This project is funded by the European Union

Horizon 2020 Regional Seminar

Addressing Euro-Mediterranean Common Challenges through Research and Innovation Cooperation

SABANA project: Demonstrating the application of microalgae in agriculture and aquaculture

Prof. F. Gabriel Acien

Dpt. Chemical Engineering, University of Almeria, SPAIN

This project has received funding from the European Union's Horizon 2020 Research and Innovation program under the Grant Agreement No. 727874

January 22th 2019, Fes-Morocco

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the European Union

How to prepare a proposal…

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Analyze the call

European Commission
Research & Innovation - Participant Portal
Proposal Submission Forms

Horizon 2020

Call: H2020-BG-2016-2017
(Blue Growth - Demonstrating an ocean of opportunities)

Topic: BG-01-2016

Type of action: IA
(Innovation action)

***Symptoms*:**

Despite the **large potential** of products derived from algae, implementation is still limited mainly due to **unfavorable economics**. At present, microalgae are being applied in a **limited volume** (< 10 000 tones dry weight/year) in various **niche markets** (including food supplements) and macroalgae mass production is facing several challenges including the lack of space to further expand.

***Treatment*:**

To reach broader economic viability, **costs** of algal biomass production need to be reduced and the **scale of production** needs to be increased significantly. Even when the price of biomass production is reduced, algal biomass needs to be **refined into multiple products** in order to increase its total value and achieve **economic feasibility**.

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Preparation of the proposal

***Background*:**

- Deep knowledge of the field
- Previous experience in related projects
- Knowledge of main actors involved: Technology, Market, Politics, etc..
- *Lobby and networking*

***Work* :**

- Coordinator:
  - Prepare the concept
  - Identify the main actors
  - Elaborate the proposal/work plan
- Other partners:
  - Provide detailed/additional information
  - Define the chronogram/budget

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Preparation of the proposal

- **EXCELLENCE**
- **IMPACT**
- **IMPLEMENTATION**

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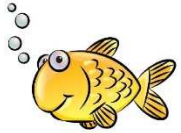
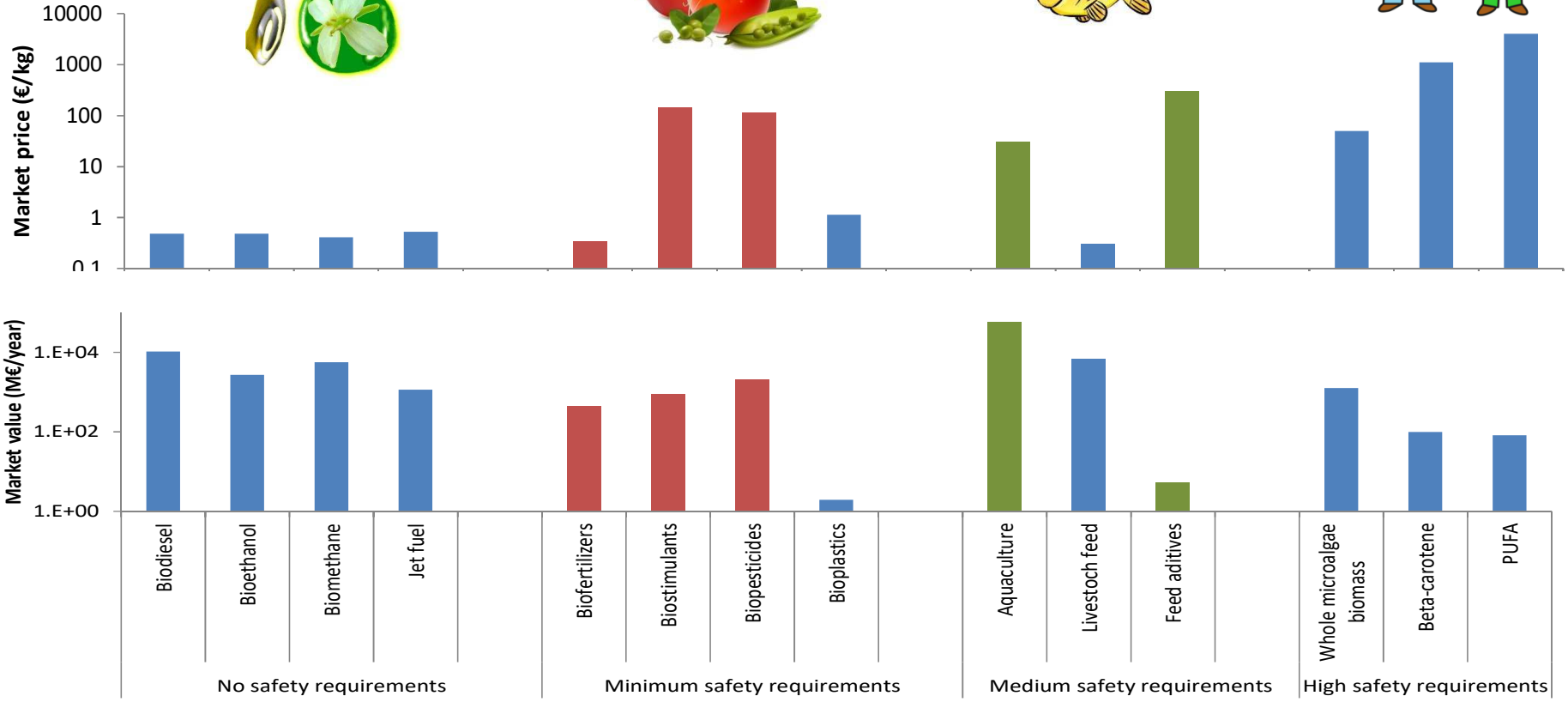
Market study

PRODUCTS/MARKETS





Agriculture and aquaculture are large markets demand new products from microalgae with lower safety requirements

