guiding principle should be to ban materials that accumulate in the environment.'

HOLY GRAIL

This is exactly where the European legislation fails, according to the researchers. Alternatives are now often made of cardboard, but that is not water repellent, so coatings are added, some of which are based on substances containing PFAS. These coatings are not yet regulated by law, despite their potentially harmful effects on the environment. There is also a risk that users are more likely to leave a cardboard straw lying around because they think it is harmless. 'Paper straws quickly become mushy and then they're not nice to drink through, as I know from experience,' says Bolck. 'We should focus on products that do what they are made to do, and fully break down after their functional life. That is the holy grail for us.'

Post even fears that the ban on plastics could be counterproductive. 'There's been a lot of fanfare around the ban on single-use plastics, but it is going to hold back technological developments that could bring positive change.' In a project financed by the Dutch government's sustainable investment scheme Invest-NL, he is looking at the possible applications of PHA (polyhydroxyalkanoate), a material that he believes to have a lot of potential. PHA is a polymer made by microorganisms and it can be made from organic waste streams. You can use it to make, for example, a straw that feels like traditional plastic, but which breaks down '100 to 1000 times' faster than traditional plastic when it enters the environment. ´Conventional plastics take several hundred years to do that, so this is a real gain. Yet all biodegradable plastics are banned for specific applications and to me, that's really strange.'

DEMO FACTORY

PHAs are being embraced in the United States and Asia, however. There, they are already being produced on a larger scale, but hardly at all in Europe. But a demonstration plant is being built in the Netherlands in collaboration with five water boards, research centre STOWA, the Dordrecht waste processor HVC, and Paques Biomaterials. The Dordrecht plant will produce PHBV, a bioplastic from the PHA family. Bacteria make the polymer from organic waste streams such as industrial wastewater. By controlling the supply of food in a reactor, the bacteria can make up to 80 per cent of their weight in PHA, which is then extracted as a powder.

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'PHA is made by bacteria themselves and acts as their energy reserve, so it makes sense that it is highly biodegradable,' explains René Rozendal, director of Paques Biomaterials.
Post and his colleagues are now in possession of several kilos of the material for research purposes. The possible applications of PHBV are being investigated in Wageningen, and Post thinks the company is onto something really special. 'The material has a number of properties that are fundamentally different from other PHAs currently being produced and that makes it a promising material for making thin films. This has been very difficult to do with PHAs, but with this material it seems possible.'
Post sees opportunities for agriculture in particular. The accumulation of plastic in the soil, through things like fertilizer coatings or agricultural mulch films, is a major problem. In Europe, only 63 per cent of all agricultural plastics are collected. What happens to the rest is unknown, but it is likely that a large proportion remains in the soil. Yet there is no European legislation for controlling this. According to the European Chemicals Agency (ECHA), the biggest source of microplastics is artificial fertilizer coatings that enable the delayed release of nutrients. 'It is incomprehensible to me that non-degradable plastics are still deliberately being buried in the ground and stay there,' says Rozendal of Paques Biomaterials. 'That is why we invented a coating based on PHBV that you can put in the soil with a clear conscience.'

INNOVATION ON THE FOOTBALL PITCH

Another innovation came out of the collaboration between Post's group and a turf producer. Turf grows better on nets, making it easier to harvest and transport to the customer. Normally, these nets are made of polypropylene, which does not break down in the soil. But nets based on PHA would break down too quickly, so the researchers opted for PBS (polybutylene succinate). Post: 'This is a polymer that lasts longer in the soil. The trick was to develop a material that is still strong enough after 12 months, when the turf is harvested, but that breaks down within a year of being put in place. The manufacturer wants to start selling the mats soon and there is a good chance that they'll be used on football pitches one day.'
Violette Geissen, professor of Soil Degradation and Land Management, researches the effects of plastics in the soil. She is critical of the use of plastics in agriculture, even bio-degradable plastics. Various additives are added to agricultural films made from bioplastics to give them the desired properties. 'It is not clear what the effects of these chemicals are and there is no testing before these plastics are allowed on the market. Moreover, degradability is often standardized for >

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CHRISTIAAN BOLCK,
Renewable Materials programme manager

'Ban materials that can accumulate in the environment'

favourable conditions with sufficient soil moisture and a certain temperature. No measurements are made in field conditions, and in the dry south of Spain, for example, many of these plastics do not break down at all.'

