



CONFIDENCE BUILT  
ON **EXPERIENCE**



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Senior R&D Project Manager

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Biomeet Sessions  
Inovação Biotecnológica ao serviço  
da Agricultura

7 June 2023

**A4F is specialized in the process of  
design – build – operate – transfer  
(DBOT) of commercial scale  
algae production facilities.**

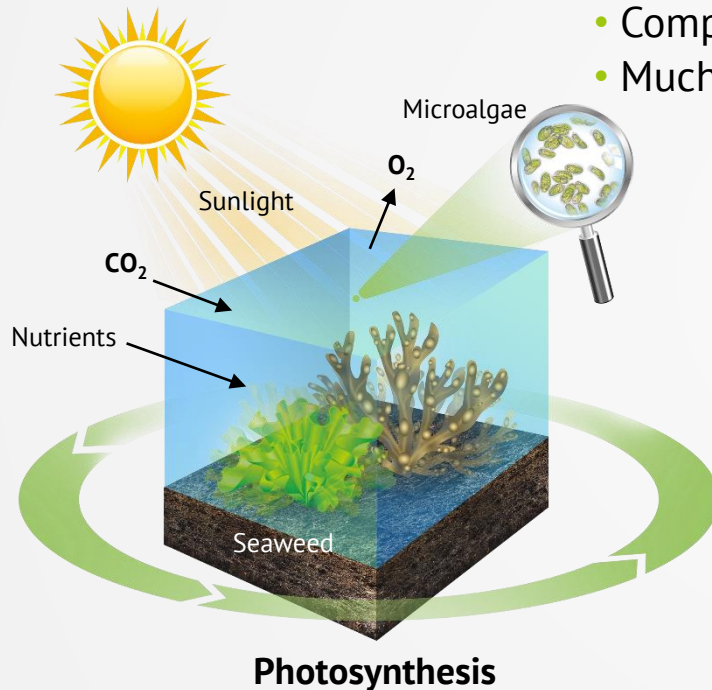
## Similar to agriculture

### No need...

- Arable land;
- Compete with food crops;
- Much water (>90% recycled)

### But need...

- CO<sub>2</sub> (Lots...!!!)
- Daily harvest, ≈ 330 Days!
- Water (fresh or seawater)
- Technology (several...)

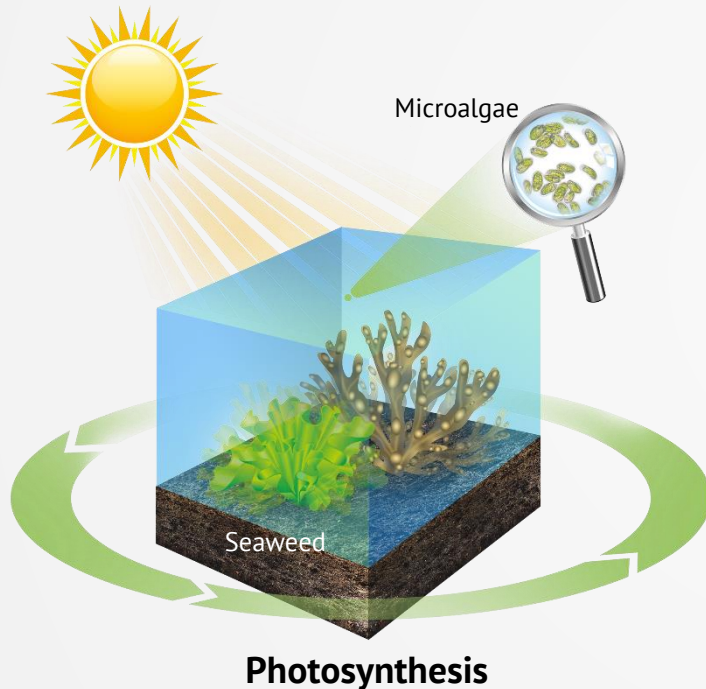


30-100 ton/ha/year  
(autotrophic/mixotrophic)  
more efficient than any other crop



Microalgae on industrial scale: 5.0 g/m<sup>2</sup>/day of protein  
Seaweed on industrial scale: 4.10 g/m<sup>2</sup>/day of protein  
Soya on industrial scale: 0.11 g/m<sup>2</sup>/day of protein

## Microalgae & Seaweed



### Protein

Essential amino acids (profile similar to food)

### Polysaccharides

Starch, glucose, alginates, agar, carragenan

### Pigments

Chlorophyll, carotenoids, astaxanthin, phycobilins

### Lipids

PUFAs (ARA, EPA, DHA), TAGs, Polar Lipids

### Essential vitamins

A, B1, B2, B6, B12, C, E, nicotinate, biotin, folic acid and pantothenic acid

# APPLICATIONS & FRAMEWORKS

## Current applications

- Food ingredients
- Healthy foods

### Food



- Premix feeds
- Specialty feeds

### Feed



- Nutraceuticals
- Pharmaceuticals

### Health



- Cosmeceuticals
- Thalassotherapy

### Cosmetics



- Biofertilizer
- Soil remediation

### Fertilizers



## Emerging applications

- Biofuels
- CO<sub>2</sub> mitigation

### Fuels



- N&P removal
- Bioremediation

### Wastewater



- Biofibers
- Bioplastics

### Chemicals



## Founded in 2008

### People

- **50+** highly educated  
> 50 % PhD & MSc
- Highly trained people:  
**20 years of accumulated experience** in microalgae industrial production