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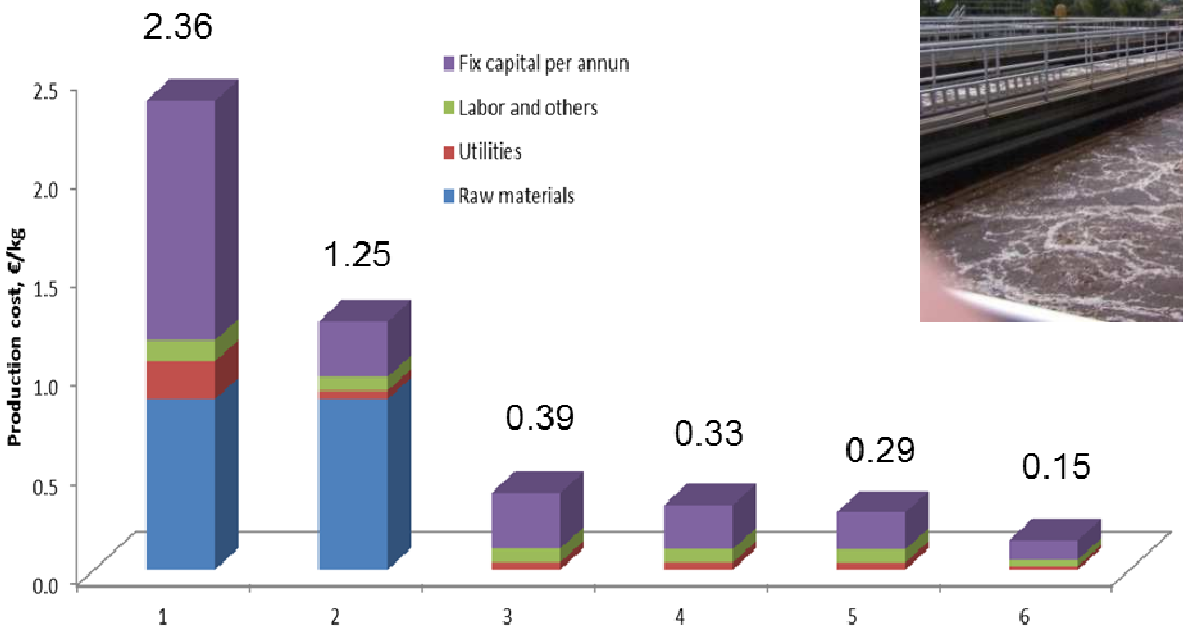
Market study

SUSTAINABILITY/COST



Microalgae production cost is largely reduced when coupling with wastewater treatment, at the same time sustainability increasing

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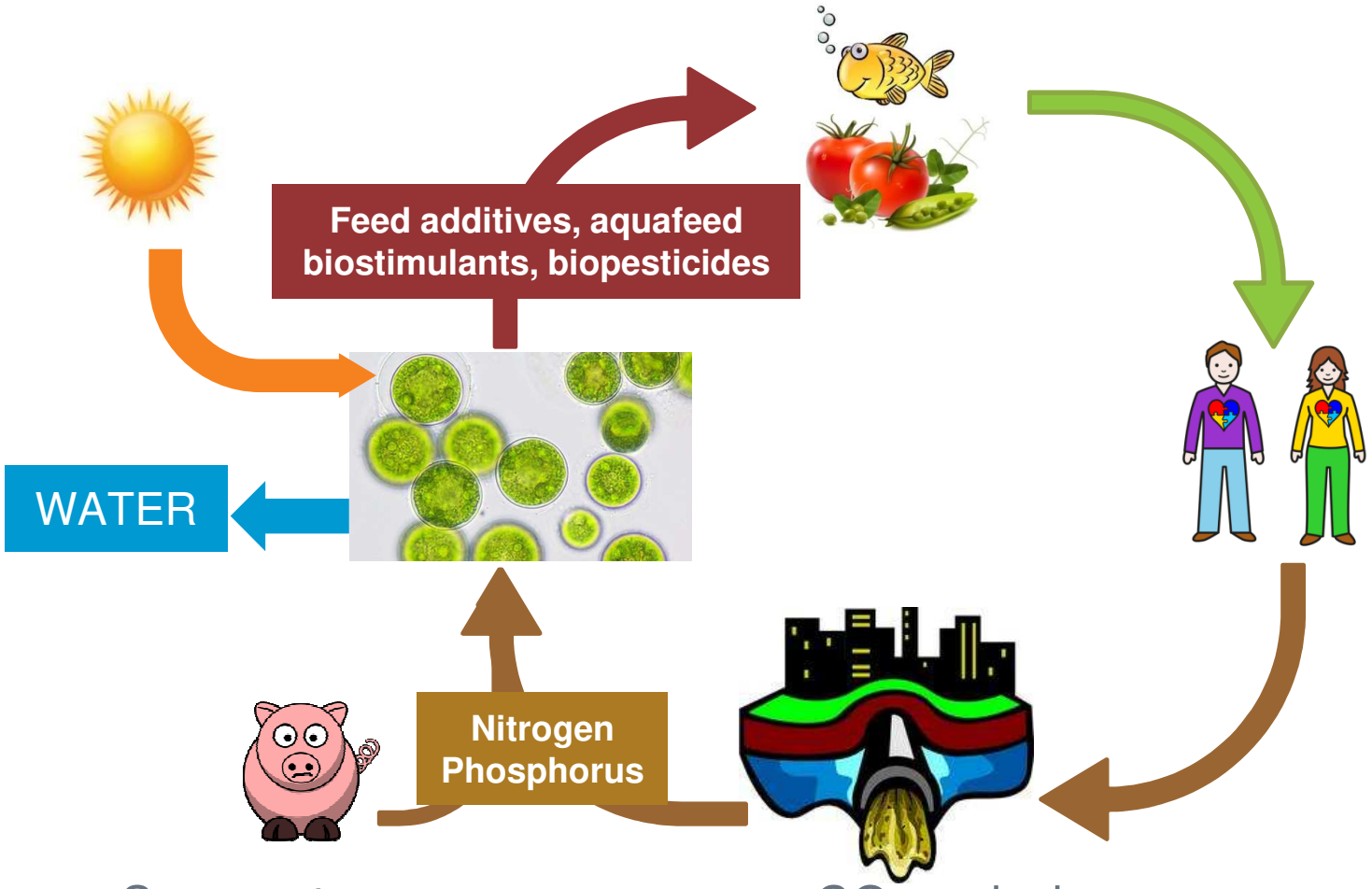
Objective



