WAGENINGEN UR
For quality of life

Wageningen UR

The centre for the ***Biobased Economy***

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Wageningen UR – The centre for the Biobased Economy

RAOUL BINO &
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The Biobased Economy is an economy in which food, feed, chemicals, materials, transport fuels, electricity and heat are produced economically and sustainably from green resources: resources that are renewable.

The Biobased Economy thus contributes to a sustainable society in which energy, food and commodities are available to all.

The transition from a fossil fuel economy to an economy based on renewable resources calls for the development of new forms of cooperation, social decisiveness and usable scientific innovations. With its research and education, Wageningen UR has a central position in the Biobased Economy. We develop applications and solutions that combine technical innovation and social-economic value. We do this together with our partners in the private sector, the public sector and other knowledge institutes, both national and international.

Wageningen UR conducts research and provides education in the production and processing of biomass and upgrading it into raw materials, semi-manufactures and products. With our research and expertise we provide knowledge and skills that make it possible for the industry to process biomass and biological building blocks into various interim and end-products, in all cases with added value. Our strength is the combination of integral and specialised research. Wageningen UR is thus working on an economic transition in which we initiate technological developments, organise new forms of cooperation, set up chains and develop new biobased products and production processes.

Wageningen UR fosters a direct interaction with society and the individual citizen. On the one hand, in order to quickly identify and make use of opportunities, questions and concerns. And on the other, to broadly share our enthusiasm for the Biobased Economy and to translate it into actual opportunities for a sustainable economy.

In this booklet we present our research and education in the field of the Biobased Economy. Our aim is to share our enthusiasm with you and to invite you to contact us and work together with us: Wageningen UR, the centre for the Biobased Economy.

The Biobased Economy presents the Netherlands with big opportunities for green prosperity

Heading for a green-golden future

Wageningen UR at the cutting edge

The Biobased Economy remains an economy without any established players. New parties have an opportunity to develop the market and start earning money. They can gain a competitive advantage by developing knowledge and through innovation. The Netherlands is playing a leading role in this green economy. And Wageningen UR is at the cutting edge. Erik van Seventer demonstrates this with a number of products made from biomass at Wageningen UR: biodegradable polystyrene, a green plasticiser, grass paper and biofuel made of wheat straw. New developments follow on rapidly from each other. “That is explained by the fact that we in Wageningen understand organic raw materials and the production processes, but also of course the plant production and land use”, he explains.

Using a plant as gainfully as possible

Production in the Biobased Economy centres on the biorefinery of crops. Biorefinery enables us to gainfully use as much of the plant as possible. Priority number one is food production. Remnant constituents of the plant are used for the production of materials and chemicals. Remnant waste can be used for the production of bio-energy. An important success factor for the green economy is a good combination of large-scale and small-scale processing. There are countless biomass resources in world. There needs to be a first processing step close to the source as otherwise part of the yield will be lost in transport costs.

Research, advice, initiation and innovation

Wageningen UR plays an important role here: “We oversee the entire chain. We understand the agricultural aspect and develop the knowledge needed to use the green commodities more sustainably and effectively and we help to close the loop between waste and production. We work together on the development of knowledge and innovation with private companies, other knowledge centres and the public sector. The Biobased Economy is a global development that is right for the Netherlands, which has a strong foundation in chemicals,agriculture, logistics and a high level of commercial confidence. Wageningen UR is developing naturally into a leading international R&D centre for the development of the Biobased Economy and biobased products. That way we are working on green prosperity.”

‘‘New parties can seize the market and start earning money’’

ERIK VAN SEVENTER

Top quality crops for bioproduction

Genetics for new commodities

There is more to a starch potato than what meets the eye

Successful biorefinery calls for high grade crops that are suitable for this purpose. Plant breeders develop those crops. They understand the genetics and the interaction with the traits, are able to intervene in the production of plants and to optimise their composition for the end-user. Luisa Trindade gives the starch potato as an example. “There is a lot more than starch to be gained from it. It also contains proteins that are used for animal feed. Plant breeders improve the amino acid composition of the proteins by raising the essential amino acid content. We also raise the quantity of extractable pectins (a thickener), optimise the structure and in the same time extract lower content constituents from the potato, such as terpenes for the production of bioplastics.”

Optimisation

The optimisation concept is suitable for many crops. One of which Wageningen UR works on is miscanthus – a large grass type. Miscanthus is a crop that can be sustainably grown and stores a lot of minerals in its roots at the end of the growing season. These nutrients are mobilised during the following spring and reused for growth. The dead crop that remains above ground in the winter provides an important source for biomass. “We are looking into whether we can introduce an early harvest while the crop is still green. At that stage the crop contains more high value components such as proteins and chlorophyll, little or none of which is found in the winter. The harvested crop is suitable for the production of energy, biomaterials and bulk chemicals.”