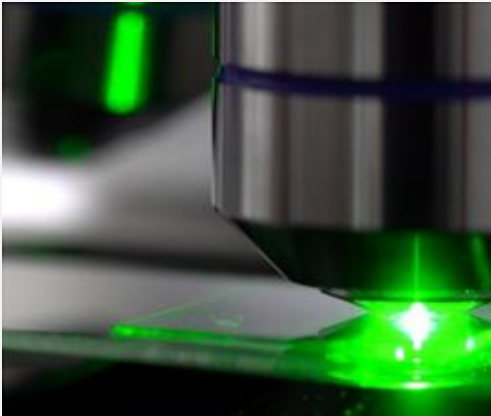
### Co-financed Projects

- **29+** R&D projects with  
**>250 M€** funding
- Involved in **11** projects:  
**biorefining** for added value products and energy

### # Units Operated

- **5 units**, from R&D to Commercial Scale
- **Currently** building **4 units** in Europe and Africa
- Currently involved in other projects abroad: South America, Africa, Europe and Middle East

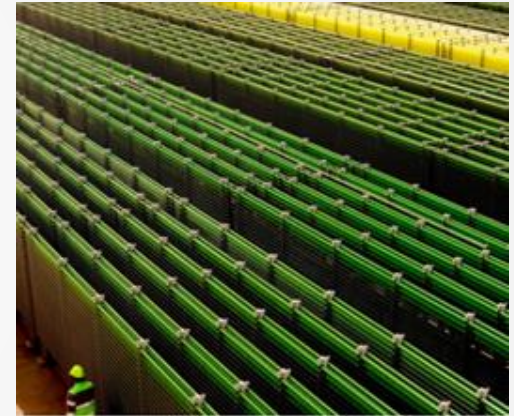
## APPLIED R&D



## CONTRACT R&D TECHNOLOGY SUPPLY



## INDUSTRIAL PRODUCTION



An aerial photograph of a vast green field, possibly a cornfield, with a bright light source in the sky. The light source is positioned in the upper right quadrant, creating a lens flare effect. The field is divided into rows, and a road or path is visible on the left side. The sky is a clear, pale blue.

**APPLIED R&D**

## Applied R&D in Biotechnology



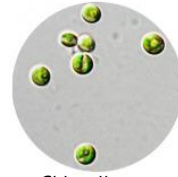
## Microalgae production expertise at pilot and industrial scale



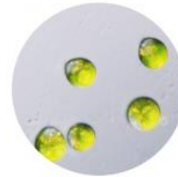
*Arthrospira* sp.  
(Spirulina)



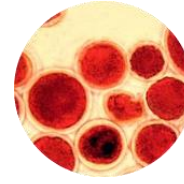
*Chlamydomonas*  
sp.



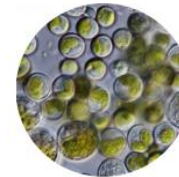
*Chlorella* sp.



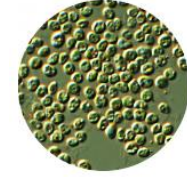
*Dunaliella salina*



*Haematococcus*  
*pluvialis*



*Lobosphaera*  
*incisa*



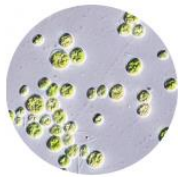
*Nannochloropsis*  
sp.



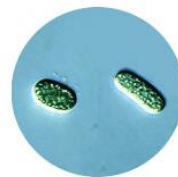
*Phaeodactylum*  
*tricornutum*



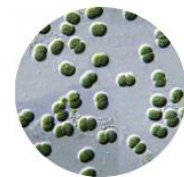
*Raphidonema*  
sp.



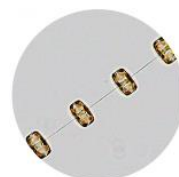
*Scenedesmus*  
sp.



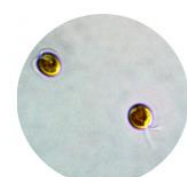
*Synechococcus*  
sp. PCC 7002



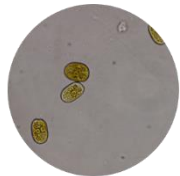
*Synechocystis* sp.  
PCC 6803



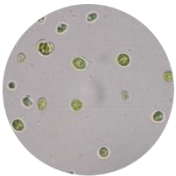
*Thalassiosira*  
*weissflogii*



*Tisochrysis*  
*lutea*



*Prorocentrum*  
*Cassubicum*



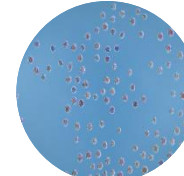
*Scotiellopsis*  
sp.



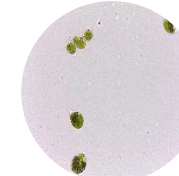
*Tetraselmis* sp.



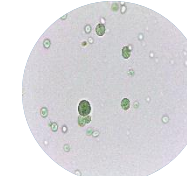
*Odontella* sp.