Save water, save energy, save CO_2 emissions, recover nutrients…, thus be sustainable

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Objective

The objective of SABANA is to develop and demonstrate an integrated microalgae-based sustainable biorefinery to produce a range of value-added products (biostimulants, biopesticides and aquafeed additives) and low-value products (biofertilizers, aquafeed) for agriculture and aquaculture, using marine water and recovering nutrients from wastewaters (sewage, centrate and pig manure), accomplishing market (quality, price, regulations) and social (acceptance, capacitation, skills) requirements.

It provides a solution for three current key issues in the EU:

- Improvement of the safety and sustainability of food production in agriculture and aquaculture
- Contamination problems resulting from nutrients dissemination and scarcity (phosphorous)
- Minimization of greenhouse gas emissions from wastes (wastewater and flue gases)

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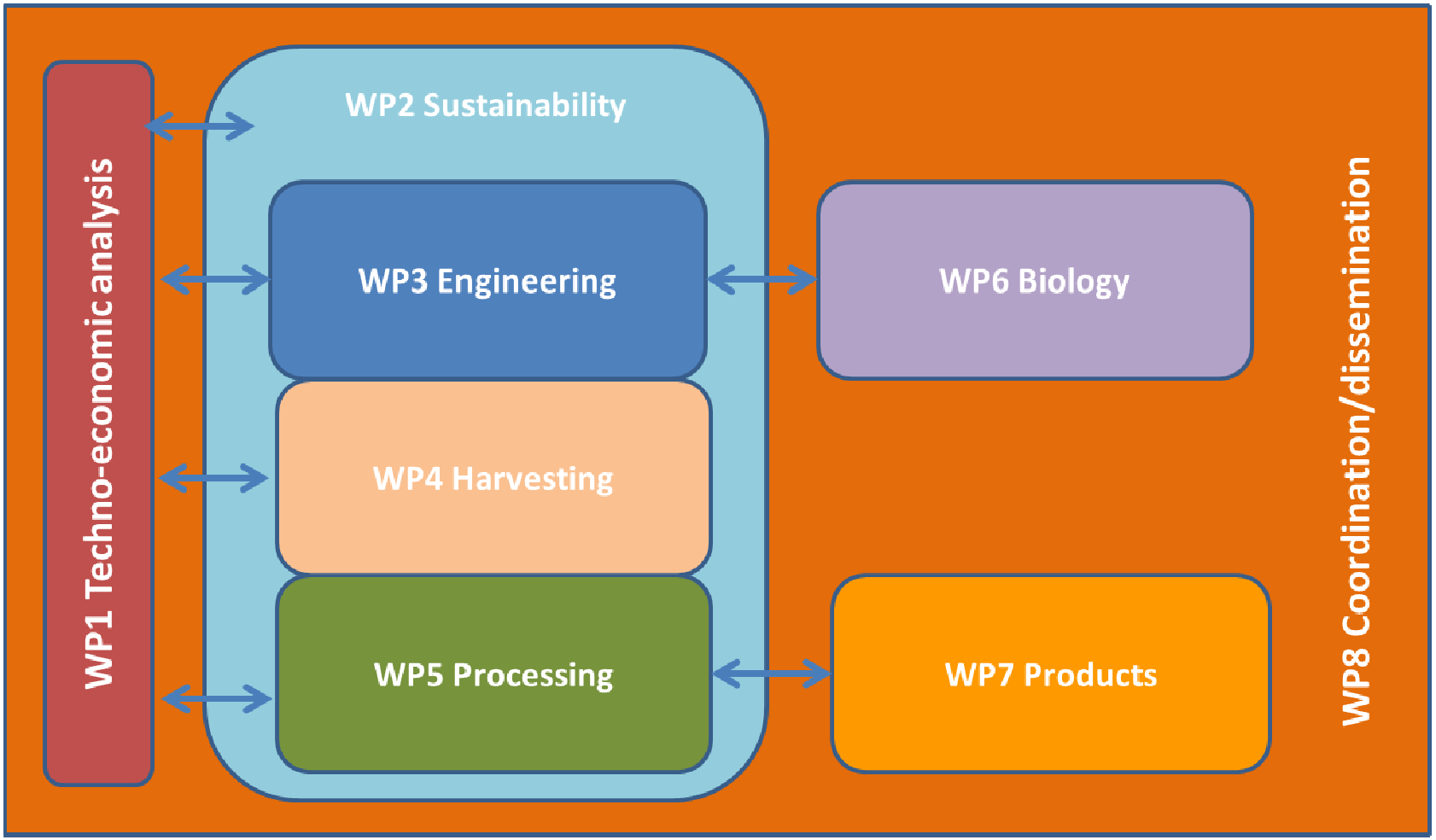
About the project

