

## WAGENINGEN UR BUILDS LARGE-SCALE ALGAE TESTING LAB

# Prospect of green gold?

**Algae have been hailed as the fuel of the future, and as a source of valuable nutritional supplements. Yet although algae cultivation companies are starting up one after the other, it is too soon to talk of an algae revolution. To optimize algae cultivation, Wageningen UR is building a large-scale research facility.**

TEXT HANS WOLKERS ILLUSTRATIONS MIESJEL VAN GERWEN AND WAGENINGEN UR

Look, pure algae oil!' Proudly, Carel Callenbach, director of Europe's largest algae nursery Ingrepro, holds up a small bottle full of light orange fluid against the light. 'This contains lots of omega-3 and -6 fatty acids, making it a valuable supplement in fish feeds.' Algae oil for the fish feed industry is just one of many lucrative products supplied by his company. The range also includes nutritional supplements for sport horses, food colourings and raw materials for bio plastics. According to Callenbach, algae production can be economically viable, even on a limited scale. 'Although we are the biggest company in Europe, we produce on a relatively small scale', he says. Callenbach advocates an approach which sees algae production more as a means than as an end in itself: 'You can make the whole water purification system cheaper and better by using algae which turn nutrients in wastewater into biomass. Those nutrients would otherwise be lost. You can close cycles by breeding algae at strategic

places', he explains.

Algae production company LGem in Made in Brabant is doing good business too. LGem concentrates on producing high-quality ingredients for the nutritional supplement industry and for the production of fish larvae. Production costs are admittedly extremely high, particularly those of the purified ingredients for nutritional supplements, but the market pays high prices for the products. 'We can be happy if we manage to produce for forty euros per kilo. And there are additional costs on top of that, such as for freeze-drying and vacuum packing the algae paste', says director Eugène Roebroek. 'On the other hand, the nutritional supplement market does pay four to six hundred euros per kilo of the dry material.'

### GROWING ON SALTWATER

The hype started two and a half years ago: algae seem to be the ideal biodiesel producers. But this outbreak of green gold fever >

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**RENE WIJFFELS,**  
Professor of Bioprocess  
Technology

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### STRESSED ALGAE PRODUCE USEFUL SUBSTANCES

If you subject to algae to stress, they produce some useful substances.

For instance, too much light puts the plants under stress because damaging free radicals are produced in their cells. Algae react to this by producing carotenes, antioxidants which mop up the free radicals and limit the damage. These carotenes turn green algae orange. It is quite easy to extract them from the algae slurry for use as colourants, antioxidants or nutritional supplements.

Another form of stress is to put the algae on a diet. Algae like plenty of nitrogen, and if you do not give them enough of it, they cannot produce so much protein and resort to making fat, which is stored in the algae cells as small droplets. This fat is particularly valuable as it forms the basis of biodiesel as well as having uses as an animal feed supplement and in the chemical industry.

was of short duration. As it turned out, it did not seem possible to breed the plants at a profit. Slowly but surely it is now becoming clear that producing algae on a large scale can be profitable, as long as other products are extracted from the green soup as well. It was professor Rene Wijffels from the Bioprocess Technology chair group who came up with the idea of extracting valuable substances from algae. Twelve years ago, Wijffels hit on the plan of breeding algae in special reactors. ‘I was not finding enough of a challenge in my job as lecturer. All sorts of promising finds were being made at sea, and I delved into this subject’, says Wijffels. ‘I was particularly fascinated by the fact that you could breed algae with the help of an interesting substrate, namely light.’ Wijffels is convinced that algae have tremendous advantages over food crops. Many species of algae grow on saltwater, so that you do not have to draw on scarce freshwater supplies. Nor do you need any agricultural land, so that algae production neither competes with food production, nor encroaches on the rainforest. ‘But it was still a real battle to get this subject on the map’, says Wijffels. ‘Interest from industry was limited to start with. That changed completely when biodiesel started becoming popular.’ Suddenly there was a lot of interest in algae cultivation, something on which Wijffels’ chair group had by then built up considerable expertise. So when a market suddenly began to emerge, they were ready for it.

### ALGAE CULTIVATION AS A SCIENCE

Meanwhile, algae cultivation has grown into a real science, and both universities and the business world have thrown themselves into the subject. The success of small-scale Dutch algae producers, whose companies are running well, is not going to stop Wageningen UR from building a research facility for algae: AlgaePARC. According to Wijffels, such a facility is needed. ‘Current algae cultivation is relatively small-scale and inefficient’, he says. ‘The companies cater for a small niche market, so there is very little experience with mass production of algae.’ In AlgaePARC, universities and com-