*Porphyridium*  
*cruentum*



*Euglena gracilis*



*Galdieria*  
*sulphuraria*

## Macroalgae production expertise at pilot and industrial scale



*Fucus  
Vesiculosus*



*Ulva spp.*



*Gracilaria spp.*



*Porphyra spp.*

## Extracts production expertise at industrial scale



**Carotenoids**  
> 3.5% *Carotenoids*



**Phycocyanin**  
> 85% *Protein*  
> 25% *Phycocyanin*



**Protein**  
> 60% *Protein*



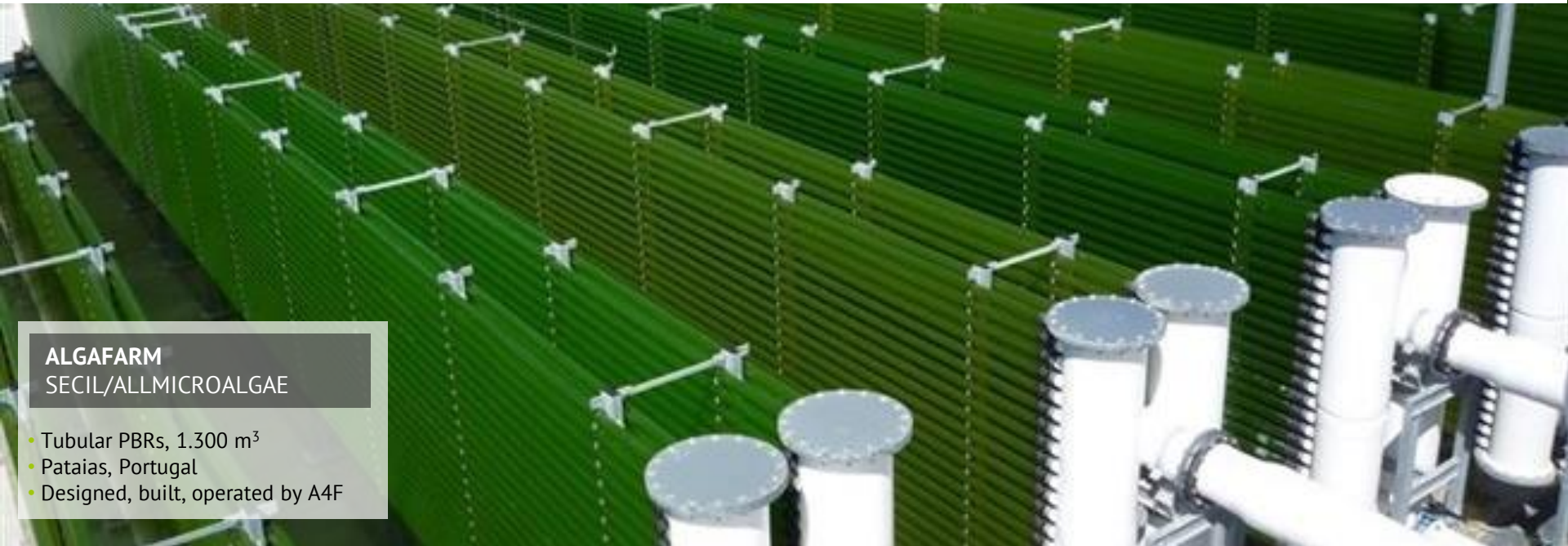
**Omega-3**  
> 14% *EPA*



**Bulk**  
50:50 *Protein and Carbohydrate*

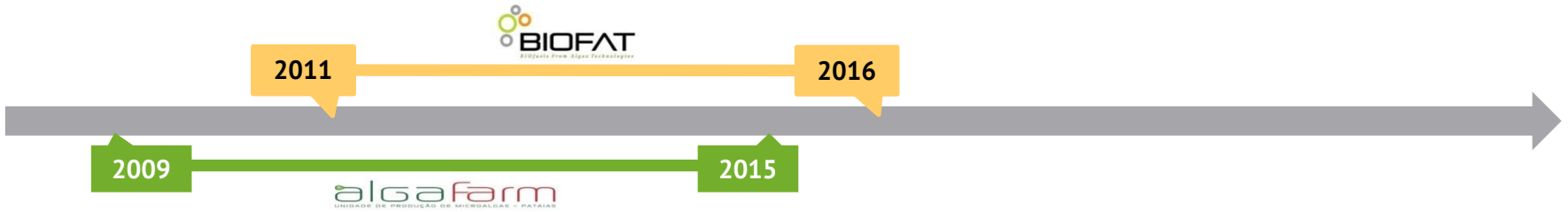
An aerial photograph of a vast green agricultural field, possibly a cornfield, with a bright sun flare in the center. The sun is positioned in the upper right quadrant, creating a large, bright white and yellow glow that radiates across the sky and onto the field. The field is divided into neat rows of crops, and the overall color palette is dominated by various shades of green and blue.

# INDUSTRIAL PRODUCTION



**ALGAFARM**  
SECIL/ALLMICROALGAE

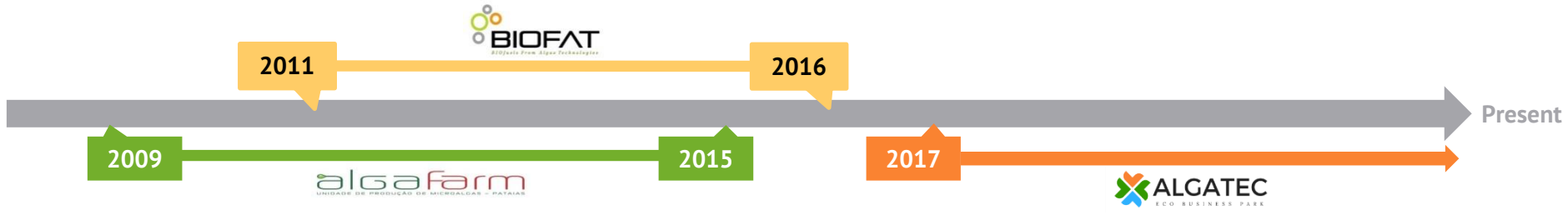
- Tubular PBRs, 1.300 m<sup>3</sup>
- Pataias, Portugal
- Designed, built, operated by A4F