SABANA

Work packages



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About the project

SABANA

PARTNERS

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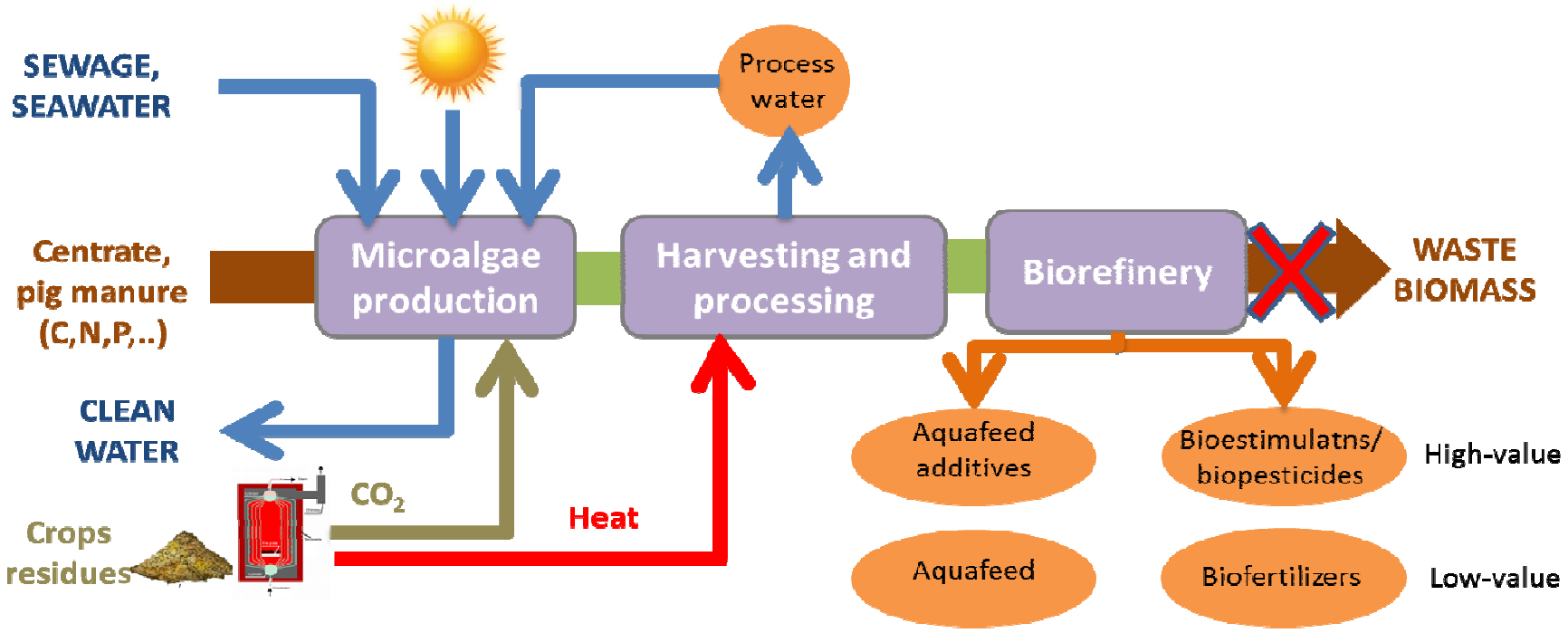
Block diagram of the project



LARGE SCALE BIOMASS PRODUCTION

INTEGRAL UTILIZATION OF BIOMASS

DEMO1 SCALE=1 ha

DEMO2 SCALE=5 ha

DEMO3 SCALE=20 ha

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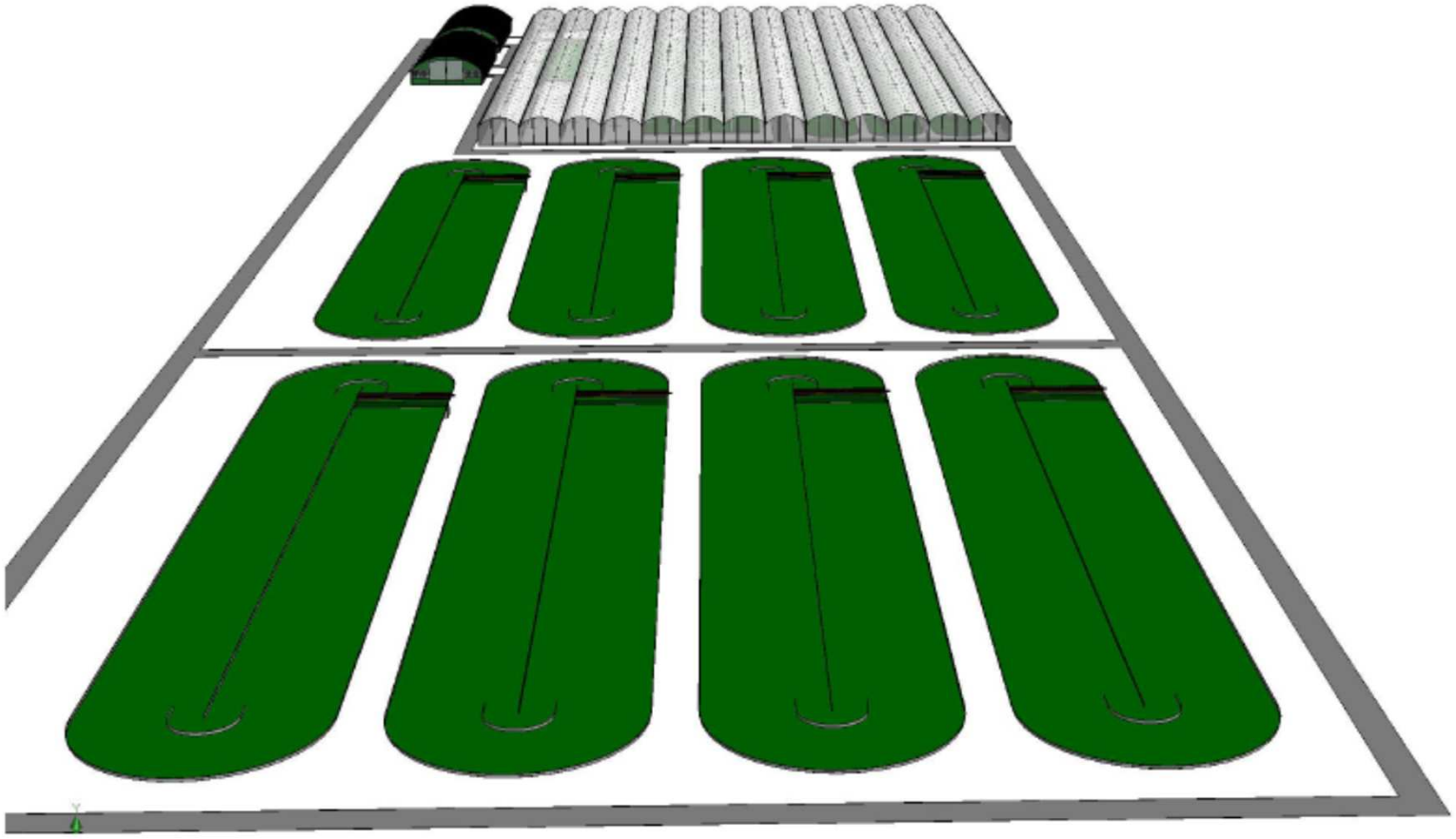
Research-Innovation (5 ha)



