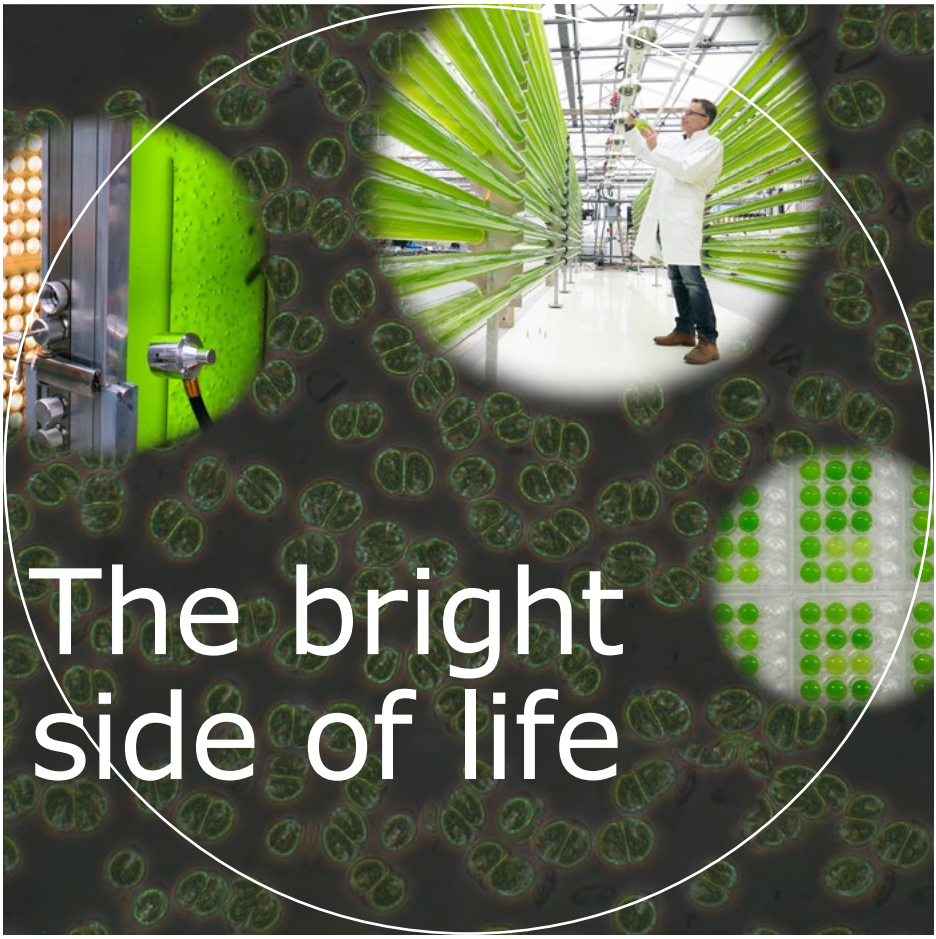

The bright side of life

Prof.dr Maria J. Barbosa

Inaugural lecture upon taking up the position of Personal Professor of Microalgal Biotechnology at Wageningen University & Research on 26 August 2021

WAGENINGEN
UNIVERSITY & RESEARCH

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DOI https://doi.org/10.18174/559704
ISBN 978-94-6447-055-0

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The bright side of life

Mr. Rector, Colleagues
Dear family and friends,
Ladies and Gentleman,

Fernando Pessoa, a famous Portuguese writer, left behind "O livro do desassossego", "the Book of disquiet", a collection of thoughts from the author. Not always bright, or positive, but his thoughts. Occasionally I randomly open it and read what's on that page, I did so when I started preparing my inaugural address 1.5 years ago, and this is what I took out from the page I opened:
"Vive a tua vida, não sejas vivido por ela",
"Live your life, don't be lived by it"

This might sound a cliché, but it is not. We often remain in our own comfort zone, afraid to change, to step in the unknown, to be amazed by the simplest things in life.

We are going through disquiet moments

a pandemic, explosive population growth presses on food production, with consequences to nature, deforestation, depletion of the oceans. Nature strikes back. Hunger and malnutrition exist, societies are polarized, there is more chaos.
It is now the time to step out of our comfort zone, to think outside the box and dare to change.

University plays a central role in our society. Science and education can create hope for the future with new technological innovations, bring balanced opinions supported by facts.

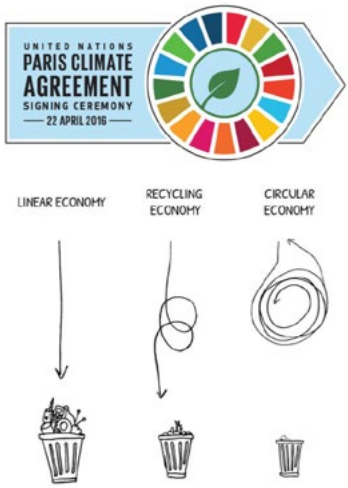
My family tells me that I am a true image of disquietness, I move, I change, I keep searching for the unknown and to be amazed. This has brought me to Wageningen and to this stage. Some of my colleagues will miss the numbers, but my intuition says that Wageningen must have one of the highest population densities, of people wanting to make a better world

I feel humble and proud to make part of the scientific community as a Professor at Wageningen University and Research.

Past, travel and future

I have had different roles in my professional life, just like all the characters from Fernando Pessoa, who had 3 pseudonyms. These roles were never a goal but a result of my questions and searches, what I stand for and believe, a logical sequence of my

steps in life.
With many doubts, insecurity and determination, I have followed my heart and intuition with a vision in my head.
Today I want to share with you the vision and journey which brought me here as well as the directions I will take in the future. The exact journey I can only reveal in my farewell speech as I hope to travel with serendipity and be amazed throughout the journey, with wonders that science can give us.

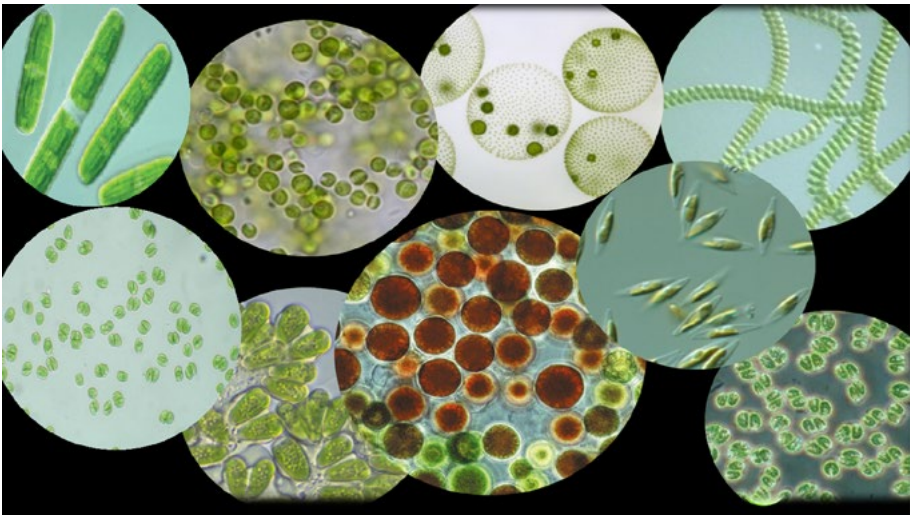


The existence of hunger and malnutrition in the world, and the ambition to find solutions made me fall in love with microalgae in 1995, during my Master study in Portugal. For me, photosynthetic microorganisms were and are a weapon to fight against hunger and malnutrition in developing countries. Historically, there were examples of its use as food by different civilizations such as the Kanembu in lake Chad, Aztecs in Mexico. Microalgae are rich in proteins, essential lipids, and micronutrients such as iron, iodine, zinc and precursors of vitamin A. These nutrients lack in the diet of millions of people suffering from malnutrition.

