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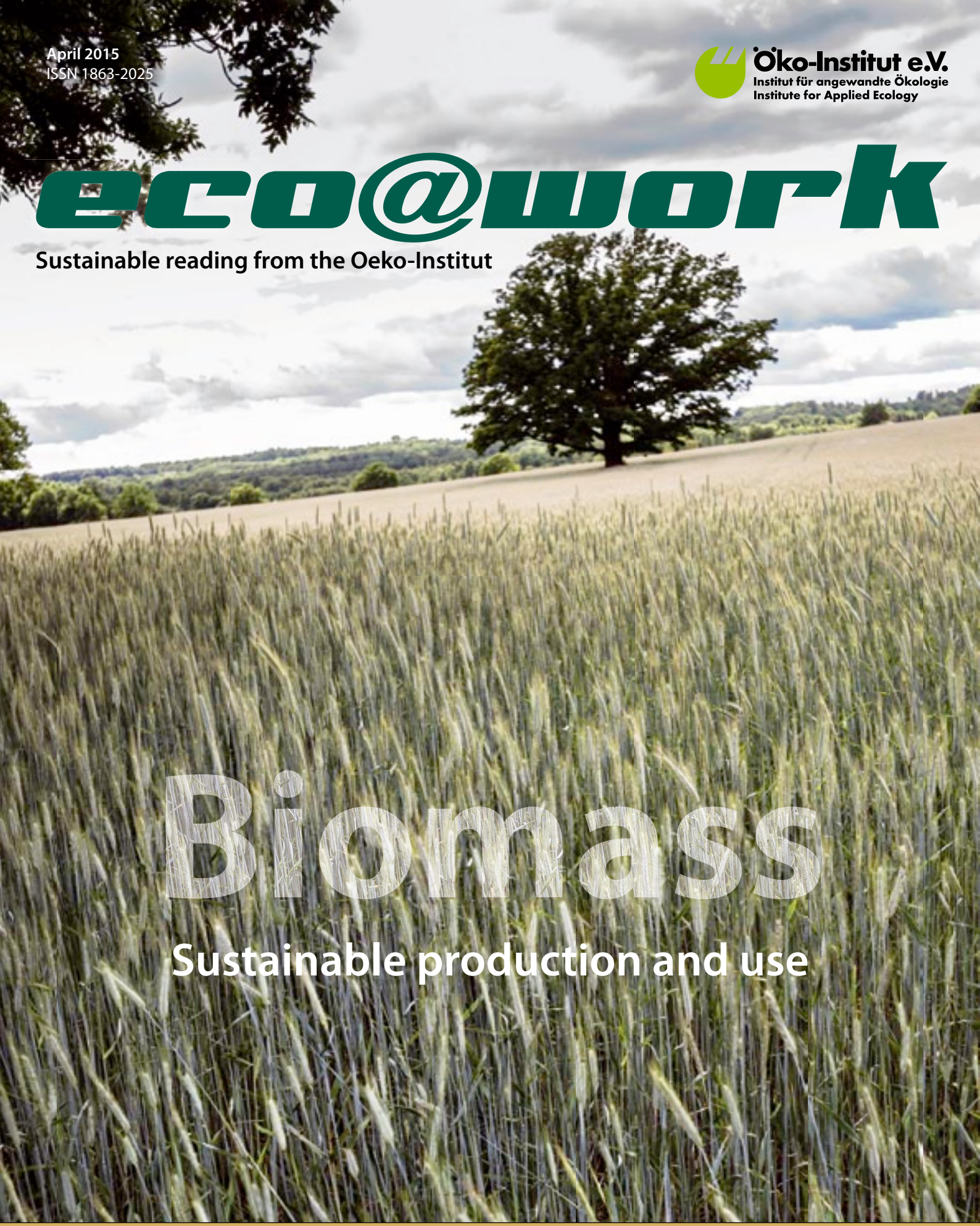
Sustainable reading from the Oeko-Institut



Biomass

Sustainable production and use

Energy supply units
Interview with Professor Daniela Thrän

Supply and demand – pathways towards optimised biomass use

Biomass comes in many different forms and has a wide variety of applications. Examples are the use of timber in the furniture industry, residues in energy production, and fibre in the garment industry. In other words, it is an extremely versatile raw material. However, the biogeographical spaces that provide these inputs are used with varying degrees of intensity, sometimes with adverse consequences. As you may be aware, I live in the Darmstadt area and am very familiar with the Pfungstädter Moor, a great example of the successful conservation of precious peatlands. Peat was still being extracted for fuel here as late as the 1950s, and reeds were still being cut for use as a roofing material. Today, much of the peatland has been restored to a natural state and provides a habitat for numerous native species of bird and plant.