An optimum chain

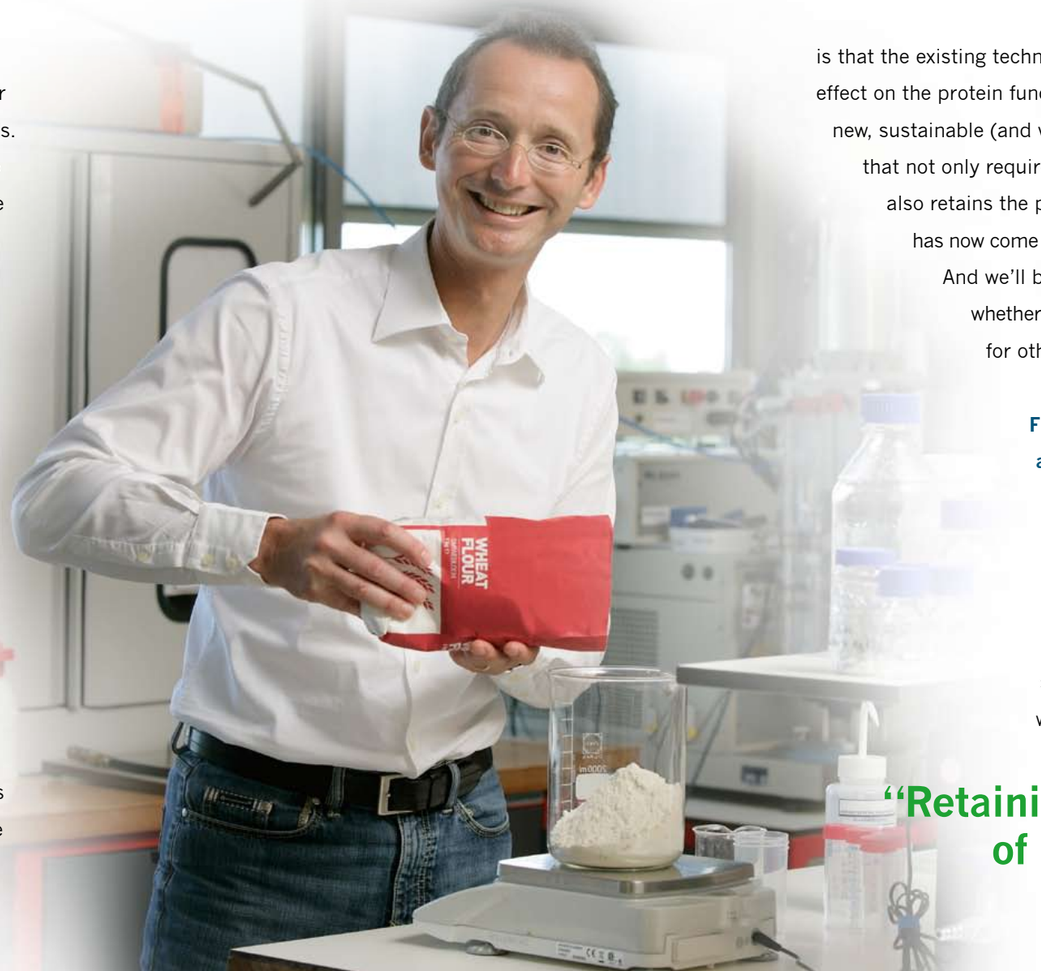
The Netherlands is a small country. It cannot produce all the biomass needed for the Biobased Economy here. The country does however play an important role at the start of the chain, the breeding. Luisa Trindade explains: “In the Netherlands there are excellent breeding companies and there is an impressive amount of knowledge. We haven’t got the space to grow many crops, but we are good at processing them. At Wageningen UR we link breeding and processing to improve crops for use in the Biobased Economy.”

“Breeding is the first link in a good chain”

LUISA TRINDADE

Looking for new separation techniques

“Identifying opportunities and developing technology”



Towards a sustainable food industry

Plants are becoming increasingly attractive for purposes other than food for people and animals. Chemicals, biofuels, materials, nowadays also originate from biomass. It is difficult to increase production because we have reached the limits of land and water use. “That means that we have to work towards better separation techniques to get more out of the plant. The current separation techniques adversely affect the quality of the proteins, so we’ll have to come up with something else”, says Remko Boom.

Retaining protein functionality

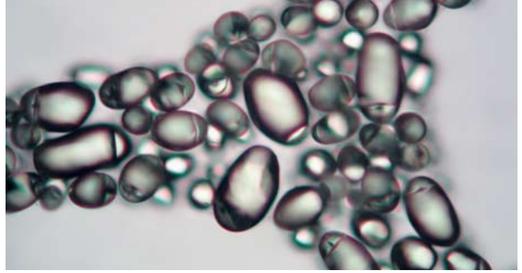
Remko Boom is achieving notable success with the development of a new separation technique for wheat flour. Dutch wheat is grown mainly for its starch, which is processed into animal feed. But wheat also contains other useful substances. The goal is to separate all materials in a plant as efficiently as possible. “The trouble is that the existing techniques always have an adverse effect on the protein functionality. We’ve discovered a new, sustainable (and very fast) separation method that not only requires less water and energy, but also retains the protein functionality. The time has now come to further optimise the process. And we’ll be looking into the question of whether we can also use this technique for other plants.”

First food, then fuel, materials and chemicals

Remko Boom is now looking for new protein sources for human foods. He has already succeeded in using dairy protein to make a fibre similar to that of meat and which is also retained after ooking. Another idea is to give cultivated fish such as salmon a vegetarian diet. The animal protein that is saved can be used for human food instead. Algae also present attractive options. “I want to find out how we can initially extract food from plants and algae. We have to look for opportunities and then develop process technologies for using alternative biomass in the food chain and in the remnant streams for biofuels, materials and chemicals.”

“Retaining the quality of proteins”

REMKO BOOM



Bioplastics set to replace traditional plastics

Ordinary plastic, but better

Varied products

Polystyrene, coffee cups, plastic bottles, film: bioplastics are already being used for a wide range of products. And there's a good chance that they were conceived in Wageningen. Wageningen UR researches the production of chemicals, materials and energy carriers made from biomass. It yields high performance fibrous materials for paper and textiles, for instance. But we are focusing mainly on biobased plastics, says Christiaan Bolck. "We use biomass for the production of polymers, the building blocks for plastics. We augment these with additives until we have a material that possesses the right colour, properties and life span for the specific application."

Closing the loop

The products developed are found in the agriculture and horticulture sectors, but also in the packing industry and even for applications in cars. Not all bioplastics are biodegradable. "They can be, but do not necessarily have to be", clarifies Christiaan Bolck. "It depends on the type of product and where you intend to use it. The prefix 'bio' refers to the raw material it was made of, not the degradability aspect. We work on various types of plastic. It is convenient to be able to throw a potato sack in the green container with the peel. You can collect mobile telephone covers and reuse them or extract energy from them. The most important aspect is to close the loop."

Substitute for traditional plastics

Wageningen UR has a great deal of knowledge of bioplastics. Countless products that end up on the market are developed in partnership with industrial partners. "We can make virtually all of the plastic-synthetics of today 'biobased', and even improve their quality. This will become the substitute for traditional plastics", is the firm conviction of Christiaan Bolck. And that will happen faster than you think.

"Making use of nature's own functionalities"

CHRISTIAAN BOLCK

The relationship between biodiversity and the Biobased Economy

“Dyke slopes with many plant types are more resistant against erosion”

Implications for ecosystem functions

What does biodiversity has to do with the Biobased Economy? Frank Berendse explains the connection. His research focuses to a large extent on the mechanisms responsible for preserving biodiversity in ecosystems. But also on the implications of the loss of biodiversity for the ecosystem functions that are important to people, such as water treatment, air quality and the resistance to erosion of mountain slopes and dykes.