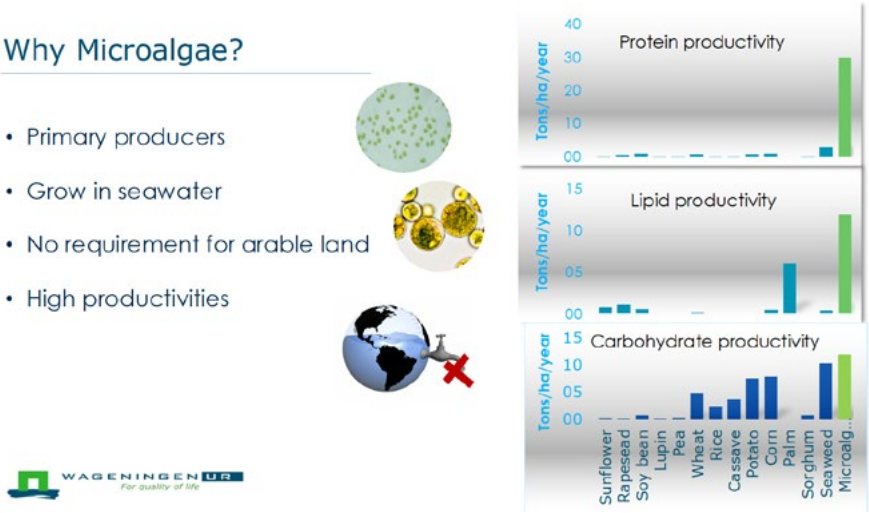
There is no brightness without darkness

While in many countries hunger and poverty is the daily reality, the western and rich societies are depleting nature for their own comfort and luxury, and I believe most of us contribute to this without even realizing. We need to be more conscious on our "manufacturing world". Consumption patterns must change, food chains must be shorter. Industry needs to move to simpler processes, using sustainable resources and producing zero waste. We are in a transition period from a linear and fossil-based economy to a circular and biobased economy. This transition is urgent to be able to reach the United Nations sustainable development goals and the Paris Climate agreements. Each one of us has a role in this change and can make a difference.

An urgent and short transition, which needs to be based on different solutions. We need to embrace diversity in this transition.



Microalgae, these bright microscopic photosynthetic microorganisms, are one of the solutions. These microorganism can produce a variety of products in need by our society in a sustainable way: biomass with high nutritional value, proteins, lipids, minerals, vitamins and pigments.



The beauty of the process is that microalgae only need light, seawater and carbon dioxide, a greenhouse gas, to make these products. The biomass productivity per ground area can go up to 30 times higher than landcrops, depending on the crop. They do not need fertile land, as agricultural landcrops,
or sugar, as most microbes in the biobased industry.

In our work, we create knowledge and technology to enable applications of these photosynthetic microorganisms in our society in different ways:
To provide nutritional food to combat malnutrition in places where agricultural activities are limited,
to replace present unsustainable oil sources such as palm oil, which is causing deforestation, or fish oil which is depleting the oceans,
and providing a new source of nutritional proteins, required to cope with the growth in population.
Microalgae are after all the primary producers of these compounds.

I will take as example the omega-3 polyunsaturated fatty acids EPA and DHA, a familiar product, on which we have been working for many years to make the autotrophic production more efficient.
These omega-3 fatty acid are essential nutrients with well-established health benefits. The demand is growing with the increase in population and increase in aquaculture. Aquaculture accounts for 50% of the world fish production and is estimated to grow up to 70% in 2050. EPA and DHA supply is presently almost 100% derived from fish. Besides leading to depletion of the oceans, it does not meet the demand, based on recommended intake and growth ambition of the aquaculture sector.
In nature, microalgae are the primary EPA and DHA producers. They are consumed and accumulated through the food chain to give the high levels of EPA and DHA that we find in marine, oily fish.
Strangely enough, this oil is still the main dietary source of these omega-3 fatty acids in the human diet.

But we do not always need to take the long way home as sang by Tom Waits.

In the 90's when I started working with microalgae, the scientific community was very small and polarized. There were the bioprocess engineers and the cellular and molecular biologists, using different model organisms.

The engineers focused on the development of new reactor designs, mass and light transfer and process strategies, using strains that could be grown outdoors. At that time the few existing pilot scale reactors were very handicraft. On the other side, the biological and molecular work done for understanding cellular processes and optimizing photosynthesis, carbon capture and utilization, was done with model microalgae such as *Chamydomonas,* with no industrial relevance.
Despite working on the same goal: efficient conversion of light into biomass and products by photosynthetic microorganisms, these communities never came together.

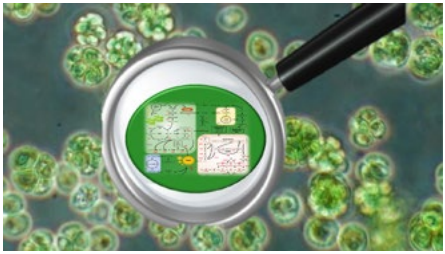
For me, there was a world to be discovered, expertise's to be integrated and a technology to be developed and implemented.

I came to Wageningen as a PhD student in the Bioprocess Engineering group to work on the scale -up of photobioreactors. It was a group of pioneers: my promoter Professor Hans Tramper was a pioneer in biotechnology, on education and research, and my co-promoter, Professor René Wijffels was at that time pioneering a new group on Marine Biotechnology.

This was a very important period for me, I learned 4 things that I would like to share with you

One. Engineering tools can be used to simplify complex questions
Two. I can do much more than I ever thought I could. Thank you, René, for believing in me and for making the right questions. Your trust, freedom, direct feedback and good laughs were fundamental for me to be able to travel further.
Three. A PhD thesis is a small step forward in science, but an important step for a young scientist. I learned that the world will not be changed by one big, extraordinary step, but instead by small steps, done in an extraordinary way, with belief and enthusiasm.

The last thing is somewhat practical but not less important. "Never allow 4 hands at the same time on one photobioreactor". Thank you, Marcel Janssen, colleague and friend, you had back then and still have an important role in the development of this field at Wageningen University. Your practical tips are very handy, but your knowledge on light, growth and photosynthesis of microalgae are essential in the microalgal biotechnology group.