This is just one small example, but it shows that where the sensitive issue of biomass is concerned, it's all about the bigger picture: a great many factors need to be considered. Often, food production interests are diametrically opposed to those of climate protection and low-carbon energy generation. Some of the problems and conflicts that can arise in the production and use of biomass are addressed in this issue of eco@work. It is five years since we last informed you about our work in this field. Since then, there have been many changes, not only in the Institute itself but also in the wider world. The 2010 issue of eco@work focused on our activities in the field of sustainable biomass certification. This time, we are looking at supply and demand. We explore ways of optimising land use in the context of environmental and climate protection, but we also think about the issue of food security. And we consider how to make use of biomass while minimising its negative impacts. For me, innovation is the most exciting aspect of this topic: I am inspired by ideas such as the manufacture of biodegradable plastic from crab shells, recently unveiled by a Harvard research group. The chitin in the crab shells can be used to produce a robust plastic-like material which biodegrades naturally in a matter of weeks. It's a brilliant idea – and although it won't change the world, it does pave the way for innovations that we will need in our transition towards a sustainable raw materials supply.

I hope you enjoy reading this issue of eco@work.

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Contents

In Focus

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"Energy supply units will be smaller in size"

How can regenerative resources make the best possible contribution to our energy supply? This is the key issue on the bioenergy agenda for Professor Daniela Thrän, who heads the Bioenergy Systems Department at the German Biomass Research Centre (DBFZ) and the Bioenergy Department at the Helmholtz Centre for Environmental Research (UFZ). She expects energy supply units to shrink in future, with more targeted use of bioenergy in combination with other energies.

Professor Thrän, what is the best contribution that bioenergy can make?
That question has both a scientific and a societal dimension. The best contribution that it can make will, of course, depend on the opportunities and limits to bioenergy use, and it will also depend on society's objectives. Let's take the example of climate change and energy supply security. As we know, these can be conflicting agendas. If we want to reduce greenhouse gas emissions, we have to focus mainly on the power generation industry, but if we want to reduce our dependency on crisis regions, transport is a more relevant sector. We have to adopt an integrated approach to the multitude of issues relating to climate and energy supply security, and we also need to consider land use, resource availability, food security and the available technologies in order to answer the question.

What role will bioenergy play in future?
The key issue will be bioenergy quality, not quantity. Energy supply units will be smaller in size. A key aspect is to close the gaps left by other forms of energy, combining various energy products. For example, power should be generated from biomass on days when there is no sunshine or wind. It's important to make use of the opportunities to couple several forms of energy.

What will this mean in practice?
By combining material and energy use, we can increase biomass efficiency. That is already happening. For example, one of the by-products of diesel production is what is known as a press cake, which is used in the animal feed industry. There are similar linkages in the timber industry as well: each kilo of timber is now used 1.6 times in Europe. This combined use is not always straightforward, so expansion will be progressive. We shouldn't expect too much too soon.

How high is public acceptance of bioenergy, in your view?
I think that acceptance has a lot to do with the level of knowledge, and it also has to do with perceived benefits. That was the problem with E10 initially, although acceptance has now increased. But at first, there was considerable resistance from the oil and car industries, and consumers weren't sure why they should be using E10. I believe we should be focusing more on consultation and spatial integration. For example, if a community sets up a biogas plant, and if the feedstock is supplied by local farmers and the heat generated is used to supply the village, the level of acceptance will automatically be higher.

What opportunities exist to use biofuels in the aviation industry?
There are various initiatives under way at present, which focus on oil-rich biomass, algae feedstocks and conversion of biomass into synthetic gas and then bio-kerosene. There is firm evidence that biofuels can be used in this industry: many airlines have already conducted trials. The problem is that these biofuels are more expensive than fossil-based kerosene.