**BIOFAT**  
FP7 PROJECT

- Cascade raceways, 3.000 m<sup>2</sup>
- Pataias, Portugal
- Designed, built, operated by A4F

# LARGE INDUSTRIAL PROJECTS



**ALGATEC**  
ECO BUSINESS PARK

- Multi-technology production, 14 ha
- Biorefinery
- Póvoa de Santa Iria, Portugal
- Commissioning stage



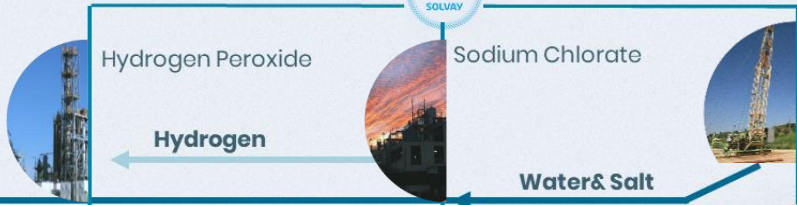
# Industrial Symbiosis in a Co-location Approach



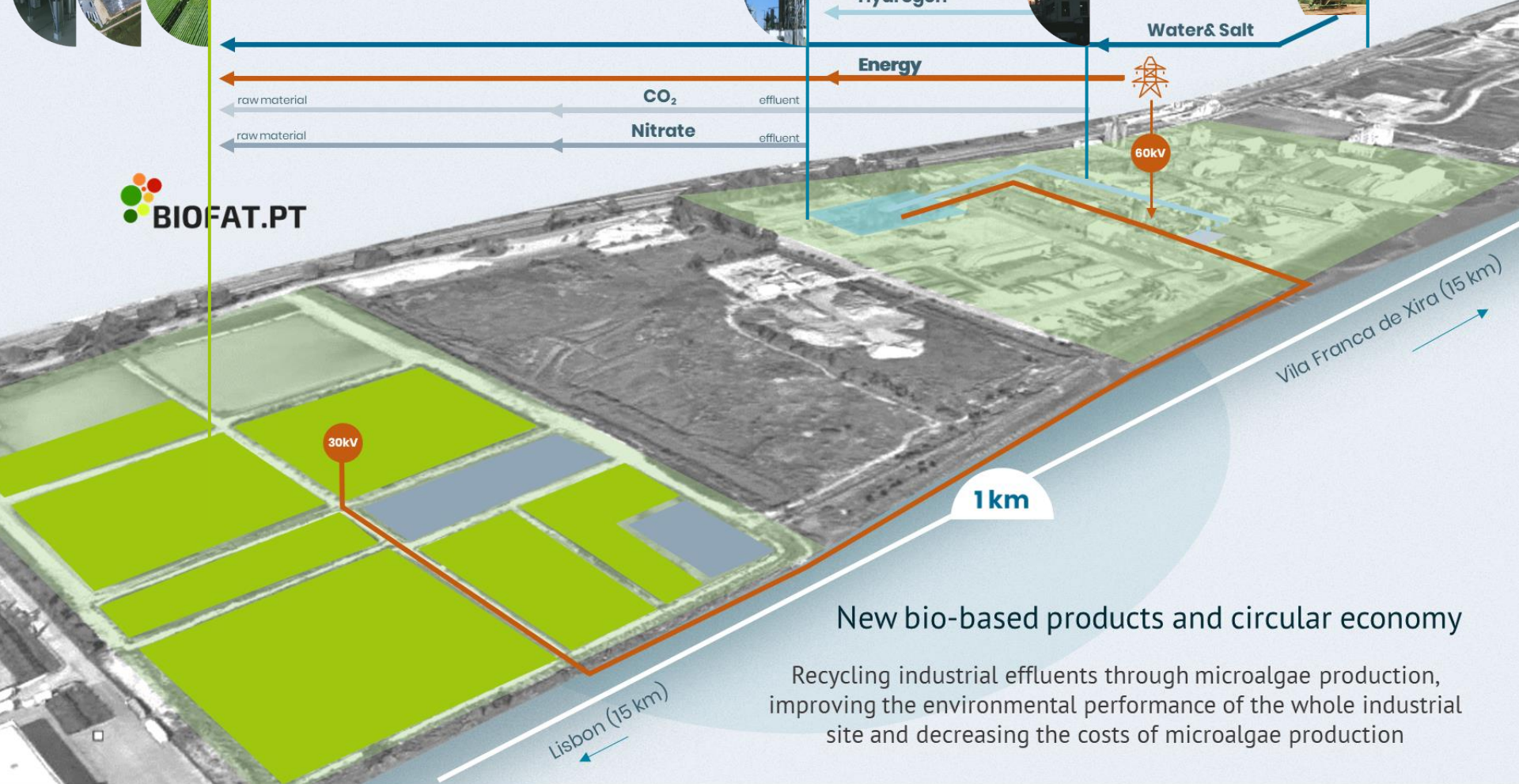
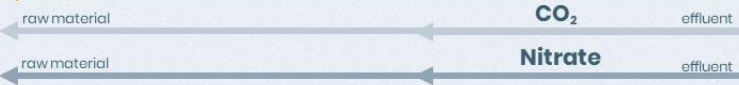
## H<sub>2</sub>Chem



Microalgae & Extracts



Site Matacões



Vila Franca de Xira (15 km)

30kV

1 km

Lisbon (15 km)