Industrial production of photosynthetic microorganisms was almost inexistent. It was clear that efficient cultivation systems, at minimal energy requirements and costs, needed to be developed. It was also clear that this had to be done in close collaboration with the development of industrial strains that can be productive in these systems under dynamic conditions as found outdoors. You should imagine a photobioreactor with a small cell factory inside, living in balance and harmony in a certain location. Like a couple, there should be a perfect fit between them and with the location they choose to live in.

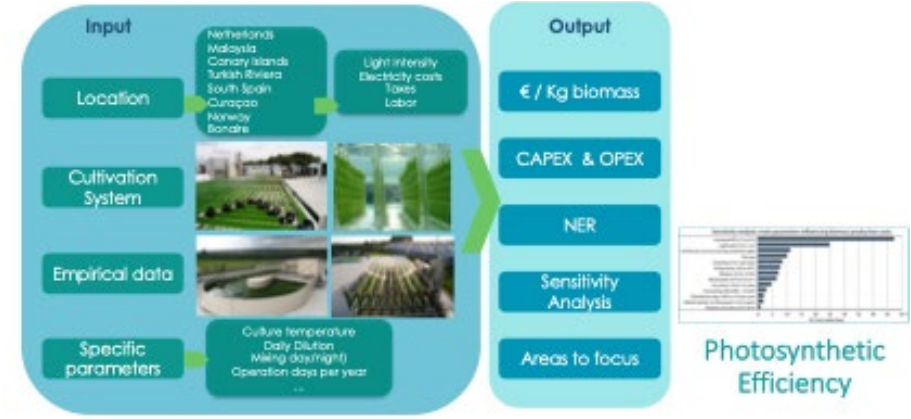
I truly believe in a holistic approach, with space for specialists and generalists, biologists, and engineers. To innovate and have an impact in society, multidisciplinair approaches are needed. In this specific case expertise's in microbiology, genetics, biochemistry, and bioprocess engineering had to come together to move the field forward.

As a storyteller, I will go through a few of the most exciting and innovative work we do and our ambitions:

But before doing that I would like to address all my past and present PhD students. You are all different and all equally special to me. As I have written you, you are part of this professorship.
I am very proud of you as all of you have been, or still are, in the process of searching for the unknown, making discoveries that no one else has done before you, and working as a team and supporting each other. And I can only thank you for the trust you give me to guide and mentor you in this process. You are the bright side of my work!

Techno-economic model

In 2007 I did a techno-economic analysis on algae production, which is being continuously revisited and improved up to date, and is on the basis of our research program. Several PhD students have used and improved this model.

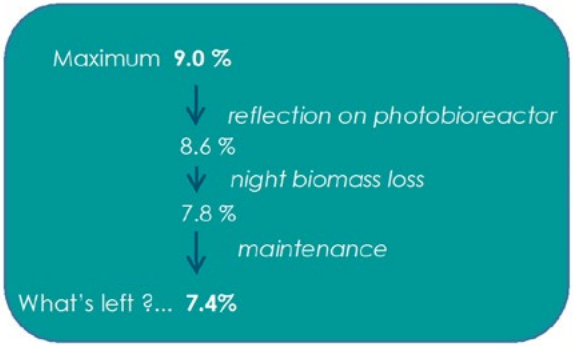


A techno-economic analysis is an engineering tool to understand complex problems. This helped us to identify the bottlenecks in the production and biorefinery of microalgae and generate important research questions at both engineering and fundamental levels in order to develop a sustainable and economically competitive process.

Besides technology, geographical and social constrains are also key parameters to determine production costs. This model presently comprises 10 countries, from Norway to Portugal, resulting from several collaborations. Economy of scale was studied: from a small greenhouse with 100 square meters (m2) algae production to locally feed bivalves, **up to** 100 hectares outdoors, for replacement of fish and palm oil. The largest reduction in costs is obtained from scaling up from 1 to 10 hectares.

Photosynthetic efficiency

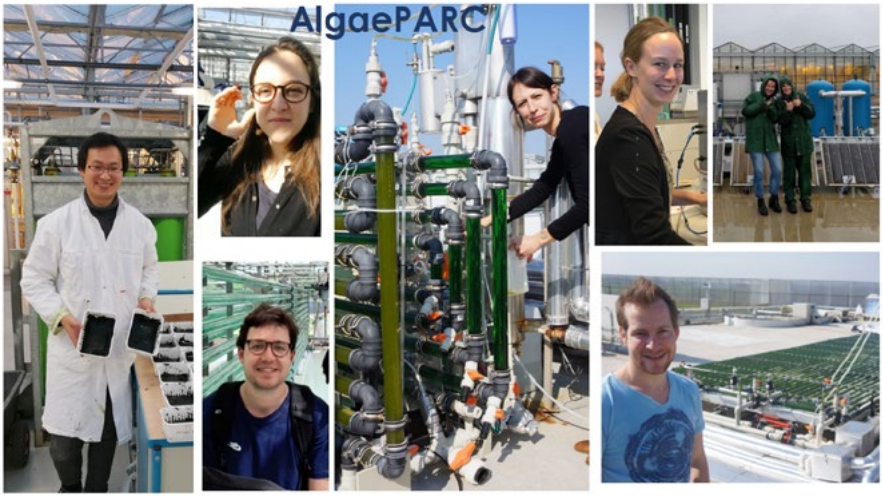
Photosynthetic efficiency is the fraction of light energy converted into chemical energy. This parameter clearly stood out as being the most important to reduce production costs. In theory a maximum of 9% efficiency on sunlight can be obtained. But in practice this value will be lower due to physical and biological constrains, like light reflection on the reactor, night biomass losses and cell maintenance. We believe that in practice 7.4 % could be achievable.



We started simulating outdoor light conditions in our safe lab environment. A maximal photosynthetic efficiency of 6.5 % was achieved, while simulating the light falling on a vertical reactor in one summer day in Spain. This was a fantastic result.

But this was still the lab… outdoors there are many other parameters with impact on this number; temperature, wind, clouds, just to name a few.

AlgaePARC was established by our group in 2010 and since then it has been used by many PhDs.
AlgaePARC is a unique pilot scale photobioreactor infrastructure which was launched in 2010 with a large research programme in collaboration with 19 industrial partners, with the goal to translate fundamental research to application and validate



findings at lab scale. This was innovative and very exciting.
In parallel we also pioneered in education, with the introduction of courses on microalgal biotechnology at MSc and PhD levels, using a design approach. The MSc course Microalgal Biotechnology and the graduate course on microalgae process design: from cells to photobioreactors, are very successful and highly rated by students and the scientific community.
A new technology needs educated professionals for implementation in society.

Wageningen University had the first industrialized microalgae pilot facility in the world: AlgaePARC. This allowed us to study engineering principles and develop

process strategies, for the first time in an automated and industrially relevant environment. AlgaePARC enables us to implement basic research rapidly at higher Technology Readiness Levels. This resulted in better collaborations with industry and gave our research impact. We were pioneers and AlgaePARC made us unique, opened doors to many new collaborations but also showed the complexity of scaling-up this process efficiently.