Even so, how can biofuels be promoted in this industry?
Mandatory climate commitments for the aviation industry are one option. However, the solutions have to be found at the international level, as this will involve setting up appropriate infrastructure at the world's major airports and hubs. And of course, we need pioneers, such as airlines that are willing to trial biofuels in their regular operations, not just on occasional test flights.

Thank you for talking to eco@work.
The interviewer was Christiane Weihe.

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In conversation with eco@work: Professor Daniela Thrän, Head of Bioenergy Systems at the German Biomass Research Centre

Diverse but finite

Sustainable production of biomass

Biomass is in abundant supply. It comes in the form of foodstuffs, such as cereals, fruit and sugar. And we are familiar with its uses as a material input: timber in the manufacturing of paper and other goods, sugar crops in biofuels production, cotton in the garment industry … the list goes on. And let's not forget bioenergy, which now represents around 80 per cent of the world's renewable energy supply. Biomass is everywhere. And no wonder, for it has a lot to offer. But how is it cultivated? When is it genuinely green and low-carbon? And how much potential does it have to offer, also in terms of sustainability?

"Biomass has many different applications and demand is set to increase," says Hannes Böttcher from the Oeko-Institut. A Senior Researcher in the Energy and Climate Division, he is well aware that meeting this demand will not be an easy task. "Biomass production can't be increased at will," he explains. This is because the supply of fertile land available globally is limited: indeed, the amount of arable land will have to increase simply to enable the world to achieve food security (see A question of ethics – Biomass use, p.8). And on much of the land already being farmed, sustainability issues mean that there is limited scope to expand production. Intensive farming, often involving the use of pesticides, unsustainable irrigation systems, monocultures and inadequate soil protection, can have negative impacts on the environment and climate. "Of course, there's no disputing that biomass use offers many benefits, not least for the climate. It is regenerative, it helps to store carbon in wood products for the long term, and it is a good substitute for fossil fuels and helps to reduce greenhouse gas emissions. However, there are clear limits to its potential, beyond which it does more harm than good," says Hannes Böttcher. "In Russia, for example, substantial amounts of timber are being felled in intact forests, with very little replacement planting taking place, and this is causing forest degradation. The overall carbon footprint of this type of approach is negative, regardless of how the wood is used."

Environment and climate

So what are the negative impacts of bioenergy production and how can they be mitigated? These questions are being explored by Oeko-Institut experts involved in the Study on Impacts on Resource Efficiency of Future EU Demand for Bioenergy (ReceBio) on behalf of the European Commission. Together with a consortium of five partners, including the International Institute for Applied Systems Analysis (IIASA) and the Institute for European Environmental Policy (IEEP), the Oeko-Institut is analysing the impacts of EU bioenergy production on resource efficiency by investigating, among other things, the EU's current uses of bioenergy, their environmental impacts, and interactions with sectors that use biomass. During the course of 2015, the research partners will also look at a range of scenarios based on various assumptions about the intensity of biomass demand, and the associated impacts on the environment and resources. "Biofuels do not form part of the ReceBio project. What we are doing is to look at the use of biomass in power and heat generation. Wood pellets are an example: they are one of the EU's key imports, mainly from North America," explains Hannes Böttcher.

In a desk review of the literature, which formed part of the project and has already been completed, the researchers investigated the possible impacts of bioenergy production on biodiversity, soils, water and greenhouse gas emissions. "As regards biodiversity, the intensification of land use and particularly land-use change have negative effects if, for example, forests are cleared and converted into arable or grazing land," explains Hannes Böttcher. On the other hand, farmland can benefit from a switch to biomass production. "Short rotation coppice (SRC) plantations are a good example: these involve the cultivation of fast-growing crops, such as willow, which require less soil tillage. This has a beneficial effect as it promotes carbon enrichment in soils." But there may be adverse impacts on the soil as well. "These can include soil erosion, nutrient loss and salinisation." Cultivation of energy crops can also be detrimental to water resources and the climate. "In the water sector, the main problems that we are identifying include excessive water use and pollution of water resources, often with pesticides," says the Oeko-Institut's expert. "And with the climate, there are both positive and negative impacts. The climate footprint is highly dependent on the supply chain as a whole: in other words, it all depends on how the biomass is grown, harvested, transported and processed and how it is ultimately used. To measure the footprint, we have to identify and assess every link in the chain." Certification of biofuels is mandatory in the EU, with minimum standards on greenhouse gas emissions and other environmental impacts. Questions are asked about product performance in these thematic areas – and producers and importers must have the right answers at their fingertips.