## New bio-based products and circular economy

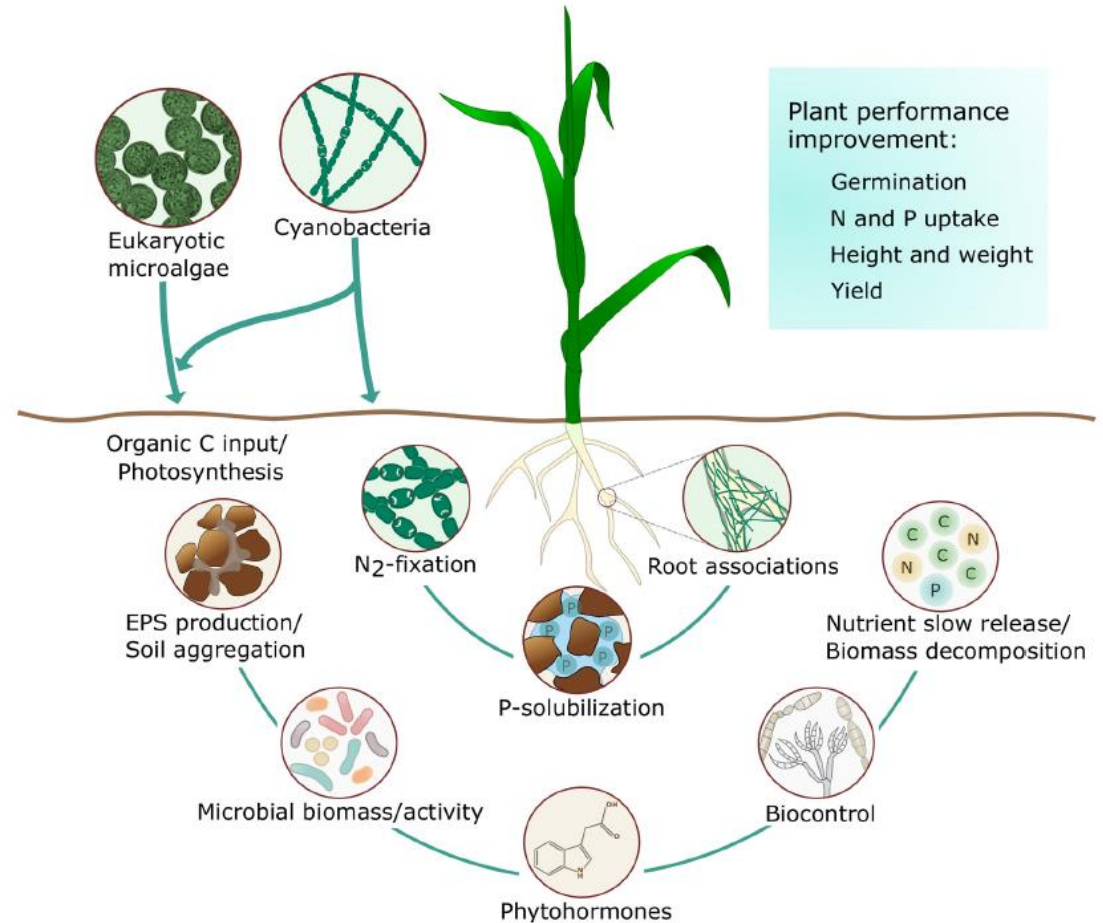
Recycling industrial effluents through microalgae production, improving the environmental performance of the whole industrial site and decreasing the costs of microalgae production

A close-up, low-angle shot of a green plant stem, likely a corn cob, against a bright blue sky with a sun flare. The stem is on the left, and the sun is on the right, creating a lens flare effect. The background is a clear blue sky.

# **ALGAE-BASED BIOFERTILIZERS AND BIOSTIMULANTS**

# ALGAE-BASED BIOFERTILIZERS AND BIOSTIMULANTS

- Versatile resources for agriculture
- Input of organic carbon
- Improve soil aggregation and stabilization
- Positive influence on soil microbial populations
- Promote plant growth and health
- Help fixating  $N_2$



Source: Alvarez et al 2021

## Algae-based fertilisers present many advantages

Characteristics	Traditional Fertilizers	Biofertilizers		
		Bacteria	Fungi	Microalgae/Cyanobacteria
Environmental damage by degrading the soil, water contamination, and eutrophication induction.	✓	x	x	x
Creation of symbiotic bonds with the plant roots and microorganisms within the soil.	x	✓	✓	✓
Role in the nitrogen cycle making it available to the plant.	x	✓	✓	✓
Promotion of the solubilization of phosphorus.	x	✓	✓	✓
Soil fertility improvement.	x	✓	✓	✓
The slow rate of nutrient release for the consumption of the plant	x	✓	✓	✓
N fixation by individual strains, P solubilization, and hormone production for promoting the growth of the plant.	x	x	x	✓
CO <sub>2</sub> capture and greenhouse emissions reduction capability during the addition of organic carbon to the soil.	x	x	x	✓
Industrial production and widespread used in the agriculture field.	✓	✓	✓	x

Source: Osorio-Reyes  
2023

Algae can act as biostimulant promoting plant growth

Algae can enhance soil fertility and microbiome properties

Original Article

## *Bacillus* and microalgae biofertilizers improved quality and biomass of *Salvia miltiorrhiza* by altering microbial communities

Xuemin Wei<sup>1</sup>, Xuanjiao Bai<sup>1</sup>, Pei Cao, Gang Wang,

Institute of Medicinal Plant Development, Chinese Academy of Medical Sciences & Pek