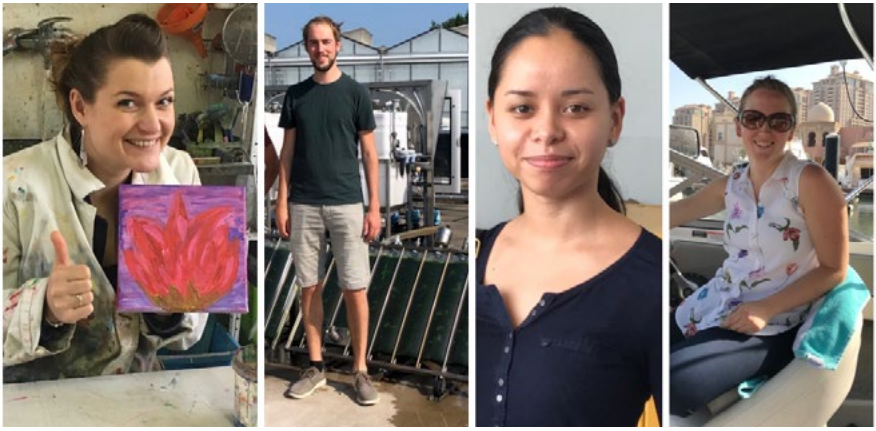
The gap

Photosynthetic efficiencies obtained outdoors were much lower than the 6.5% obtained in the lab. Depending on the reactor configuration, it ranged from 1 to 3%. It was all not so simple: biofilm formation, contamination, climatological changes. There was one important parameter that needed to be included in the formulae: the strains. Different strains cope differently with environmental conditions.
Unlike in nature, many conditions in photobioreactors can be well controlled, but at investment and energy costs. This raised the question: can we select, adapt, evolve or engineer microalgae strains with industrial relevance, to make them productive under the desired conditions?

Industrial microalgal strains need to be productive under dynamic conditions.
It is a complex system, a factory: the cell, in a reactor, subjected to varying conditions outdoors.

Dynamic conditions

Light, temperature vary in time, think of day-night and seasons, but also in space. Gradients occur in photobioreactors: light gradients exist as cells close to the light source absorb most of the light, leaving limiting or no light to the remaining cells further way from the light; oxygen gradients take place in long tubular photobioreactors. Microalgae need to be robust to best perform under these conditions, to avoid intensive temperature control and mixing, and in this way, decrease energy requirements.



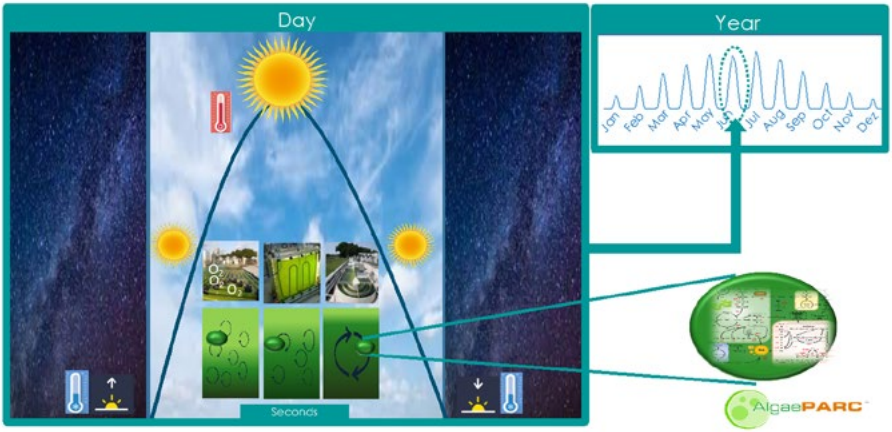
Gradients in time and space

Most microalgae have optimal growth temperatures between 20 and 30 degrees. Culture temperatures in the reactor, can go up to 50 degrees in the summer, especially in southern sunny countries. This means that intensive cooling is presently required,.

We have isolated thermal resistant strains in Bonaire and Qatar, the last in collaboration with Qatar University. We started with a mix of strains collected from nature and isolated the fastest grower under industrial relevant conditions chosen by us.

After characterization of the Qatari strain, *Leptolyngbya s*p, we scaled up the process in Qatar to pilot scale.

We were able to achieve 60% higher photosynthetic efficiencies outdoors in Qatar with the new strain, in comparison to the values measured with our model strain *Nannochloropsis sp.* in the Netherlands, cultivated in similar systems outdoors.


Day
Year
Jan
Feb
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May
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Jul
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Oct
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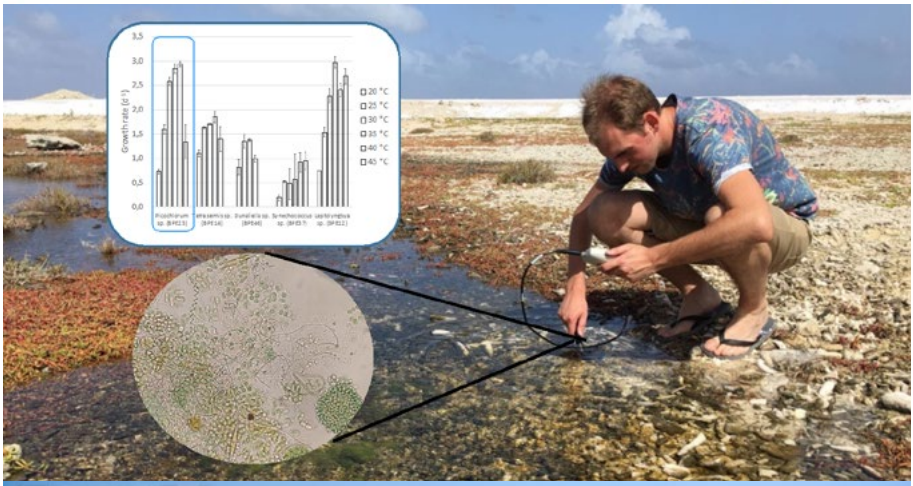
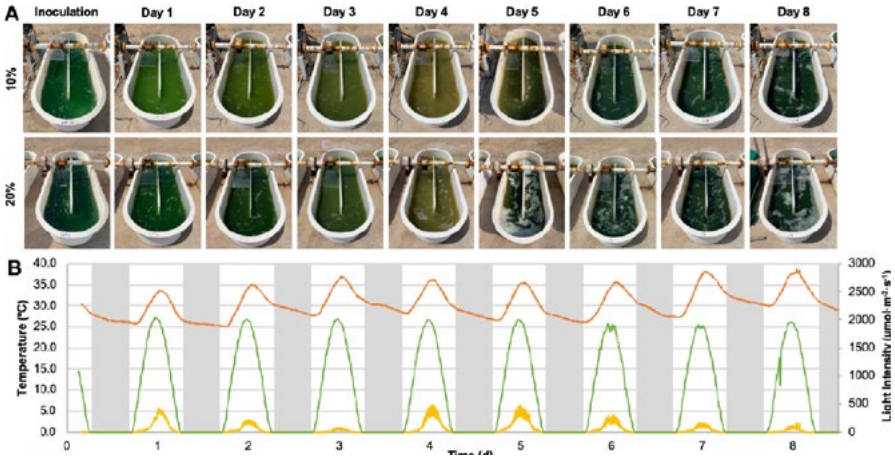
Seconds
AlgaePARC