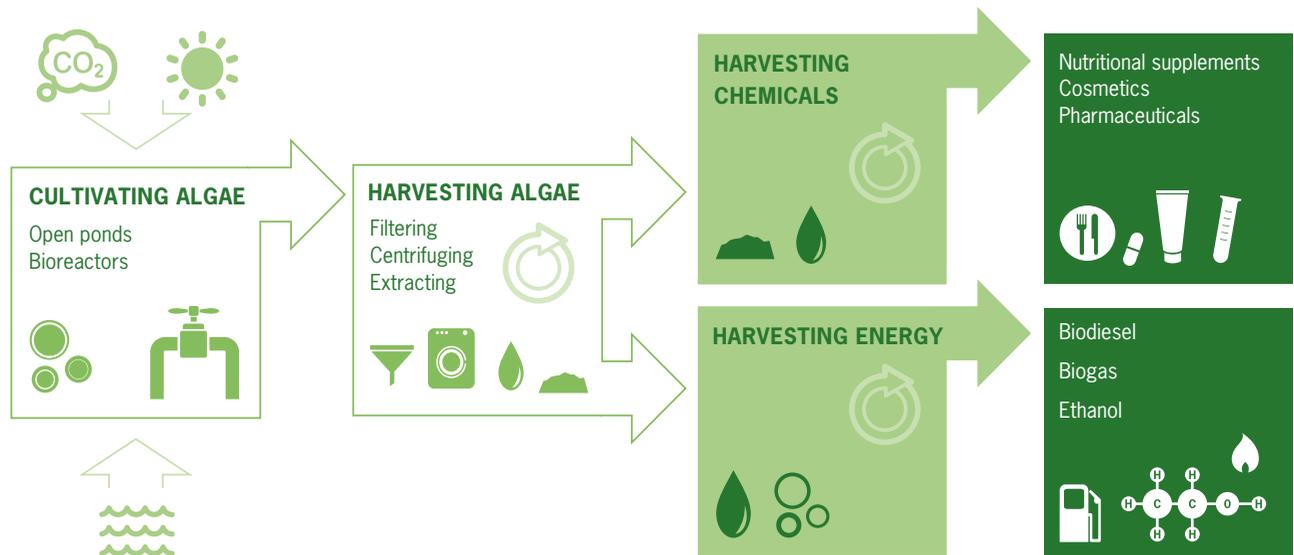
panies will do research on how to optimize algae cultivation. The government and the business world have such confidence in the future of large-scale algae cultivation that they have dug deep into their pockets to set up AlgaePARC. The testing facility will be ready in November. ‘Companies are very eager to join in’, says Wijffels. ‘I think it is going to be a success.’

### LOW COSTS

According to project leader Maria Barbosa, AlgaePARC will bridge the gap between small-scale laboratory research and large-scale industrial production. The Bioprocess Technology chair group at Wageningen University has been conducting lab-based basic research for some years. Its achievements include establishing the efficiency of photosynthesis at different amounts of light and for different species of algae. AlgaePARC is going to conduct tests on a rather larger scale. ‘There is a big market for products such as biodiesel or for ingredients required by the chemical and food industries’, says Barbosa. ‘But little is known about the best way to cultivate algae for low-cost production.’ So at the moment there is not a single production system capable of producing biofuels – which all the hype was about – at a profit. ‘If you use all the constituents of algae biomass, such as valuable nutrients for the food and chemical industries, as well as biofuels, you will be able to run a viable business in the future’, according to Barbosa.

The planned pilot plant is on a relatively modest scale. Four algae cultivation systems currently on the market will be tested. ‘An open pond will serve as a benchmark, because this is what is already being used by companies’, explains Barbosa. ‘We want to compare it with two types of tubular system with different numbers of layers of horizontal tubes containing algae, and with a system which uses vertical plastic double membranes with the algae in between them.’ Each system has its own limitations. For example, the gas exchange in tubes can be limiting: excess oxygen builds up while there is too little CO<sub>2</sub> available for the algae.

## CULTIVATING ALGAE FOR ENERGY AND RAW MATERIALS



It is also easy for the algae to be exposed to too much light. 'A single layer of horizontal tubes captures a large amount of light, but that can hamper the growth of the algae', explains Barbosa. If you place several layers of tubes on top of each other, you reduce the light intensity by thinning out the light, as it were, and that is good for the algae. It also means you can fit in more tubes per square metre. And in the membrane system, gas exchange goes better.' Running the testing systems throughout the year makes it possible to gauge the amount of biomass that algae can supply on a yearly basis. Barbosa: 'This gives researchers more insight into the various parameters influencing algae growth, and helps us arrive at an objective norm.'

### PUMPING AND AERATION

The launching of the AlgaePARC will give algae research a real boost. With a cost price of at least four euros per kilo, producing algae is still an expensive business. 'Costs will have to go down by a factor of ten.' Cost savings on this scale can only be reached if you are able to work more cheaply and efficiently in several areas. Wijffels: 'Pumping

and aeration use up quite a bit of energy, and that can probably be brought down. You can also achieve something by automating the system and using cheaper materials – foil instead of glass, for example.' Wijffels thinks he can do this by making good use of technical experts. 'Production companies have often been started by biologists who did not understand the technology', he explains. 'From the start, we have had technicians to

develop and optimize the system, and that is something we are certainly going to go on doing.'

Project leader Barbosa sees a rosy future for Wageningen algae research. 'AlgaePARC is just the start. We aim to grow and to establish optimal algae cultivation systems elsewhere in Europe too. In so doing, we hope to become the European centre for algae cultivation.' ■

### ALGAEPARC

Building only starts this summer, but Wageningen University's planned research facility for algae cultivation is to be up and running within six months. The complex, covering about 700 square metres, will be near the Wageningen campus. The Process Technology chair group at Wageningen University will collaborate closely with Food and Biobased Research, part of Wageningen UR, as well as with the business world. The partners will experiment with four different systems

of algae cultivation to gain a solid knowledge of efficient, large-scale and economically viable algae production. The building costs for AlgaePARC, more than two million euros, will be covered by the province and the Ministry of Agriculture, Nature and Food Quality. Research costs for the first five years, amounting to at least four million euros, will be paid out of the Dutch government's profits from natural gas and contributions from the business world.