Agreements on restoration and retention

During the important biodiversity conference in Rio de Janeiro at the beginning of the nineties, global agreements were made about the restoration and retention of biodiversity. There is now a pressing need for this to be done. “That was immediately followed by a wave of research into the implications of losing biodiversity”, explains Frank Berendse. Wageningen UR was at the forefront of this. A large-scale experiment was set up involving 108 test fields with various numbers of grassland plant types. The research took ten years, but it was already apparent after two years that there was a strong link between the number of plant species and production levels. “When the number of grassland types was reduced in a test field from 8 to 1, production halved.”

“Biodiversity is of great importance to biomass production”

FRANK BERENDSE

Dykes safer thanks to biodiversity

“In expansive natural areas such as pampas, savannas, steppes, where no role is played by fertilisation, biodiversity is of great importance to biomas production”, explains Frank Berendse. He is of course also interested in finding out why. The answer is found in the fact that the root systems of various plants extract their nutrition at different depths. “We have made a new molecular method available that makes it possible to see where the roots of which plant species are found. It is usually difficult to differentiate those roots from each other. We have also discovered that Dutch dyke slopes with many plant species on them are more resistant to erosion than those with few plant species. The retention of biodiversity on dyke slopes therefore lends itself well to being combined with an effective safety policy and the large-scale production of biomass.”

Working on artificial leaves with BioSolar Cells

A solar cell that produces biofuel

Solar cells with extras

Could it be that one day everyone will have solar panels on the roof that produce enough fuel to fill up your car tank? It is not inconceivable. Wageningen UR is conducting research into BioSolar Cells as an alternative to the existing solar panels for that purpose. The special aspect of BioSolar Cells is that – unlike existing photovoltaic cells – they are able to directly produce liquid fuels. Researchers are effectively working on an artificial leaf!

Contribution of the Netherlands' best physicists

BioSolar Cells are based on photosynthesis, the unique process that makes it possible for plants to convert light into organic compounds. Wageningen UR, one of the initiators of the BioSolar Cells research, is studying ways of enhancing photosynthesis in such a way that this natural process can be used for sustainable energy supplies. "We are enhancing the efficiency of photo-synthesis in this research programme. Photosynthesis is a plant's engine. If you want to drive faster, you have to improve photosynthesis", explains René Klein Lankhorst.

Highly productive plants required

Another reason to work on the efficiency of photosynthesis is the need to use the available soil more intensively. After all, plants have to provide food as well as energy. "We need highly productive plants for that purpose, plants that use nutrients efficiently and grow quickly. In many areas there is not enough plant growth because of the lack of water or the small amount of fertiliser provided. To move ahead we need to enhance the plants themselves." Researchers are working on a mechanism to have plants work more efficiently with the sun, for example, by reducing the light absorption level per leaf layer and changing the position of the leaves.

"Photosynthesis is the engine of the economy"

RENÉ KLEIN LANKHORST

Small-scale biorefinery the most attractive option

Biomass cultivation gives farmers new opportunities

“Taking a plant apart gets the most out of it”

JOHAN SANDERS

Fossil fuels are cheaper

The Netherlands is aiming to replace thirty per cent of the fossil resources with biomass by 2030. That is an ambitious aim that calls for a large extra quantity of biomass. How can we cultivate that biomass in an economically responsible way, and what is the most profitable way of extracting the valuable raw materials? There is a pressing need for research. “For fossil fuels are often much cheaper”, explains Johan Sanders.

Opting for the highest value

“It’s important to start out by deciding what you want to achieve. There are five applications that call for large volumes and which are rising in value: electricity, liquid transport fuels, bulk chemicals, animal feed and food. Fractions that are isolated from plants often have a huge value in themselves: sometimes even higher than fractions originating from the petrochemical sector.” Separating substances from plant materials through biorefinery makes it possible for us to use each component at its highest value. That is important. “It enables farmers to generate new income from plant materials. Without taking the plant apart, they only make use of the highest value of one component.”

Small-scale pays

The bigger the factory, the cheaper the product. That’s how it usually goes, but it doesn’t hold true for biorefinery. Small-scale biorefinery yields benefits throughout the entire chain. It is important to set up small-scale biorefineries. There are already success stories in this area, says Johan Sanders. “In Africa there are fourteen mobile factories in containers where valuable substances are extracted from cassava. In the Netherlands we are working on mobile grass processing. Grass contains proteins for pig feed, fibres for paper production and other substances too.” Ultimately it is important to enable farmers in this way to keep the plant components, which enhance soil fertility, in the field. The farmer becomes the producer of biomass for all applications. “That way we save the highest percentage of fossil fuels per hectare.”

“The Biobased Economy only has a limited effect on world food prices”

Biobased Economy presents opportunities for growth

Demand for food less determinative

Hans van Meijl has close ties with the Ministry of Economic Affairs, Agriculture and Innovation, which shapes the policy. “We do research, assess policy plans and provide advice. The Biobased Economy plays an increasing role in this”, he says. “It is important to know how the agricultural sector will develop economically now that the demand for food for human consumption is no longer the biggest factor. That demand was highlighted by the EU Renewable energy directive that has made it compulsory for 10% of all transport fuel to be biobased by 2020. We have to ask ourselves what impact this will have on farmers’ incomes, prices, land use and production.”

Flanking environmental policy required

We answer these questions in the context of the Macro Economische Verkenning (‘macro-economic study’). The study had an important influence on the government’s decision to invest many millions from the gas revenues into a sizeable research programme into the Biobased Economy. “We are fairly optimistic about the opportunities of the Biobased Economy if there are investments in knowledge and innovation and provided that the oil price stays high for a longer period. Our calculations show that this will create jobs and could improve the trade balance. The effect on world food prices is fairly limited. It is however important to pursue a flanking policy to limit the environmental impact.”

No link with poverty

We are also taking part in the social debate on ‘Competing claims”, or: is it ethically justifiable to put corn in your petrol tank when people are going hungry? “We feel that there is no direct link between poverty and biofuels. Poverty was there before biofuels had even been heard of. The problem has much more to do with dysfunctional governments and poorly operating markets. We supply the social debate with independent knowledge.”