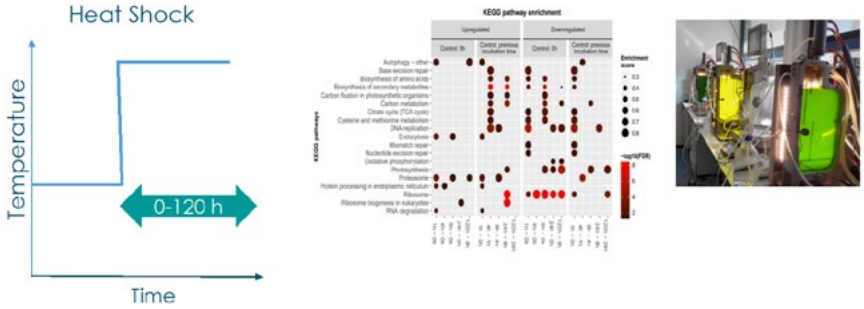

Growth rate (d⁻¹)
20 °C
25 °C
30 °C
35 °C
40 °C
45 °C


QATAR UNIVERSITY

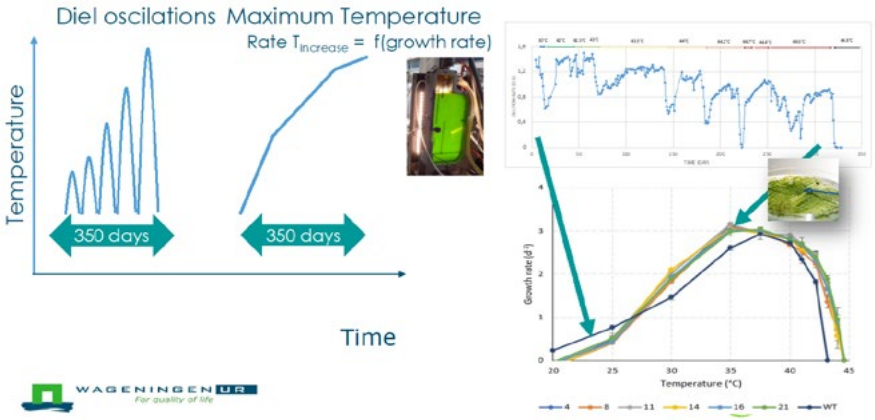


Response, adaptation and evolution

With the strain selected from Bonaire, *Picocchlorum* sp., we are presently studying how cells respond to dynamic conditions at different time scales, hours, days and years. We want to understand whether they adapt or evolve, what determines it, and what are the cellular mechanisms involved in the process.



We followed the cell response after increasing the temperature to 4 degrees above optimal growth temperature. This led to immediate cell cycle arrest and a heat shock response. Various regulatory and chaperoning mechanisms were upregulated to protect the cells from heat-induced cell damage within the first 8 hours. This immediate response was followed by a second acclimation period of 120 hours towards a new homeostasis phase. Photosynthesis, carbon fixation, ribosomal activity, and central metabolism were downregulated to reduce oxidative cell damage. At the same time, pigment and fatty acid cell content increased significantly, resulting in decreased growth.



Long term, one year evolution experiments have been done in two different ways, by continuously increasing the daily peak temperature and by slowly increasing the temperature above the optimum. This has led to an increase of the maximum tolerated temperature by 2.5 degrees Celsius. We are now searching for changes in the genome which could explain this new phenotype, which we showed to be stable. This is still ongoing work, done in collaboration with Harm Nijveen, from the bioinformatic group in the plant science group.
With this work we want to decipher the cellular strategies for thriving under fluctuating environmental conditions.

Oil production

In contrast to biomass and protein production, lipid production is extra challenging as large quantities of lipids are produced only under conditions which impair growth, such as nutrient limitation and starvation.

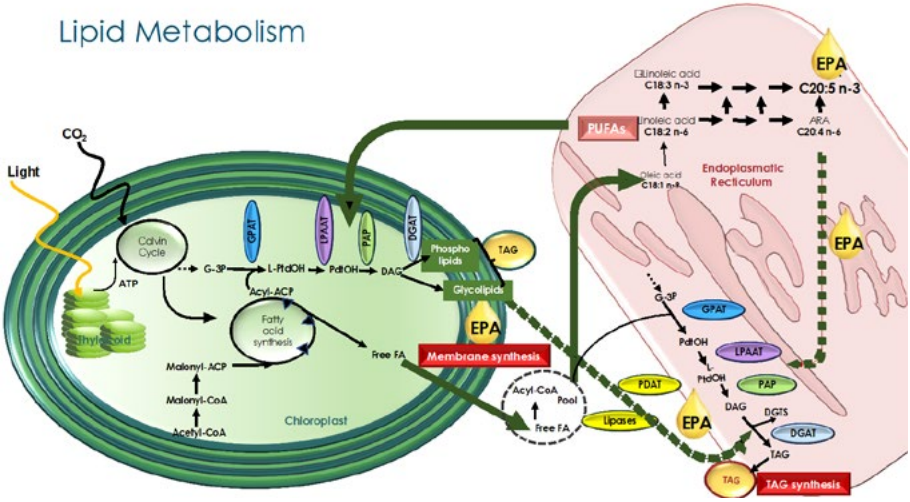
We have developed process strategies to improve lipid production in photobioreactors and we have studied lipid metabolism and reshuffling under dynamic environmental conditions.
In the last years we have studied lipid production and lipid metabolism in *Nannochloropsis*, which is a microalgae that can be grown outdoors and is presently used in aquaculture. This strain produces and accumulates the omega-3 fatty acid EPA in the membranes of the chloroplast during growth.

Oil accumilation: nitrogen starvation

Under nutrient replenished conditions, cells use most of the energy absorbed to grow. But under nitrogen starvation, cells can accumulate up to 60% of triacylgycerols in oil, at the cost of growth. They do this to store energy; light energy still comes in, the photosynthetic machinery is still active but since the cells do not have the nitrogen required to grow, they funnel the energy into lipids.
Nutrient deprivation, as well as dynamic temperature and light lead to lipid remodeling in the cell. How exactly the remodeling is regulated and done at molecular level is not known. We have made the first steps in this direction by demonstrating that during nitrogen starvation there is intact translocation of EPA from the chloroplast membrane to the oil bodies, but there is also *de novo* synthesis of EPA and carbon reshuffling.

Lipid metabolism

We aim in the future to get more insight in the mechanisms and regulation of lipid remodeling during dynamic conditions and nutrient deprivation.
Increasing lipid productivity relies both on strains with enhanced photosynthetic machinery and carbon partitioning towards the lipids of interest, and on photobioreactors able to intercept all sunlight while ensuring high photosynthetic efficiencies.