Algal Research

Volume 59, November 2021, 102434



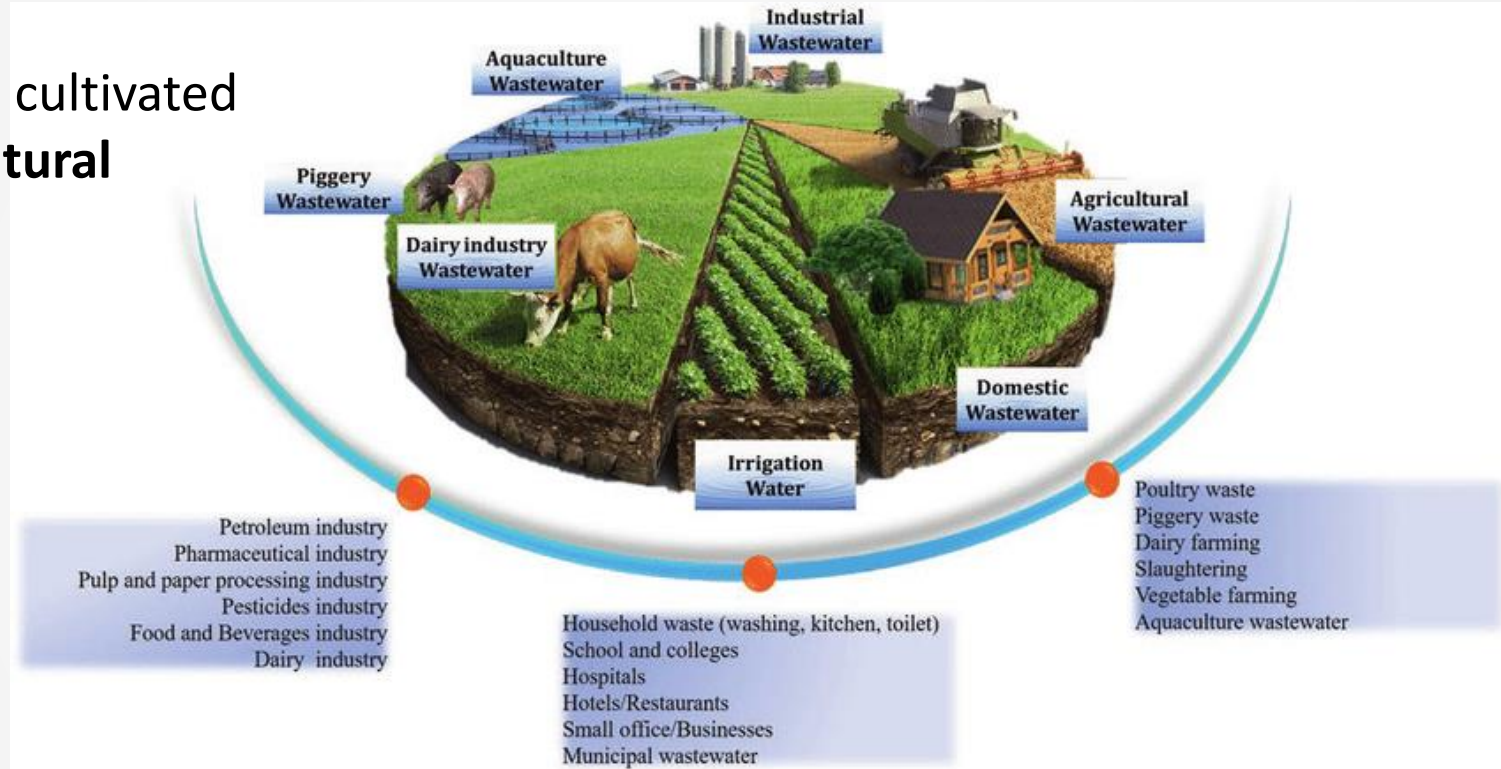
## Plant growth biostimulant activity of the green microalga *Desmodesmus subspicatus*

Ester Mazepa<sup>a b 1</sup>, Barbara V. Malburg<sup>a c 1</sup>, Gilda Mógor<sup>a</sup>, Amanda C. de Oliveira<sup>a c</sup>,  
Juliana O. Amatucci<sup>d</sup>, Diego O. Corrêa<sup>a b</sup>, Jacqueline S. Lemos<sup>a</sup>, Diogo R.B. Ducatti<sup>a</sup>,  
Maria Eugênia R. Duarte<sup>a</sup>  , Átila F. Mógor<sup>d</sup>, Miguel D. Nosedá<sup>a</sup>  

An aerial photograph of a lush green agricultural field, possibly a rice paddy, with a bright light flare or sunburst effect in the center. The field is divided into sections by narrow paths or furrows. The overall color palette is dominated by various shades of green and a clear blue sky.