‘‘More jobs, better trade balance’’

HANS VAN MEIJL

Producing more biomass whilst reduction CO_2 emissions

The agriculture sector both consumes and produces greenhouse gases

More biomass means more CO_2

Could organic waste contribute to solving the climate problem? Absolutely! Peter Kuikman explains how that works. "CO_2 is released when we prepare the soil to grow crops. About a quarter of all greenhouse gases originate from the production of food through land use, animals and manure. That means that if we start producing more biomass, there will be a further increase in greenhouse gas emissions. That's despite the fact that we're doing our best to reduce the emission of CO_2 and other greenhouse gases like nitrous oxide and methane!"

''Organic waste could contribute to alleviating the climate problem''

PETER KUIKMAN

Keeping CO_2 in the soil

Organic waste helps us to produce more biomass whilst reducing CO_2 emissions in the agricultural sector. "Pyrolysing (burning without oxygen) organic waste or other biomass yields an oily substance that can be used as a fuel. The remnant product is called Biochar, which contains substances that are very useful for plant nutrition. Research has shown that returning Biochar to the soil gets good results. "Biochar stays in the soil for a long time. It makes an effective contribution to the retention of CO_2 and could be used as a catalyst for soil remediation. Biochar is also expected to be able to enhance the efficiency of nutrient usage. We are looking into the possibilities this offers via the separation of nutrients and stable fractions."

Field trials

Up until now organic waste has mainly been composted rather than pyrolysed. That way, the energy component is lost. And neither are farmers keen on using the compost because its origin is unclear. Biochar makes it possible to return organic waste more safely to agriculture. "We are studying ways of using agricultural remnant products as well as organic waste. Biochar has proved its potential in the lab. We are now testing it at field level. Companies are queuing up to produce it. Biochar is hot!"

Algae cultivation: technology with a future

AlgaePARC as a catalyst for further research

Algae accumulate fats

What happens in the cells of algae, fungi and yeasts and how can we influence that process for the production of bio products? That is a typical question for Rene Wijffels. “Algae cultivation is an area of application that has grown big”, he says. “Algae can accumulate fats and that makes them suitable for the production of biofuels.” The opportunities presented by algae are promising, not least owing to the considerable industrial interest in sustainable production. “That is also because no soil is needed to produce them, and there is no competition with food production.”

Testing and comparing cultivation technologies

The downside is that the development of the technology has not yet been completed. “We started as pioneers in 1997. There is still much to be done before it becomes an industrial process. Research is currently being carried out together with many companies in Wageningen, Leeuwarden, Vlissingen and in Spain. But more large research programmes are needed, with plenty of support from the industry.” A major step forward was taken by the building of AlgaePARC (Algae Production and Research Centre), a 700 m^2 algae complex in the direct vicinity of the campus in Wageningen. Here researchers are testing four different cultivation technologies and comparing them with each other. According to calculations, a closed system is the most gainful, says Rene Wijffels. “Our dream is to put a stand-alone system in the desert, for example.”

Using all components

The AlgaePARC represents the translation of laboratory research into practice and forms the bridge to actual algae applications. “The research is driven by the oil industry, but we also want to extract other components from algae. Algae purify water and produce oxygen, protein and oil from light. If we can combine all of this, the result will be a business case. That’s why many companies are working together on this project. We are also working with certain companies on specific products. AlgaePARC is an important catalyst for this. We now have something to show.”

“Our dream is a stand-alone system for cultivating algae”

RENE WIJFFELS

Sugar beets contain raw materials for high grade chemicals

The sugar beet as a chemical factory

Lysine as a basis for nylon

Sugar beets are currently used mainly for the production of sugar. A separate factory is used to convert sugar in turn into products such as alcohol or green chemicals. But it is also possible to produce green chemicals directly in the beet itself. That is cheaper and uses less energy. Andries Koops explains a new business model. It involves products including lysine. Lysine is a natural amino acid that is needed to keep us healthy but which is also suitable for making nylon. Nylon is still made by the petrochemical industry, using fossil oil.

Directly from the plant

Lysine is currently still produced by feeding sugar to micro-organisms. “Lysine is used to enrich animal feed. We also want to use it for chemicals, but the cost price is still too high for that. We think that lysine can be produced less expensively by extracting it directly from the plant. That can be done in an existing sugar factory. No separate factory is needed for the microbial production: the sugar beet becomes the factory. That brings us close to a raw material cost price that the chemical industry can manage.” The rest of the biomass, including the sugar, yields alcohol, which means that the entire beet can be used for non-food raw materials.

No extra land needed

Another important innovation involves the development of a winter beet by several breeding companies. This connects well with the production of green chemicals. Andries Koops: “Winter beets are sown in November, are able to withstand the winter and therefore have a longer growing season. The harvest is potentially 30% higher than in regular sugar beets. The extra production capacity can’t be sold on the sugar market, but it can be sold in the market for fuels and green chemicals. That way we avoid the constraints of the strongly regulated sugar market and do not need any extra land for the production of green chemicals and energy with plants.”

“The winter beet means that we need no extra soil”

ANDRIES KOOPS

Towards alternative commodities for animal feed

“Processed straw, insects, algae and rapeseed are interesting options”

Challenges and opportunities

The animal feed industry is experiencing mounting competition on the commodities market as a result of the Biobased Economy. The increasing use of biomass for the production of fuel and food for human consumption is causing a decrease in the stream of commodities for animal feed. “We are not high up in the pecking order. But that also presents challenges and opportunities”, says Wouter Hendriks. Wageningen UR is looking for alternative raw materials for animal feed. We see many possibilities for insects, straw, algae and rapeseed. “After all, everyone wants to carry on drinking milk and eating meat in the future, don’t they?”

Making milk and meat out of straw

Insects cultivated on pig manure or other remnant streams produce higher value proteins. They also contain compounds that can strengthen the immune system. That makes it possible to use insects for fish and poultry feed, and even for pig feed. Rice straw or wheat straw can present attractive options for cattle after being pre-treated with fungi. “Straw is usually very difficult for cows to digest. Fungi break down the structure and make the straw more usable for bacteria in the cow stomach. That way we make more milk or meat out of straw. This is a particularly attractive idea for East Asian countries. A lot of rice straw is available there, which is not yet being profitably used.”