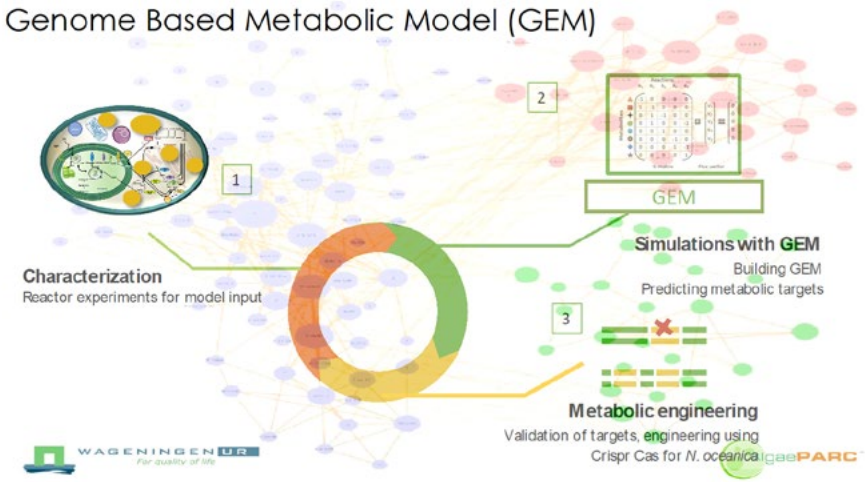


Strain improvement

We initiated research on strain improvement
Initially, using mutagenesis, adapted evolution and selection. Based on single cell technologies and *in vivo* lipid staining, we isolated cells with double lipid productivity. By coupling long-term temperature adaptation with single -cell selection, we isolated cells with higher tolerance to a wider range of temperatures.

More recently, we have developed an expanded genetic engineering toolbox for *Nannochloropsis oceanica*, in collaboration with Prof. John van der Oost.
Sarah D'Adamo joined the group in 2018 to further develop the research line on genetic engineering of microalgae. We have identified relevant genes for increasing lipid production, we have discovered a highly efficient gene expression system that employs RNA polymerase I for transcription. We further developed different methods for CRISPR-Cas12a genome editing, using either ribo**nucleo**protein delivery, or transformation with episomal plasmids and we have shown that these

methods can be used for multiplexed and marker-free gene disrupting. In addition, we implemented a Cas protein-based tool for gene silencing. All this for *Nannochloropsis oceanica.*



When you hear me, you might picture many scattered pieces of research, but that is not the case. They all have its own place in the puzzle.
The collaboration with Professor Vitor Martins dos Santos and Dr. Maria Suarez Diez interconnects part of these pieces, presently at cell level. In collaboration, a genome base metabolic model is being developed, once more for *Nannochloropsis oceanica.* With this model, we can make predictions of the impact of genetic modification on

cell physiology and yields. Such a model requires extended knowledge and data on the physiological response of the strain to different conditions, which can be obtained in highly controlled photobioreactors. The model predictions can be verified using the genetic tools which are in development. Genetics, microbiology, process engineering, systems biology come together in an iterative and meaningful way.

I value the team above productivity. Christian, Mihris, Narcis and Sabine. You have shown the power of a team, you shared experiments, data, protocols, scripts, discussed results and experimental set-ups. Your work as a team includes genetic engineering, process optimization and genome base modelling. You have made steps forward in the field in an extraordinary way.

Future

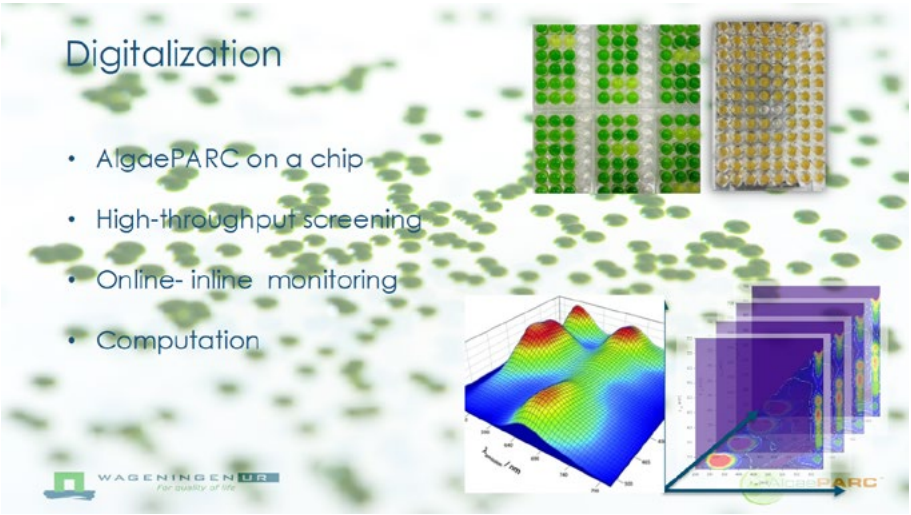
And what lies ahead? where do I want to go, besides continuation of the existing research lines?

Recently, Professor Dolf Weijers invited us to join a Gravitation proposal coordinated by him and submitted to the Dutch National Science Foundation (NWO) earlier this year. This proposal has a very fundamental character and seeks to give an answer on how multicellularity and complexity emerged in plants. Land plants evolved from algal ancestors, which are still among us and could help us find how this process took place. Our expertise on cultivation and genetic engineering of microalgae can contribute to answer this question. The consortium is a true example of multidisciplinarity. I am grateful to you Dolf, even without knowing if it will be granted, for the fantastic process next to the science. You brought together a very

diverse group of scientists who did not know each other: algal and plant biologists, ecologists, theoretical biologists, evolutionary biologists, bioinformaticians, and technologists. You initiated the bridges and let us discover the strength of the consortium and of each expertise, as well as the links between us. I look forward to hearing the outcome!

Digitalization

Many methods and technologies to acquire information have been developed in the last decade, leading to an increased complexity. The generation of large data sets is useless unless transformed into useful insights. Data Science, applied to the life science domain, is an emerging field. Digital twins, artificial intelligence, machine learning for data driven approaches might now sound buzz words, but the field is shaping and will claim its place in the development of bioprocesses. This will increase efficiency of existing processes and will enable fast process diversification. To allow this development in algal biotechnology, high throughput cultivation technologies still need to be developed for photosynthetic microorganisms to generate large data sets at a fast pace. Light represents a challenge and the scientific community in this field, despite having increased exponentially in the last years, is still small in comparison to white biotechnology and biopharma.