Safeguarding sustainability

In their study, the researchers have assembled a wide range of proposals on mitigating the negative impacts of biomass cultivation. "Key steps include protecting sites with rich biodiversity and leaving deadwood and old trees in situ in woodland," says Hannes Böttcher. "Where soils are concerned, limiting or prohibiting the removal of crop residues and tree stumps from areas with sensitive soil structures is important." A key factor in protecting water resources, he adds, is to prevent over-extraction of water reserves in water-poor regions and, more generally, to curb pollution. "In terms of the climate footprint of bioenergy, too, there is scope to take action," he says. "Soils which are rich in carbon – such as peatlands – should not be ploughed up. The same certainly applies to ancient woodland. It is also important not to make excessive demands on commercial forests: the volume of timber harvested should never be higher than the volume of growth."

Besides these practical proposals for more sustainability in biomass cultivation, there are numerous steps that can be taken more generally to mitigate the impacts on the environment, climate and society. "One option is to establish certification schemes for biomass products from sustainable sources," says Hannes Böttcher. "One possible model is the Forest Stewardship Council's FSC label, which promotes responsible forest management." However, certification tends to be voluntary. Agreements with producer countries and the adoption of clearly defined standards for imports into the EU can therefore potentially make an important contribution as well. They should be applicable on an EU-wide basis, like the Forest Law Enforcement, Governance and Trade (FLEGT) agreements, which have existed for some years and aim to combat illegal logging. The EU's current sustainability standards for biofuels do not go far enough, according to Hannes Böttcher. "The problem is that the standards only apply to liquid biofuels, not to solid biomass or other biomass applications. The standards are limited in scope and this can cause displacement effects. In other words, crops such as rape may be certified as sustainable, but if they are used to produce biofuels, this leads to a greater environmental impact of food production, in this instance vegetable oil, to which no such standards apply," he says.

Recycling and efficiency

More widespread use of these measures can make biomass more sustainable. However, its potential is limited in one key respect: it will never replace fossil fuels completely. In the EU, the sustainable bioenergy potential amounts to an estimated 20 per cent of current energy consumption. This is heavily dependent on other countries' ambitions to step up their biomass use. "We cannot simply aim to replace fossil fuels and materials with biomass. Regenerative raw materials don't offer that potential," says Hannes Böttcher. He is also critical of the concept of the Bioeconomy, in other words, a biobased economy, which he thinks does not go far enough. "Biomass is certainly regenerative, but it is still a finite resource. So we need to go further – by expanding recycling systems, for example, and improving biomass efficiency." Key steps in this process, says Hannes, are closing the substance cycles and avoiding post-harvest losses (see A question of ethics – Biomass use, p.8). "Measures to improve the recovery and use of wastes and residues are also important; one example is the separation of biological waste, which is meant to happen across the EU, but there are still major gaps in practice." So yes, we have biomass in abundance – but not enough to waste.