PLANT GROWTH DELAYED

Recent studies by one of her PhD students also show that plant growth is negatively affected by the presence of biodegradable plastics in the soil, such as polybutyrate adipate terephthalate (PBAT), polylactic acid (PLA) and a starch-based plastic. Some plastics even absorbed pesticides, making them decompose more slowly. The mechanisms behind this are not yet clear. Geissen therefore argues that it should be compulsory for biodegradable plastics to be tested in the field before they are approved for use. Yet Post, and Rozendal of Paques Biomaterials, are optimistic about PHAs in agriculture. 'If any material can decompose almost anywhere, it is this one,' says the company director. 'But it is a justified criticism that you must also look at the chemical additives in degradable plastics. Ultimately, you want to find biodegradable alternatives to those as well. Fortunately, this is coming in for more and more attention.'

RENÉ ROZENDAL,
director of Paques Biomaterials

'If any material can decompose almost anywhere, it is PHA'

PHOTO SHUTTERSTOCK

Of all the agricultural plastics in Europe, only 63 per cent are collected after use. A lot of the rest probably stays in the soil.

Post and Bolck are investigating which materials break down in which environments, because where a plastic ends up ultimately determines the rate of decomposition. Every soil has a different microbial population, for example, and weather conditions play a role too. Several projects are therefore investigating how quickly materials break down in the soil and in the sea. 'We have tanks with seawater from which samples are regularly taken,' says Post. 'We look at both the mechanical and chemical decomposition. The next step is to measure CO_2 as well. That way you can prove that biodegradation is really going on, and that the plastics are not just disintegrating into microplastics.'

Laudable as it may be to look for more sustainable and biodegradable alternatives, Bolck thinks it is even better to first critically examine the need for plastic for a specific application. That is why he was a member of the jury for the NL Packaging Awards in the sustainability category. The aim of this award is to stimulate the reduction of the ecological footprint of packaging. 'There are a lot of products that don't need to be packaged at all. In 2019 the winner was a form of print that can be stamped directly on fruit. I think that's a wonderful solution. Protecting products to prevent spoilage is a good thing, but nowadays packaging is sometimes no more than a marketing tool.'

SACRIFICE CONVENIENCE

In Bolck's view, it is inevitable that we will sacrifice a bit of convenience. According to the scientist, it would be a good thing to ban some products completely, which has already been done with free plastic bags, for example. But it is hard to know where to draw the line, because there's a fine

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VIOLETTE GEISSEN,
professor of Soil Degradation and Land Management

'It is unclear what effects plastic additives have on soil life'

line between convenience and nonsense, he observes. 'A prepared salad could be considered a luxury, but the same applies to a packet of tomato soup. You could just buy tomatoes and grow your own herbs. But do we want to return to a time when you have to spend half your day in the kitchen? That may be sustainable, but it is not realistic.'

Nor is plastic always necessary in agriculture, according to Professor Geissen. On asparagus farms, for example, mulch films are used so that the farmer can harvest in March and get a higher price from consumers who are eager for the seasonal vegetable. Some organic farmers are also switching to plastic for weed control, she notes. 'There is no regulation of the use of plastic in organic farming. Some of the plastics remain in the soil, while there are many other methods that every farmer is familiar with, such as mechanical weeding.'

European legislation is now being drafted that will restrict the use of plastics in agriculture: a development warmly welcomed by the scientists, although Post and Bolck are hoping that an exception will be made for plastics that truly biodegrade on and around farmland.

FIVE TIMES MORE EXPENSIVE

Apart from the possible legal and practical obstacles, the price of biodegradable plastics is still a major dealbreaker too. The biodegradable options can be up to five times more expensive than current fossil-based plastics. But there is another complicating factor: the current infrastructure for waste collection and recycling is not equipped to deal with many different materials. Separating plastics is a costly process, and the more different plastics you collect, the more complicated the logistics become.

The previous Dutch cabinet decided to put a lot of effort into recycling and wants to have half of all plastic packaging being recycled by 2025. The trend is therefore to create as few new plastics as possible. Bolck and Post, however, are convinced that we will not solve the plastic problem with the existing materials. One of the main shortcomings of the current system is that most plastics, even if they can be recycled, still end up in the environment. 'I fully subscribe to the circular idea,' says Bolck. 'But everything we make can also end up in the biological cycle and cause damage there. Even if only a fraction ends up in nature, as long as the material cannot break down, it will accumulate.'

SYSTEM CHANGE NEEDED

Post sees PHAs as a 'major piece of the puzzle' in reducing plastic accumulation in the environment, but he realizes that the system needs to change radically before biodegradable plastics can stage a breakthrough. 'The transition to new materials requires existing plastics to be phased out. As a society, you will first have to agree on the way forward. For the past hundred years, plastics have been optimized for their function. I think we now need to start designing materials giving priority to what happens after their functional life.' ■

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