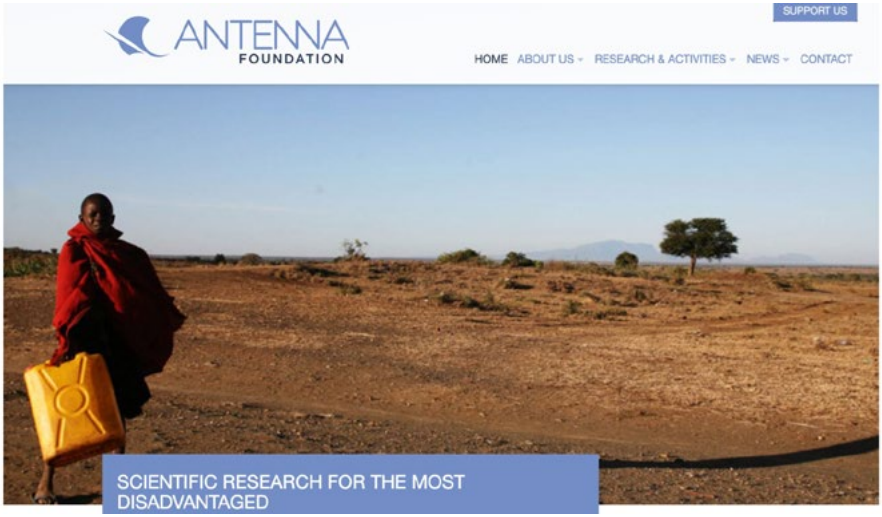


I would like to navigate the group in the development of AlgaePARC on a chip, microreactors with non-invasive online monitoring for high throughput analysis of growth kinetics and cell physiology.

The first discussions and attempts for collaboration in this topic, have taken place with Professor Aldrik Velders from NanoBioTechnology, and with Professor Vitor dos Santos for data computation.

Our digital life

With excitement I say that the field needs to enter the digital world. We, working at the university also have been forced to enter this world in the last 1,5 years. It is remarkable what we now can do in a digital world, things for which 1,5 years ago, we had to travel an entire day for.
Our adaption is fantastic, or did we evolve?
We can now be in several countries, conferences, meetings on the same day. Once Prof Willem de Vos advised me not to keep too many balls in the air, this is a big challenge at the moment. I do see fatigue due to marathons of online meetings. Life got digitally very fast, more efficient but also more flexible. So, there is a bright side to it. But two weeks ago, when I walked through Wageningen I could not keep from smiling with joy when I saw the students together during the introduction week. Somethings may not remain digital.



18 years ago, I wrote the following sentence as one of my propositions in my PhD thesis: “While developing countries urgently need help and technology transfer from industrialized nations to tackle infectious diseases, starvation and malnutrition, pertinent research often looses track in the developed world, which ends up facing only challenges of its own”

I started doing research on microalgae to combat malnutrition in developing countries. I want to follow this dream, develop simple production systems and processes based on local resources, in collaboration with NGOs, with FAO. I want to initiate education and training programmes to stimulate the development of this technology. In the last years I have worked mostly on western high-tech technologies. The knowledge gained will be of relevance to close the circle and return to my initial motivation. The first steps have been taken with the Swiss NGO Antenna Foundation and with FAO on aquaculture.
Antenna is active in local production and distribution of Spirulina, a microalga of high nutritional value in developing countries. Our first collaboration was on the development of a simple production process for Spirulina with low-cost resources. We are now exploring funding possibilities in the Horizon programme.

AlgaePARC has set Wageningen University and Research on the map for microalgal production and biorefinery and plays a central role in establishing this value chain, since it is at its start. It is now the moment to further extend the research in collaboration with other science groups and chairs.
In depth characterization of microalgal biomass components on functionality and nutritional value, prototyping, health studies, sensory analysis, consumer, and market studies are essential for implementation and impact.
Discussion and attempts for collaboration with Professors Karin Schroën, Luisa Trindade, Vincenzo Fogliano, Geert Wiegertjes, Jean-Paul Vincken and Emily de Vet are ongoing.
My ambition is to have a shared strategy on microalgae biomass research at Wageningen University and Research and to bring fundamental and applied research within the whole microalgal value chain together, from production to consumer.

Contrasts & Diversity

Where there is a will, will there be means of funding? This is a challenge many scientists face at the moment, the competition is very high, and the "I" is overrated. The Tenure track system is set op individualism while science with impact entails collaboration.

Our tenure tracks are asked to excel in all fronts: leadership, management, education and research. Standardization takes over contrasts and differences, while we claim for biodiversity and inclusiveness. Contrasts and difference create balance, in and beyond science.

Activities which do not punctuate in the Tenure Track, are set at the end of the long priority list, if ever included. Public outreach, art and science, primary and secondary education are nice to have "extra-curricular" activities, in a society where time is the new luxury.

Together with my colleagues Rick Wieggers, Snezana Gorzic, Wendy Evers, we have been involved in several "extra-curricular" activities, we have been working and will continue working with artists to set up exhibitions to bring our research close to the large public, to instigate curiosity in our work and microalgae in general: in the exhibition "Future Food" at NEMO, the science museum in Amsterdam, in the IJssel biënnale with a floating reactor, in the "Panacea" project with Arne Hendriks, a resident artist at Wageningen University and Research within the protein transition programme.

The Art & Science MIR project at Campus, in which Professor Marten Scheffer and myself were involved, confirmed once more that scientists and artists share creativity, the desire to create and explore the world around us. It can be knowledge, technology, a piece of art. They both encounter similar problems of serendipity and failure. In the work of Lenneke de Groot, the artist in the slide, with whom we worked, I saw structure in chaos, transformation; many paths, many colours, from microalgae, solid and fragile structures, all changing in time. I saw harmony in transformation. I relate this to our own work, with so many research questions, the importance of serendipity, the chaos before equilibrium, the versatility of microalgae and transformation of the scientific field in time.

As scientists in modern times, we need to do our best not to get lost in long to-do lists, and give ourselves time and space for creativity, to do what gives us the most energy.

Science, art and music are a trio in harmony. We have a Rector that plays the Saxophone, I literally take an electric piano with me on holidays in the impossibility of moving my grand piano.

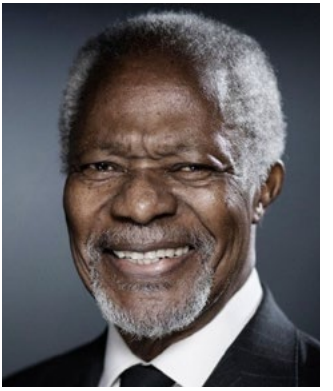
This year, the opening of the academic year is brightly entitled “Crossing Boundaries”, where science and art will be the main theme. I look forward to it.

Education

Education is completely different than what I experienced, I mostly learned from textbooks, which I must admit, was often very boring.
The new generations have access and can deal much better with large information and data sets and are stimulated to critical thinking. Our job at the university is to inspire the new generations on nature- based and inclusive solutions. We are involved in several activities in collaboration with the Wetenschapsknooppunt, a National Network bringing science to primary and high schools, and the Food Valley. High school projects and design classes have taken place at AlgaePARC, we organized the children University this year entitled "Green gold of the future". The enthusiasm, amazement and curiosity of the young children aged between 10 and 12 was worth all time invested.

I cherish and clearly remember the day I met Kofi Annan, someone I admire. He gave me his hand, looked me in the eyes and said: "You will be the leaders of the future". With "you" he meant young people. This had a great impact on me. We need to include the young generations in our outreach, even at cost of productivity.