Optimising remnant products

The animal feed industry can also use the remnant substances of algae that remain after the production of biofuel, food for human consumption and chemicals. “Algae contain proteins that are a good source of amino acids for animals”. Soya will be used more in the future as a source of protein for human food products. Rapeseed scraps and flakes can replace soya in animal feed if more rapeseed is cultivated for biodiesel. Developments are moving quickly, feels Wouter Hendriks. “We would like to contribute at an early stage to the ideas about the development of production processes for biomass so that we can promptly optimise remnant products for the animal feed industry. We want to make a solid contribution to adding value to products that man is unable or unwilling to consume but which is suitable for animal feed.

“Commodities that were never in the picture have suddenly become interesting”

WOUTER HENDRIKS

“To help policymakers to make the right choices”

Bioplastics often prove to be more sustainable than biofuels

Bringing policy and technology together

We can already do a great deal with biomass. But how do we translate all the technological alternatives provided by the Biobased Economy into policy? That is a question that Harriëtte Bos asks herself every day. She and her department are conducting policy support research for the government and various companies. “Policy and technology are far apart. It is good to bring them together in order to help policymakers to make the right choices. That is only possible if they understand the underlying technology. My task is to explain that technology in such a way that people understand it.”

Publications and research

We use the internet to make the technology understandable and accessible. “A lot is going on in the Biobased Economy. The Groene Grondstoffen (‘green commodities’) website contains factsheets in which we clearly and concisely explain relevant subjects. Also, booklets in the Groene Grondstoffen series are regularly published on subjects such as Biorefinery and Algae.” The department conducts research as well as publishing. Research subjects include the sustainability of products made from biomass. Five crops from which sugars can be extracted are compared. Sugar forms the basis for various products, including ethanol and bioplastics.

Assessing chains

But what is the most sustainable choice? How much CO_2 is released and how much energy does it take to make the product? Harriëtte Bos explains: “It turns out that it is smarter to make bioplastics from sugars than fuel. Sugar beet is an interesting crop for this purpose because it has a high yield per hectare.” Wageningen UR is studying the economic and technological feasibility of various production chains. It has emerged that biorefinery – the production of both high value and low value products from the same biomass – makes the chain more economically attractive. “We have assessed a number of chains to make an internet tool that enables people to carry out their own model calculations and establish the effect of choices on various products.”

“To make policy you have to understand the technology”

HARRIËTTE BOS

Doubling biomass production entails many dilemmas

“Two times more with two times less”

All hands on deck

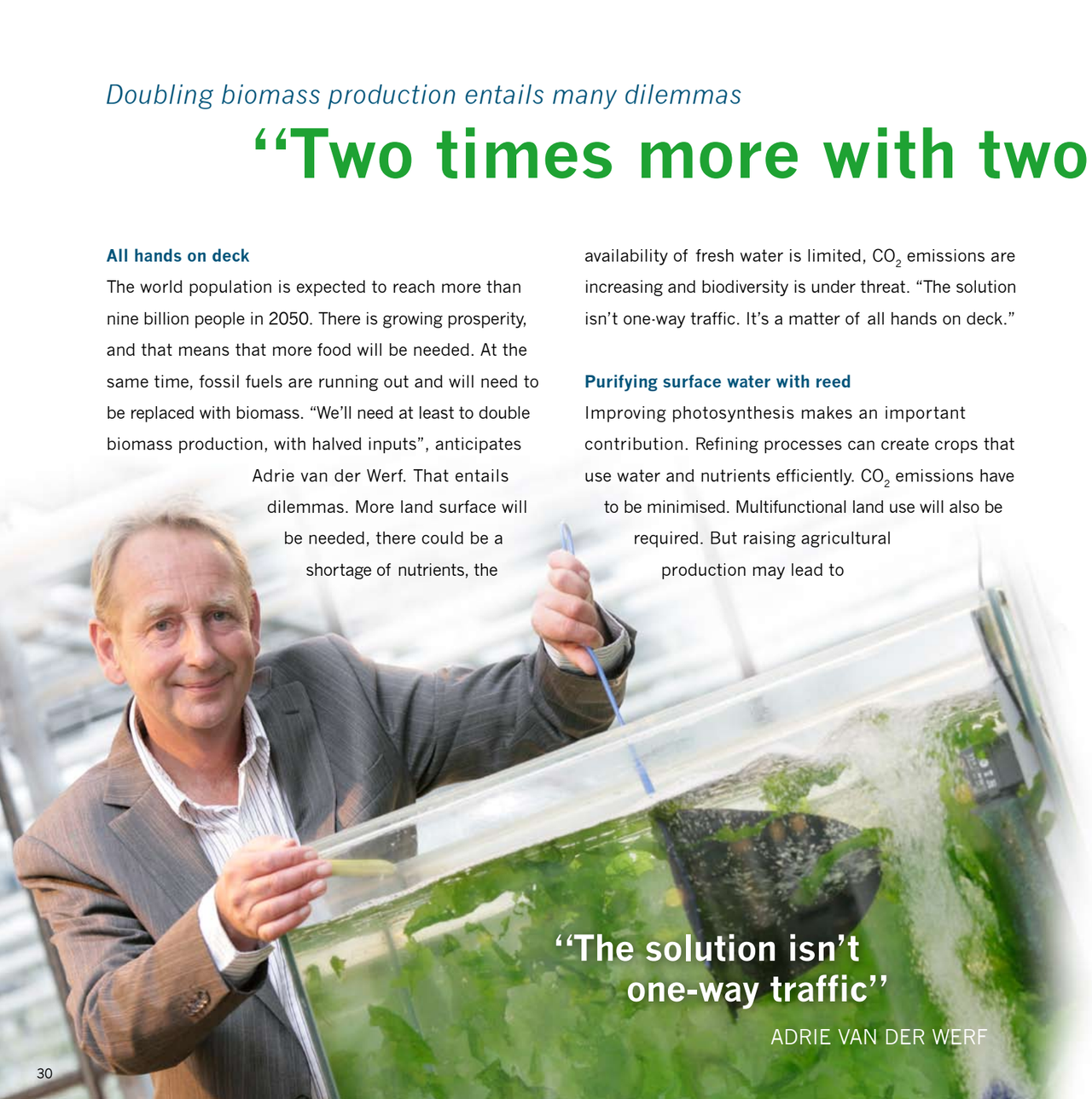
The world population is expected to reach more than nine billion people in 2050. There is growing prosperity, and that means that more food will be needed. At the same time, fossil fuels are running out and will need to be replaced with biomass. “We’ll need at least to double biomass production, with halved inputs”, anticipates Adrie van der Werf. That entails dilemmas. More land surface will be needed, there could be a shortage of nutrients, the availability of fresh water is limited, CO_2 emissions are increasing and biodiversity is under threat. “The solution isn’t one-way traffic. It’s a matter of all hands on deck.”