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Impact

- **Politic framework:** Two high-priority lines of activities identified in Horizon 2020 for the Societal Challenge 2 sector of providing a sustainable and competitive bio-based industry that includes residues and biowaste and simultaneously boosting marine innovation through smart “blue” growth and, in particular, by contributing to the development of a competitive and environmentally friendly European aquaculture.

- **Economic performance of the SABANA system:** Techno-economic studies conducted within the consortium partners to assess the economic viability of such an industrial system have attempted to calculate the economics of the process here proposed.

- **Formation:** To stablish a **Training Center** for teaching and collaboration with other institutions, organization of international courses, etc.

- **Share research:** Creation of a **Data Center** for online availability of real data from the reactors in operation, access to models developed during the project, simulation tools for different scenarios, etc.

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Impact

WASTEWATER TREATMENT SECTOR

Conventional technology for wastewater treatment imposes a high cost and energy consumption, nutrients being lost

Wastewater treatment cost: Aqualia (250 plants=500 Mm^3/yr)

- Water treatment cost=0.2 €/m^3
- Energy consumption= 0.5 kWh/m^3

- Advanced treatment processes (A2O, AO, UCT type):
  - Complex processes
  - Removal of nitrogen = 5-8 €/kg
  - Removal of phosphorous = 13-20 €/kg

Nutrient losses

- Nitrogen removal/losses=25.000 t/yr
- Phosphorous removal/losses =5.000 t/yr

} "Microalgae=0.5 Mt/yr"

Conventional treatments are designed to remove nutrients, not to produce biomass, employing a large amount of energy to do it

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Impact

BIOFERTILIZERS SECTOR

Biofertilizers, in addition to provide an eco-friendly option, also maintain the soil and crop health with increased efficiency. Global Biofertilizers Market is expected to reach USD 1.88 Billion by 2020 at a CAGR of 14.0% from 2015 to 2020. The market was dominated by North America in 2014 and accounted for the largest share in the total biofertilizers market.

The market for biopesticides is projected to reach USD 6.6 Billion by 2020 at a CAGR of 18.8% from 2015 to 2020. Biopesticides are used primarily as preventative measures for diseases in plants, made from naturally occurring substances that controls pests by nontoxic mechanisms and in an eco-friendly manner

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Impact

AQUACULTURE SECTOR

The Asia-Pacific market topped the revenue chart of the global aquafeed industry, accounting for around 76.1% and 75%, both by value and volume respectively, of the total market. The global aquafeed market is expected to reach a value of 123 billion USD by 2019, at a CAGR of 12.1% from 2014 to 2019 by revenue, and by consumption value, it is projected to reach 89 billion USD by 2019, at a CAGR of 10.7% from 2014 to 2019

The feed premix market is projected to reach USD 10.26 Billion by 2020, at a CAGR of 3.0%, as studied from 2015 to 2020. The market for feed premix products has a significant impact on the animal nutrition industry. Feed premix is broadly categorized based on their type into vitamins, minerals, amino acids, antibiotics, and others include enzymes, preservatives, organic acids, antioxidants, pigments, and flavors.

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Impact

ECONOMIC PERFORMANCE

DEMO2 (5 ha)

AQUACULTURE
150 t FEED ADDITIVES
600 T OF AQUAFEED

1-15 M€

AGRICULTURE
600 m^3 BIOSTIMULANTS/BIOPESTICIDES
6000 m^3 BIOFERTILIZERS

2-60 M€

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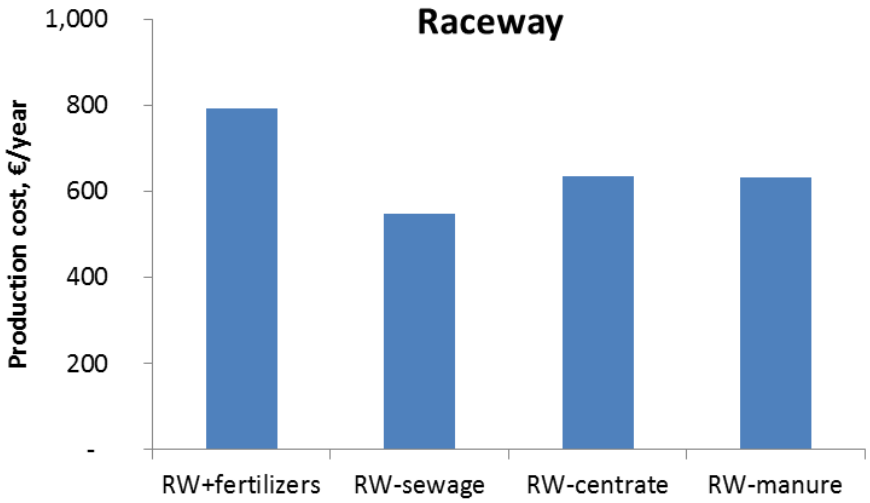
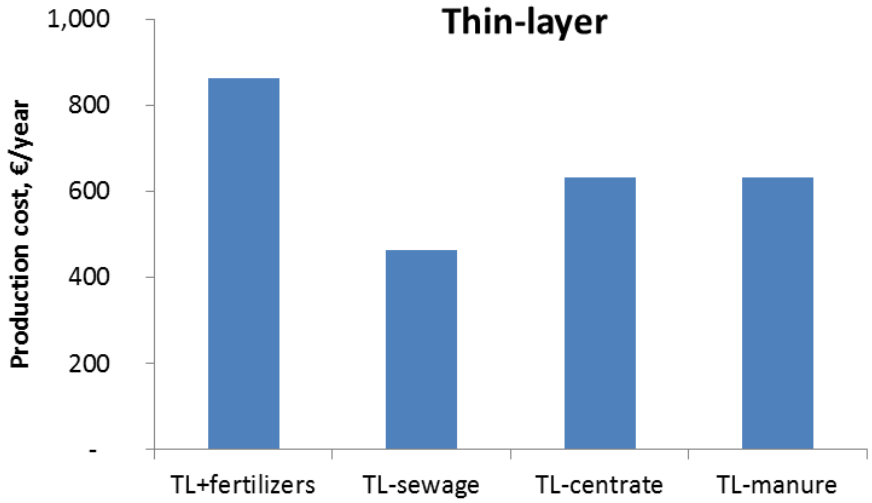
Impact