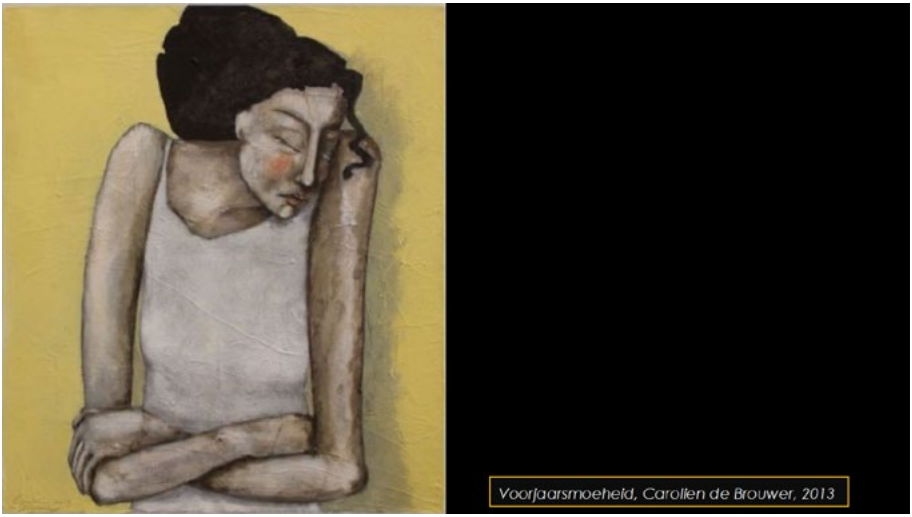
It is difficult for me, as an engineer to make this statement but "not everything can be translated to numbers".



Kofi Annan

In our job, training and mentoring of young students and scientists is a duty and a privilege.
On my back you see a painting from an artist and dear friend, Carolien de Brouwer, whose strength and fragility, determination and tiredness I admire. This painting is called “Voorjaarsmoeheid”, in English, “Spring fatigue”. The yellow background stands for cheerfulness, freedom, motivation, which is in contrast with the feeling of fatigue and introspection reflected by the woman.
To the younger scientists, in particular, to young female scientists I would like to leave a special message: the secret for success is not to never fall, but to fall and stand up. It is human to feel insecure, to fear not to be up to what we think is expected from us.
If you think that the grass from your neighbour always looks greener, maybe it is time to paint your grass red. Observe, listen, discuss, ask for feedback but follow your path, dare to be yourself.
The bright side is you and all you can do, each one of us has a unique talent, which is waiting to be discovered.

To all women here today, in this room and watching the life stream. Dare to be yourself, it is all it takes!



Travelling together

Throughout my journey in science, I travel with many people.
Young, old, students, professors, laymen and women, children, of different genders, nationality and believes, had an impact in me as a person and as a scientist.
One cannot separate the person from the scientist.

Before closing, I would like to play tribute to those travelling with me

To those who inspired my professional life:
Willem de Vos. Willem, you are the fastest and sharpest person I have ever met. Your coaching was essential for me to get here, you helped me to stay focused and have the targets clear in mind.

Mario Tredici, the godfather of microalgae. We remained in contact since my Master thesis in 1997 in Florence. You stimulated the field to grow into a mature scientific and industrial community. You were the one giving me the contact of a good engineer who was starting in the field of Microalgae at Wageningen University. Thanks to you I am here today.

Hans Tramper, your pioneer work in biotechnology was world-wide recognized and opened many doors after my PhD.

Gerrit Eggink, your support and advice were very important to me during the time we were both working at Food and Biobased Research. We should still have a farewell party.

AlgaePARC was not built in one day nor by one person. Brenda Israel, we had the most exciting time together. You have the talent to bring the right people together at the right time. Together with René Wijffels, we build the consortium for AlgaePARC with 19 participating companies. I owe my business knowledge to you.

Rouke Bosma, we designed and built AlgaePARC together. Your energy was contagious, your speed was always on HIGH, we worked very hard and we had a lot of fun together. I miss you and I hope you are well.

Dorinde Klenegris, meissie. We look so much alike in so many things, enthusiastic , dedicated, flexible and extremely bad with deadlines… probably that is why we were such a good team. Together, we enriched AlgaePARC with new projects. You found your home in Norway, but our friendship will always remain.

Hans Reith, You are MAGNIFICENT, we are an outstanding coordination team and you are definitely the John Benneman of The Netherlands.

Iago, your creative thinking in project set up and administration is a breeze of fresh air.

Fred, Wendy , Snezana, Sebastiaan, Rick and Rafa , your support is essential for our research

Miranda and Marina, you are the face of bioprocess Engineering. Everything goes through your office. Your make the new students and employees feel at home and you remind us once in a while to stop running and pay attention to each other. Marina, my life would be a chaos without you. Thank you for caring!

And to the ones closest to my heart,

Herma en Dick, jullie zijn als familie voor mij. Herma, je laat mij altijd "the bright side of life zien". Bedankt dat jullie er altijd voor mij zijn!

Carlitos, amigo, Professor Carlos Vilchez, we met in Wageningen in 1999. I was starting my PhD and you were doing a one-year sabbatical at Bioprocess Engineering. Your kindness has no limits, your laughs are genuine. Simply sitting and talking to you about everything and nothing is one of the things I most enjoy doing in life.

Sandra Caldeira, my friend from highschool, university and friend for Live. You have a contagious optimist and energy, which you spread around. You can do everything you set in your head, with warmth in your heart.

Jorge, my life is simple and beautiful thanks to you. You taught me the beauty of simplicity, and of course, of Tom Waits.

Quando olho para a parte da frente da plateia vejo meu porto seguro, a rocha debaixo dos meus pés, a minha fonte de energia. A minha FAMILIA,

Tia Lourdes, Sara, Paulo Patricia, António e Leonor. Obrigada pelo carinho, por estarem comigo, hoje e sempre. Patricia, you are a Phenomenal Woman!

António, irmão, a vida dá voltas e reviravoltas. Eu sei que estás a ver. O teu carinho está sempre comigo e faz-me sentir sempre acompanhada. Espero que te consiga fazer sentir o mesmo!

Pai e Mãe, voces deram-me as ferramentas e o amor para ser feliz. Mãe, em mim vejo a tua determinação e ânsia de viver, o gosto pela música e ciência. Em ti, pai vejo a razão, paciência e tranquilidade que finalmente encontrei em mim. Meus queridos pais, esta é a nossa cátedra!

René, my partner in life, mijn echtgenoot, mijn beste vriend, mijn coach, mijn collega. Je betekent zielsveel voor mij.
Er is nooit een saai moment in onze leven. Samen kunnen wij alles! Ik hou van jou.

Uma e Jelle, eu sou a mãe mais sortuda e orgulhosa do mundo.
Amo-vos daqui até onde nunca ninguém foi,
e de volta.
Vocês serão sempre o meu número 1.

Ik heb gezegd

Prof.dr Maria J. Barbosa

'Microalgae can provide nutritional food in places where agriculture is limited, can replace unsustainable oils such as palm and fish oil and provide proteins to cope with the growth in population. With an interdisciplinary team we create knowledge and technology to make this happen.
This inaugural lecture shares my vision and journey to become Personal Professor in Microalgal Biotechnology, and the directions I will take in the future.
Team, education, interdisciplinarity, society and art are the keywords reflecting my lecture.'

ISBN 978-94-6447-055-0