Purifying surface water with reed

Improving photosynthesis makes an important contribution. Refining processes can create crops that use water and nutrients efficiently. CO_2 emissions have to be minimised. Multifunctional land use will also be required. But raising agricultural production may lead to surface waters being polluted by the flushing of nutrients and phosphates. “We can purify surface water using reed. That also yields a lot of biomass. In Rekken (The Netherlands) we are running a trial with generating heat from reed from our test field, with the addition of grass clippings. The incineration residues contain phosphates that we extract using smart methods.”

Agriculture and industry can benefit from each other

Bringing industry and agriculture closer together contributes to the use of residual materials from industry for biomass production. They include heat, CO_2 and nutrients. Adrie van der Werf: “We have a project in which we use the residual materials for the production of Azolla, one of the world’s fastest-growing plants. It yields biomass that can be used for various purposes. And why do we only produce biomass on land when 70% of the earth’s surface is covered by water? We could cultivate algae and seaweeds that are rich in valuable substances, possibly with the aid of residual materials from industry.” “To feed the world we need to produce twice as much with half of the inputs”. That, according to Adrie van der Werf, is the challenge.



“The solution isn’t one-way traffic”

ADRIE VAN DER WERF

The art is to release all the components

Biomass makes cheap fuel possible

Developing and implementing biorefinery

To ensure the success of the Biobased Economy we need to make optimum and sustainable use of the available biomass. “That’s why we’re working on the development and implementation of biorefinery processes”, explains René van Ree. Biorefinery releases the various components that biomass contains. “All of the components are encapsulated in the biomass structure. The art is to break open that structure in order to release components such as sugars, lignin, proteins, oil and fibres. We process these fractions into biobased products and bioenergy”, says René van Ree.

“We have to make optimum use of the available biomass”

RENÉ VAN REE

Using advanced technologies

Wageningen UR uses highly advanced technologies to make bio transport fuels and biological hydrogen. “We’re already getting a lot done in the laboratory, the time has now come to upgrade to a pilot.” It’s already possible, for example, to implement biomass in an existing oil refinery. “But the biomass first has to be converted into an oil or gas fraction for that purpose using biorefinery. Biorefinery takes less energy than traditional petrochemical processes, and thus makes it possible to extract cheap fuels from biomass”.

Linking demand and availability

“As well as developing technologies we make models to link the market demand for products with the availability of biomass in order to shape the optimum chain. It’s important to convert the right biomass into the right end-products. Clean wood, for instance, shouldn’t be used as fuel. You have to start by extracting the valuable components from it and then using the residual material for fuel. We’re developing strategies for that purpose for both the private and the public sector. Power companies want to know how to respond to the future availability of biomass in a competitive market, for example,” says René van Ree. We have developed integral models that are needed to work this out.

Healthy soil in the Biobased Economy

Brazilian Indians as a source of inspiration

Burning without oxygen

How do you keep the soil healthy? That is a classic issue in agriculture. The Biobased Economy makes extra demands on soil quality, says Thom Kuyper. “Which soils do you use to grow crops? And what happens if you use so much of the plants that hardly any remnant material is put back into the soil? How do you keep the soil sustainable? A win-win situation in the Biobased Economy is the fact that plant remnants do not go directly into the soil, but are first incinerated without oxygen.

“Unravelling the secrets of black soil”

THOM KUYPER

That’s how we extract energy. The remnant material is a stable soil remediating agent.” This technique was inspired by Indians in Brazil.

No special micro-organisms

Brazilian Indians had ‘black soil’, which was two to three times richer in humus than other soils. The knowledge of the Indians was lost. “They had a method for turning wood into charcoal and returning it to the soil”. Wageningen UR together with Brazilian researchers study the black soil. “We already know that the secret involves a lot more than a very special bacteria. But we don’t yet know precisely what.”

Earthworms turn over the soil

Patience is important too. Charcoal penetrates deep into the soil. In Brazil the charcoal goes sometimes up to two metres deep. That can only be caused by soil life such as earthworms. The process takes dozens to hundreds of years. “Now that we know that worms play a role, we are starting a small-scale demo project. The starting point of our research is that the Biobased Economy cannot be allowed to compete with the global food supply. We will therefore have to use other soils and are looking for ways of remediating exhausted soils.”

Waste water contains a lot of biomass and nutrients that are not currently used. That can be changed.

Water treatment as a factory for clean water, nutrients, energy and bioplastics

Throwing out the baby with the bathwater

The Biobased Economy is all about biomass. Biomass is also found in waste water, together with valuable nutrients. As things stand, they are not being used. That's a pity, feels Huub Rijnaarts. We are working on new technologies to make waste water suitable for reuse and to extract nutrients and energy from the water. For the production of artificial fertiliser, for example, the nutrients nitrogen and phosphorous are currently extracted from the atmosphere or from the subsoil. They return to the ecosystem with the waste water via agriculture and consumers and are not reused. That is despite the fact that there is a global phosphorous shortage.

Towards an anaerobic technology

"Our aim is to extract the nutrients and return them to where they are needed: for the production of biomass in agriculture. We can convert the organic substances in the waste water into useful materials such as biodiesel, methane gas, electricity, polymers or bioplastics", explains Huub Rijnaarts. As things stand it all disappears in the form of sediment in the waste incinerator. The current water treatment process is based on oxygen and micro-organisms. "Our alternative is an anaerobic, i.e. oxygen-free treatment technique. For that purpose we create conditioned circumstances comparable with those of a cow's stomach."