Christiane Weihe

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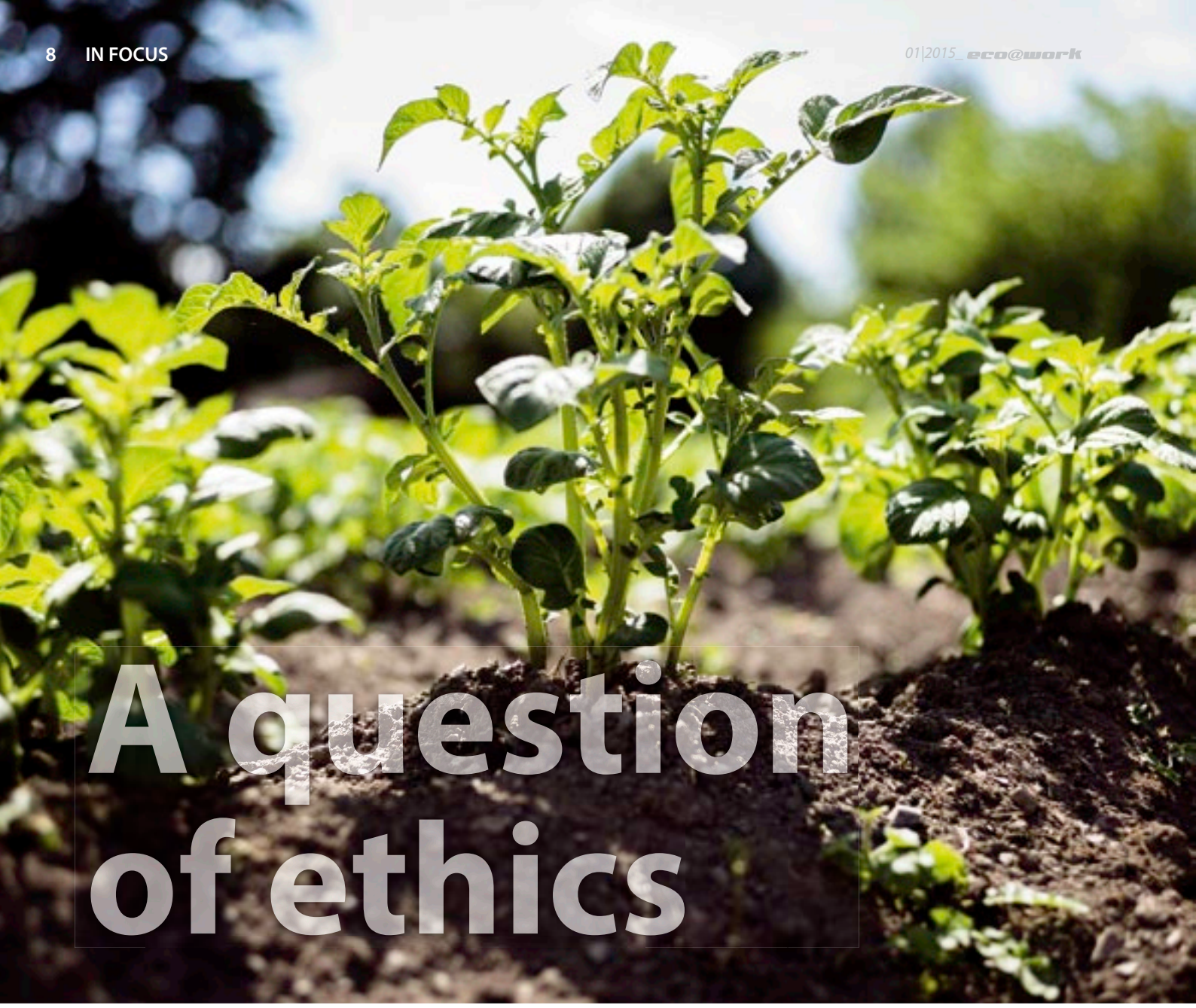

A question of ethics

Biomass use

Type "pictures of biomass" into Google, and what pops up on your screen? Photos of rape fields, wood pellets and biomass plants – the full bioenergy spectrum. Images linking biomass to food production, on the other hand, are hard to find. On the Internet, biomass seems to be synonymous with bioenergy: food plays a minor role in this context. And yet the food/fuel nexus deserves to be centre stage in the debate about sustainable biomass use. The precedence of food security over energy should be a given. But the competition is intensifying.

The United Nations Food and Agriculture Organization (FAO) estimates that around 800 million people worldwide are chronically hungry. In view of the predicted developments in the world food markets, this is unlikely to change any time soon: the FAO projects that global agricultural production in 2050 will have to be 60 per cent higher than in 2005/07 in order to meet demand from a growing world population. The demand for regenerative raw materials is also growing, not least as a result of changing dietary habits. "Meat consumption is increasing, and this has a direct impact on food and animal feed production," says Katja Hünecke, Deputy Head of the Oeko-Institut's Energy and Climate Division in Darmstadt. "The reason is that far more resources are needed to produce a kilo of meat than a kilo of grain." Agriculture – mainly food and animal feed production – occupies around 37 per cent of the world's land-

mass, but the failure to comply with the principle of sustainability is, quite literally, costing the earth: the world loses roughly 24 billion tonnes of fertile soil every year (see Diverse but finite – Sustainable production of biomass, p. 4). According to the 2015 Soil Atlas, 17 per cent of the agricultural land in the European Union is degraded – with soils significantly damaged or even completely destroyed.