ECONOMIC PERFORMANCE

Initial scenario: Biomass production cost reduction by integration of wastewater treatment





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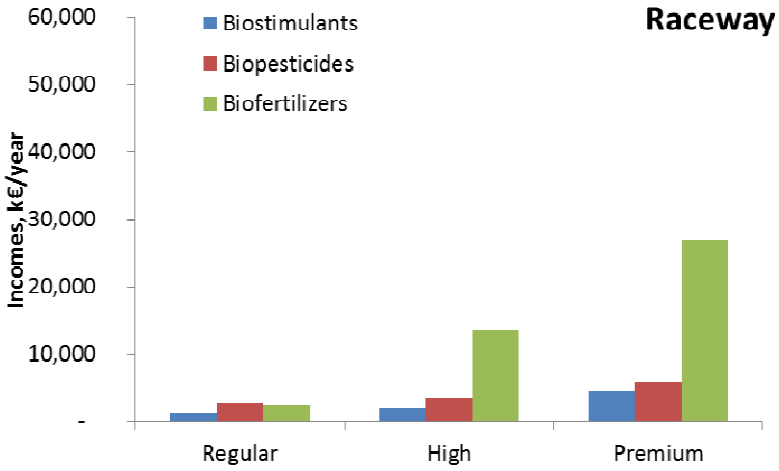
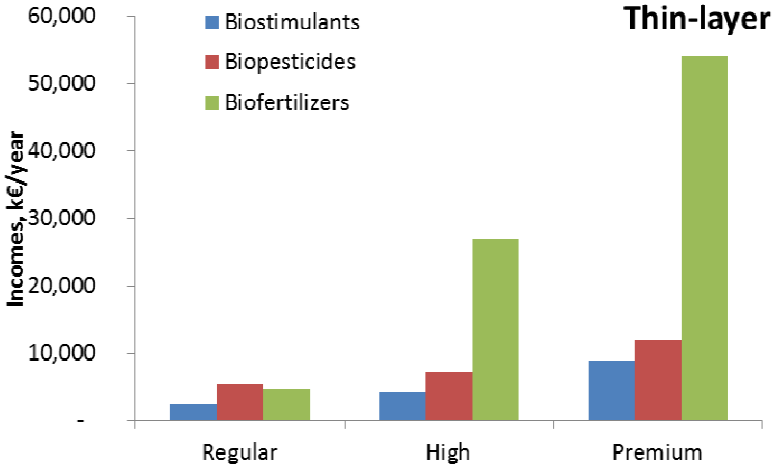
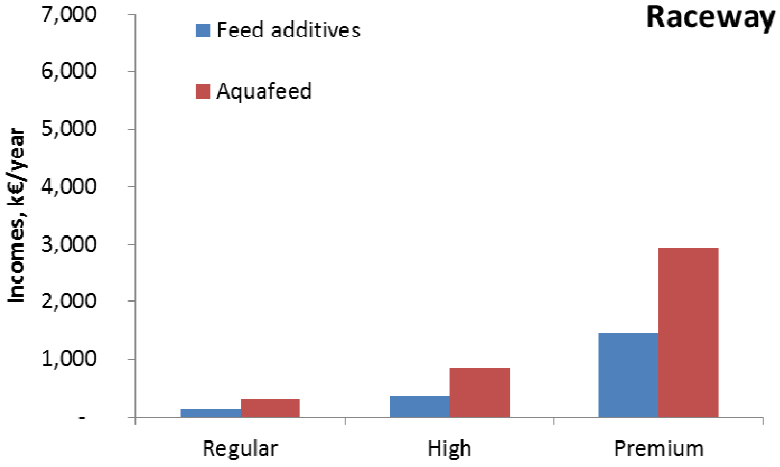
Impact