Separating waste water in the home

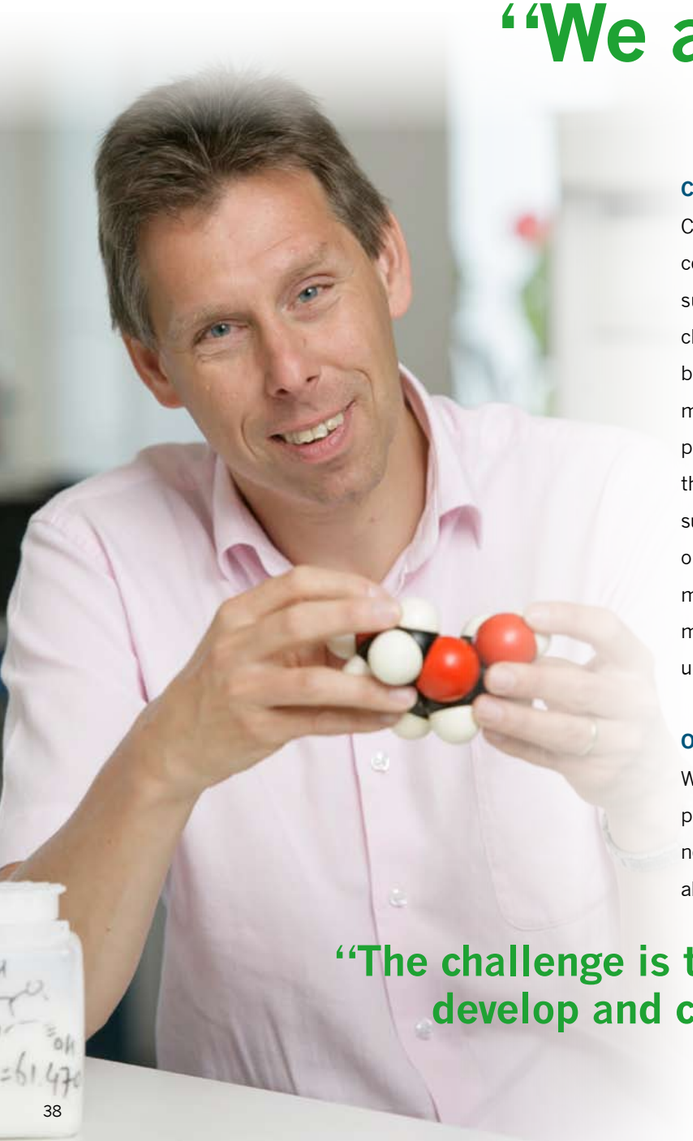
"We use micro-organisms to produce methane gas or other substances from biomass. After being treated the water still contains phosphorous and nitrogen. This is extracted with a separate technique", continues Huub Rijnaarts. There remain a number of outstanding research questions. To efficiently extract water, gas and nutrients, it will be necessary to keep household sanitation waste water separate from laundry and rainwater. Tests are currently being conducted on this subject. Practical experience has been gained at 32 houses in Sneek (The Netherlands). "We are also looking for a technology that can be used to extract micro-contamination, medicine traces and harmful viruses and bacteria from the rainwater.

"We produce methane gas from biomass in waste water, just as grass is converted in a cow's stomach"

HUUB RIJNAARTS

Biochemicals are the building blocks of biobased materials

‘‘We are turning basic chemicals green’’



Comparable technologies

Can you make car parts out of wheat or corn? Yes, certainly, says Jacco van Haveren. “We are working on substituting fossil oil-based chemicals with biomass chemicals. These green chemicals form the building blocks of biobased materials such as paints, solvents, medicines and glue. But we also use them to make parts for sailing boats, cars and computers.” Most of the chemicals originate from natural carbohydrates such as sugars, starch and cellulose, but also vegetable oils, lignin and proteins. “For that purpose we use modern technologies such as biotechnology, but also more chemical technologies similar to those currently used for making chemicals out of the fossil oil.”

Opportunities for industry

Whereas the demand ten years ago was mainly for the production of biodegradable products, today there is a need for biobased products with a longer lifespan. “We’re able to modify the structure of the natural raw materials in such a way that components don’t fall off your car before their time and the paint stays on your house for more than ten years.” Now that the technology is available, it is up to the industry to start using it, says Jacco van Haveren. “Biochemicals cost a bit more than traditional chemicals because they are made in smaller quantities. But that is set to change. Companies are showing increasing interest in our technology.”

‘‘The challenge is to continue to develop and create economic viability’’

JACCO VAN HAVEREN

More economic appeal

A market-ready product developed by Wageningen UR is a non-toxic plasticiser. “We have also developed chemistry for do-it-yourself paints, glues and coatings. Other than that, we’re working on reducing production costs by improving production processes for biochemicals that are already on the market. There is enough biomass in the world to meet the demanded volumes. Once we have developed the envisioned technologies, only 2-3% of all biomass will need to be used for chemicals and materials. So, that means we do not have to tighten our belts. We do however need to make the production more effective in order to make using them more economically attractive.”

“Training people for tomorrow’s biobased society”

Supply and content of education changes

The Biobased study programme

The Biobased Economy is broad. Many of the subjects taught in the Bachelor’s programmes Agrotechnology, Biotechnology, Plant Sciences at Wageningen University have links to it. The same holds true of the subsequent Master’s programmes. That broad approach has been deliberately chosen. “The business community calls for people with a certain specialist field in the Biobased Economy, but at the same time can see the bigger picture. We supply those people”, explain the programme directors Sonja Isken and Anja Kuipers.

Education develops at a fast rate

In common with the Biobased Economy itself, education on the subject is developing at a fast rate. It would be an illusion to think that students can learn everything now and use it for the rest of their lives, people have to learn all their live. Things are moving fast, especially where the Biobased Economy is concerned. “The specialist subject Marine Biotechnology started out with research into the use of sponges for medical applications, but now students learn also how to produce biofuels from algae”, gives Sonja Isken as an example. “It’s impossible to predict which direction it’ll take. Teachers have to constantly update subjects based on research. Things usually move ahead in small steps, with a bigger step being taken every now and then.”