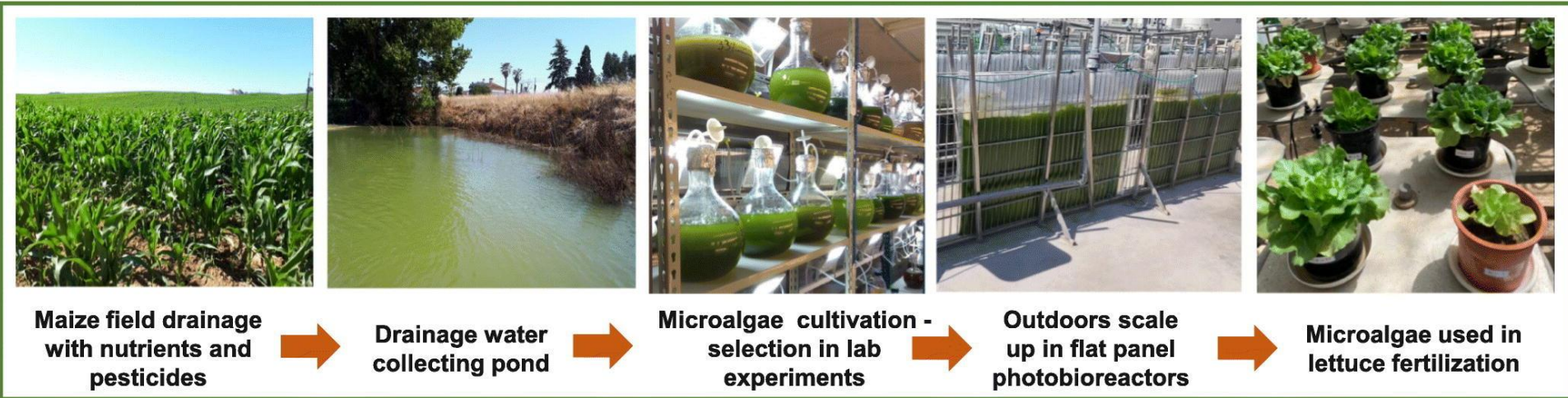
# **ALGAE FOR WASTE STREAMS VALORIZATION (AND BIOFERTILIZERS PRODUCTION)**

Algae can be cultivated using **agricultural** wastewaters



# ALGAE FOR WASTE STREAMS VALORIZATION AND BIOFERTILIZERS PRODUCTION

**“*Chlorella vulgaris* and *Scenedesmus obliquus* suspensions, grown in maize drainage water, can be used on-farm, as low cost slow-release organic fertilizers, doubling lettuce fresh biomass and improving soil health”**




**Nutrients and water recycling**



**Pesticides degradation**



**Reduced costs in mineral fertilizers**



**Improved productivity and soil health**

Source: Alvarenga et al 2023

# ALGAE FOR WASTE STREAMS VALORIZATION AND BIOFERTILIZERS PRODUCTION

Combination of wastewater treatment, biofuel and biofertilizer production

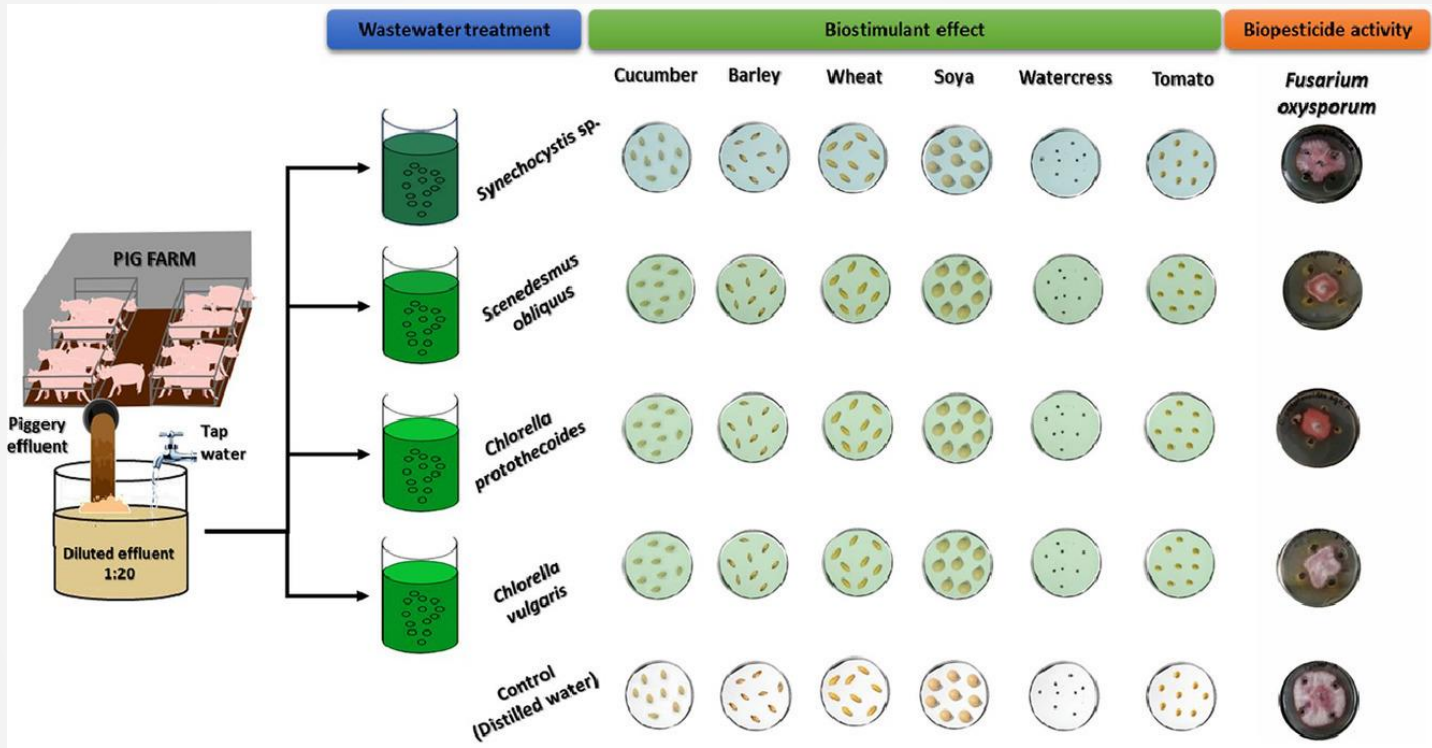


- *Scenedesmus* sp. was cultivated using **domestic wastewater** and **coal-fired flue gas**
- Use of de-oiled microalgal biomass was efficient biofertilizer for rice crop
- Microalgae increased available nutrients in soil
- Microalga supplementation reduced chemical fertilizer