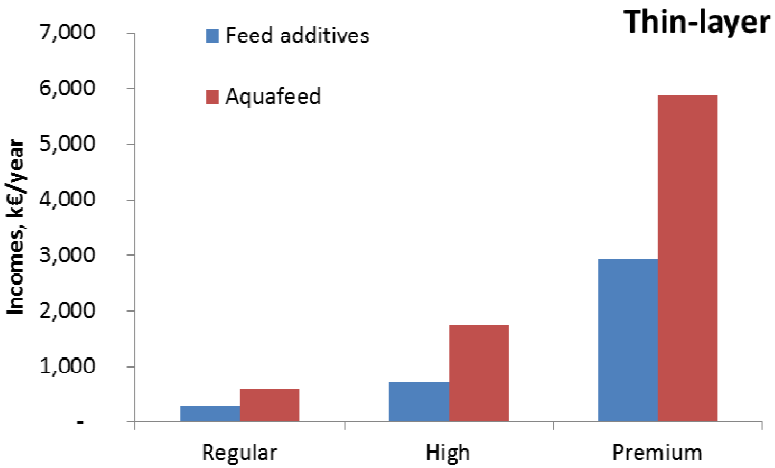
ECONOMIC PERFORMANCE

Initial scenario: Incomes according to estimated market value









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Impact

Impacts attained by the project and their relation to the expected impacts

- Develop marine innovation by de-risking investments and demonstrating the technical and economic feasibility of environmentally sustainable large-scale algae biomass production for biorefineries producing a range of value-added products.
- Bring to the market new, cost-effective and environmentally friendly technologies and production systems.
- Increase stakeholder engagement in and societal acceptance of sustainable algal biomass production.
- Enhance the competitiveness of European industry by supporting new jobs, growth and investment while ensuring environmental sustainability and a low environmental impact
- Improve the professional skills and competences of those working and being trained to work within the blue economy.

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About the project

RELEVANT DATES

European Commission
Research & Innovation - Participant Portal
Proposal Submission Forms

Horizon 2020

Call: H2020-BG-2016-2017
(Blue Growth - Demonstrating an ocean of opportunities)

Topic: BG-01-2016

Type of action: IA
(Innovation actio

Proposal numb

Proposal ANA

D G-2016-1

ble of contents

		Action
	General information	
	Participants & contacts	
3	Budget	
4	Ethics	
5	Call-specific questions	

How to fill in the forms

The administrative forms must be filled in for each proposal using the templates available in the submission system. Some data fields in the administrative forms are pre-filled based on the previous steps in the submission wizard.

H2020-CP-IA-2015.pdf Ver1.05 20160118 Page 1 of 41 Last saved 17/02/2016 08:41:20

SUBMISSION February 16th, 2016

EUROPEAN COMMISSION
Research Executive Agency (REA)
B.2 - Sustainable Resources for Food Security and Growth
Head of Unit

Brussels,

F Gabriel ACIEN FERNANDEZ
UNIVERSIDAD DE ALMERIA
CARRETERA SACRAMENTO CAN
04120 ALMERIA
SPAIN

Subject: Horizon 2020 Framework Programme
Call for proposals: H2020-BG-2016-2017 (H2020-
Proposal: 727874 — SABANA
Evaluation result letter — GAP invitati

Dear Madam/Sir,

I am writing in connection w -mentioned call.

Having complete to inform you that your proposal has **passed this phase** and th to start **grant preparation**.

Pl summary report (ESR). It reflects the comments and opinion of proposal — as endorsed by the Agency.

ant preparation

paration will be based on the following:

1. **Proposal:** 727874 — SABANA
2. **Topic:** BG-01-2016 — Large-scale algae biomass integrated biorefineries
3. **Type of action:** Innovation action
4. **Project officer:** Nila PETRALLI
   Nila.PETRALLI@ec.europa.eu
   +32 22962211
   Sustainable Resources for Food Security and Growth

Please always use the Participant Portal messaging function (via your Participant Portal account). Do NOT contact the project officer via other means (e-mail, letter, etc) — unless explicitly asked to do so.

1

APPROVED June 24th, 2016

European Commission
Research & Innovation - Participant Portal
Proposal Submission Forms

Horizon 2020

Call: H2020-BG-2016-2017
(Blue Growth - Demonstrating an ocean of opportunities)

Topic: BG-01-2016

Type of action: IA
(Innovation action)

Agreement number: 727874 — SABANA — H2020-BG-2016-2017/H2020-BG-2016-1
Associated with document Ref. Ares(2016)5683156 - 30/09/2016

EUROPEAN COMMISSION
Research Executive Agency (REA)
Director

GRANT AGREEMENT

NUMBER — 727874 — SABANA

Agreement ('the Agreement') is between the following par
he one part,
Research Executive Agency (REA) ('the Agen
mission ('the Commission')[1],
ssented for the purposes of signatu **ecutive**
ncy (REA), Industrial Leadersh **esources for**
d Security and Growth, Ka

he other par
he coo

ed in CARRETERA SACRAMENTO
ESQ5450008G, represented for the purposes of
ment, Research and Innovation, Antonio POSADAS

they sign their 'Accession Form' (see Annex 3 and Article 56):

ALIA) SA, M38878, established in CALLE FEDERICO SALMON
d, VAT number ESA26019992,

FALIA SEPARATOR GROUP GMBH (WSPC) GMBH, HRB7223/
, established in Werner-Habig-Strasse 1, Oelde 59302, Germany, VAT number
899,

KARLSRUHER INSTITUT FUER TECHNOLOGIE (KIT), established in
SERSTRASSE 12, KARLSRUHE 76131, Germany, VAT number DE266749428,

HORIZON BIOTECH SL (BIORIZON) SL, AL37324, established in CTRA. ALICUN N° 60,
QUETAS DE MAR-ALMERIA 04740, Spain, VAT number ESB04707139,

IIKROBIOLOGICKY USTAV - AVCR, V.V.I. (IMIC), 61388971, established in VIDENSKA
), PRAHA 4 14220, Czech Republic, VAT number CZ61388971,

UNIVERSITA DEGLI STUDI DI MILANO (UMIL), 80012650158, established in Via Festa
Del Perdono 7, MILANO 20122, Italy, VAT number IT03064870151,

8. A.I.A. AGRICOLA ITALIANA ALIMENTARE S.P.A. (A.I.A. S.p.A.) SPA, 110039,
established in PIAZZALE APOLLINARE VERONESI 1, SAN MARTINO BUON ALBERGO VR
37036, Italy, VAT number IT00233470236,

[1] Text in *italics* shows the options of the Model Grant Agreement that are applicable to this Agreement.