“The trick is to provide a specialist who also sees the big picture”

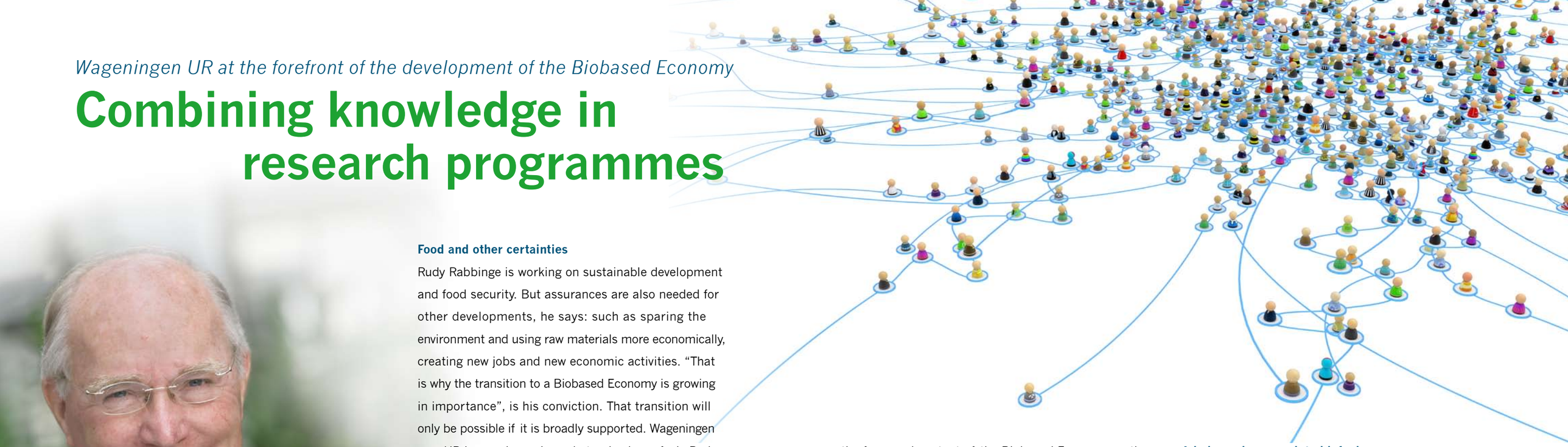
SONJA ISKEN & ANJA KUIPERS

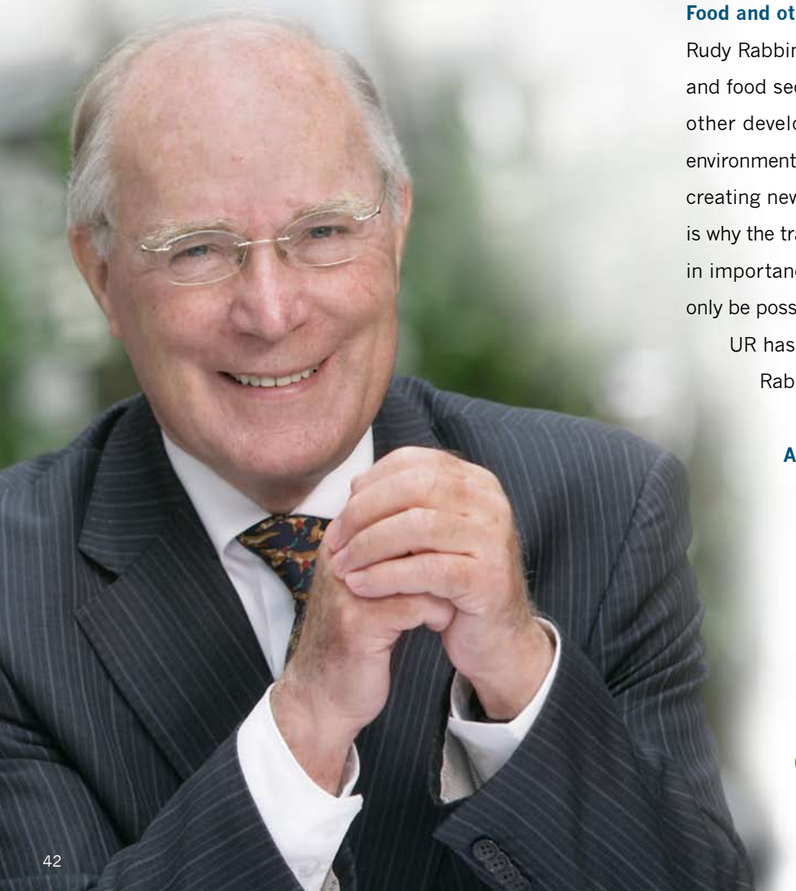
The supply is growing too

Students are becoming more interested in subjects linked to the Biobased Economy and both programme directors predict that this grow will continue. The subject Renewable Resources in Bulk Chemical Industries, which is completely related to the Biobased Economy, has started under Biotechnology and is now a biobased education programme pur sang, for example. Anja Kuipers: “As the Biobased Economy is gaining importance this will be incorporated in our study programme. The optional courses and BSc minors are attracting students from various degree programmes within and outside of Wageningen. Wageningen University is thus training people who are ready for a green future.

Wageningen UR at the forefront of the development of the Biobased Economy

Combining knowledge in research programmes





Food and other certainties

Rudy Rabbinge is working on sustainable development and food security. But assurances are also needed for other developments, he says: such as sparing the environment and using raw materials more economically, creating new jobs and new economic activities. “That is why the transition to a Biobased Economy is growing in importance”, is his conviction. That transition will only be possible if it is broadly supported. Wageningen UR has a pioneering role to play here, feels Rudy Rabbinge.

Applied science companies

“Wageningen UR is among the first movers. We talk to members of government and advisory bodies and take part in the Biodiversity Taskforce who are considering the form and content of the Biobased Economy on the initiative of companies. It’s not for nothing that we are asked a lot of questions. “We operate within the business community, policy and science and adopt a neutral position. We have knowledge of the basic processes and principles of living systems and produce hard quantitative data. We also stand out from other scientific institutions because we use ‘science for impact’ as a principle. That is only possible if we offer quality and excellence, and we are succeeding in that!”

“We are striving for quality and excellence”

RUDY RABBINGE

A balanced approach to biofuels

On behalf of Wageningen UR, Rudy Rabbinge has recently initiated various major research programmes in which the business community, Wageningen UR and other knowledge institutes and public bodies work together. They include the Carbohydrate Competence Center, which collects knowledge in the area of carbohydrates. The aim of this is to contribute to a healthy, sustainable society. Another initiative is the research programme BioSolar Cells, aimed at finding an alternative for biofuels in the form of organic solar cells.

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Colophon

This is an publication of Wageningen UR, september 2011

Editing: Erika van Gennip, Erik Toussaint

Text, translation and design: The Communication Company Nijmegen

Photography: Fred van de Heetkamp, Wageningen UR

Stockphoto: Shutterstock

Printing: Drukkerij Knoops

This product is printed according a Cradle to Cradle® optimised printing process as conducted by Knoops Eco Printing B.V. in collaboration with EPEA Internationale Umweltforschung GmbH

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