Alongside these challenges, there is the issue of rising bioenergy production, which competes with various other forms of biomass use, particularly food production. In 2011, the FAO and OECD predicted that by 2020, around 15 per cent of global coarse grain and oilseed production and 30 per cent of sugar cane production will be driven by strong demand for biofuels. "In recent years, bioenergy has become ever more important; for example, the amount of biofuel manufactured from agricultural products more than tripled globally from 2000 to 2012, and we are expecting this trend to continue," says Katja Hünecke. The growing significance of biofuels also affects prices on the food markets. "Of course, biofuel production is just one factor, but it certainly has an effect," she says. "Even if we assume a very small correlation – let's say 1 per cent – between bioenergy use and hunger, this means that around eight million people are affected."

How much bioenergy would wealthy countries have to give up in order to bridge the food gap? This issue was explored by Oeko-Institut experts in a recent analysis for the German Federal Ministry for Economic Affairs and Energy. "Here, we developed an indicator which measures the relationship between the potential food deficit in countries affected by hunger and bioenergy demand in affluent countries," says Katja Hünecke. This was calculated on the basis of population figures, the percentage of hungry people according to the Global Hunger Index (GHI) produced by the International Food Policy Research Institute (IFPRI 2013), and the assumption that in countries affected by hunger, each hungry person suffers from a 500 calorie deficit, meaning that their daily diet falls short of what is needed for good nutrition. As the next step, the experts calculated the reduction in bioenergy availability in affluent countries that is required to make up this nutritional gap, based on the hypothesis that 10 per cent would be met from animal sources and 90 per cent from crops. "We then converted the calories into petajoules and deducted this figure from the amount of bioenergy available in affluent countries," says Katja Hünecke. These calculations were then tested in various scenarios and underpinned with sensitivity analyses. "We found that the nutrition gap responds very sensitively to the postulated GHI limit value, the reason being that with a low GHI, more hungry people are included in the calculation than with a high GHI. This reveals a much higher food deficit."

The findings of the analysis show that the calories needed to meet minimum nutritional requirements in countries affected by hunger are a fraction of current bioenergy demand in countries with high GDP. "Our calculations show that simply based on the arithmetic, without taking account of issues such as food access and distribution, wealthy countries could bridge this hunger gap by cutting their bioenergy demand by around 7 per cent," says Katja Hünecke. In the researchers' view, the amount of land being used to grow energy crops in these countries should be reduced rather than increased. But there is another way of freeing up farmland, as Katja points out, and that is to produce and consume less meat and other animal products. "The German Foundation on Future Farming has calculated that 5 per cent of farmland could be freed up if every German went without meat and dairy for one day a week. And this figure could rise to 15 per cent if we complied with German Nutrition Society recommendations."

Cascade use

Another important step towards sustainable biomass use is to substantially boost efficiency. There are many options here. As a starting point, there is potential to extract the maximum from harvests and increase yields in many regions of the world. This can be achieved through better crop rotation and improved management, avoiding harvest losses due to poor storage and transport, for example. As Katja points out, "only around 50 per cent of the food produced around the world actually reaches the consumer." But it also includes policies and strategies that adopt an integrated approach to the bioenergy/food nexus, rather than viewing the two sectors in isolation. "There is also a need for many more initiatives that couple different forms of biomass, so that efficient use can be made of by-products, for example. This is closely linked with the cascade principle, in which material use comes before energy." There are many definitions of what constitutes a good cascade. "In simple terms, it means that when using timber, for example, its first use should be as a building material. After that, it can be used to make furniture, with energy coming last of all."

Improving efficiency is an important starting point for future biomass use. But Katja Hünecke wants more: she is calling for a more ethical approach. In her view, what industrialised countries do with their farmland is ultimately an ethical issue. "There needs to be more equitable distribution of prosperity," she says. And that may well include giving up some of the financial gains from bioenergy production. "Ultimately, it's about how we deal with other people in the world community, and that may mean that we have to make sacrifices and accept that we may not be able to achieve all our goals. But if we take a hard look at hunger in the world today, that should be something that the industrialised countries are willing to accept."

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