Source: Nayak et al 2019

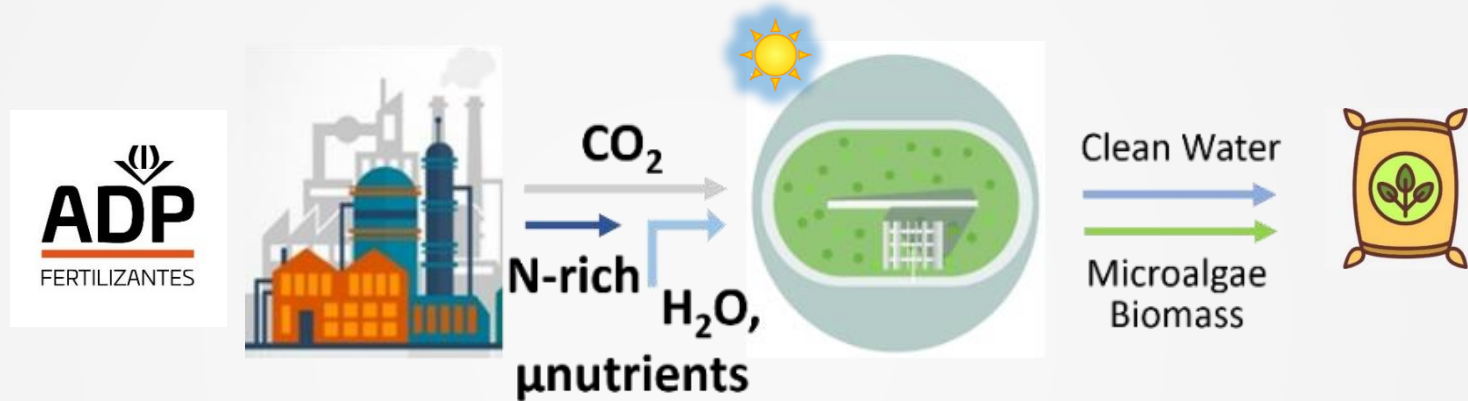
# ALGAE FOR WASTE STREAMS VALORIZATION AND BIOFERTILIZERS PRODUCTION

Biostimulant and biopesticide potential of microalgae growing in piggery wastewater



Source: Ferreira et al 2022

## Microalgae Cultivation for Bioremediation

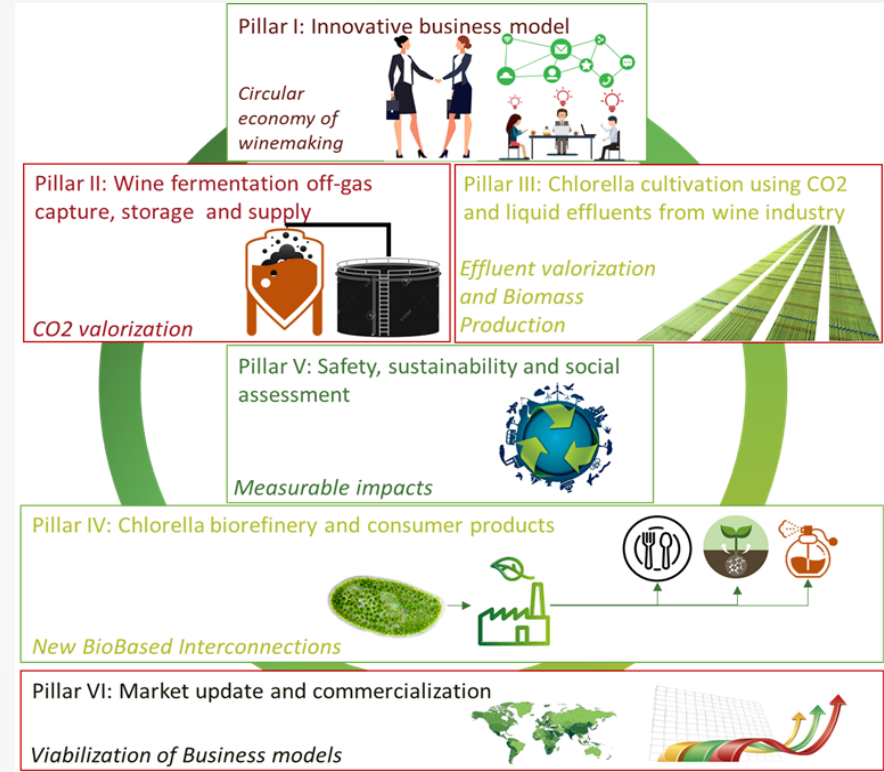


- Ongoing work: **characterization of the microalgal biomass for biofertilizer and biostimulant potential** on vegetables and fruit trees by ADP Fertilizantes. The valorization of the biomass will boost the **economic viability** of the overall process.
- Future work: **evaluate feasibility of using onsite available flue gas** as  $\text{CO}_2$  source.



REDwine aims to:

- implement a new business model for wine producers, where they will become microalgae producers by valorising their effluents.
- incentivise the transition of the wine production industry to an innovative, circular and sustainable model that will increase and diversify revenues for its stakeholders.





**Thank You!**



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