1

SIGNED October 13th, 2016
November 17th, 2016

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How to perform the work…

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Development of the project

RELEVANT DATA

Project Summary

Project 727874 (SABANA)

Responsible Unit:	REA/B/02
Call:	H2020-BG-2016-2017 submitted for H2020-BG-2016-1 / 17 Feb 2016
Topic:	BG-01-2016 - Large-scale algae biomass integrated biorefineries
Type of Action:	IA
Duration:	48
Submission Stage:	

Important Dates:

Entry into force of the Grant:	13/10/2016
Project Start Date:	01/12/2016
Project End Date:	30/11/2020

Budget Information:

Proposal overall costs :	10,646,705.00 €
Maximum grant amount after evaluation :	8,848,523.75 €
Total costs (including non-EU funded) :	10,646,705.00 €
Total Costs:	10,646,705.00 €
Maximum Grant Amount:	8,848,523.75 € 83.11 % of total costs

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Development of the project

MANAGEMENT STRUCTURE

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Recent achievements

DEMO FACILITY

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Recent achievements

SABANA

DEMO FACILITY

Raceway reactors

Large scale reactors

Thin-layer cascade

Tubular reactors

Auxiliary facilities

- Air, flue gas
- Culture medium
- Harvesting
- Spry-dryer
- Biomass processing

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Recent achievements

Optimal harvesting strategy

	Culture 1 g/L	Sludge 10 g/L	Paste 100 g/L	Cost aprox (€/kg)	Energy (kWh/m^3)
Option 1	Centrifugation			0.30	1.00
Option 2	Sedimentation	Centrifugation		0.05	0.13
Option 3	Dissolved air flotation	Centrifugation		0.07	0.15

- Pre-concentration step is mandatory
- A final dewatering step is required to achieve final concentration of 100 g/L for processing
- Robust large scale processing is not easy…

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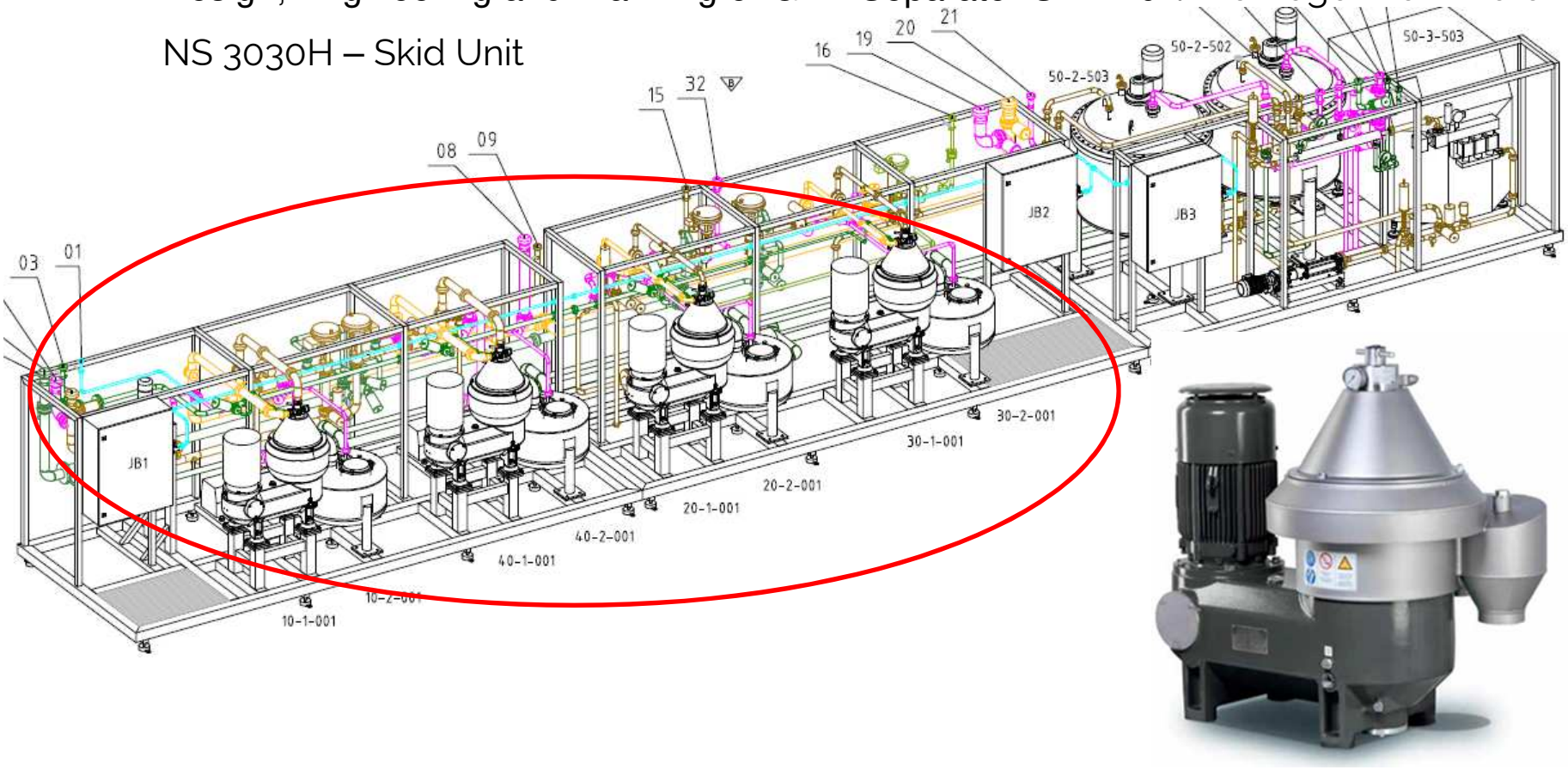
Recent achievements

Optimal harvesting strategy

- PRODUCTION scale:
  - Design, Engineering and Planning of GEA Separator SDA 40 + Homogenizer Ariete NS 3030H – Skid Unit



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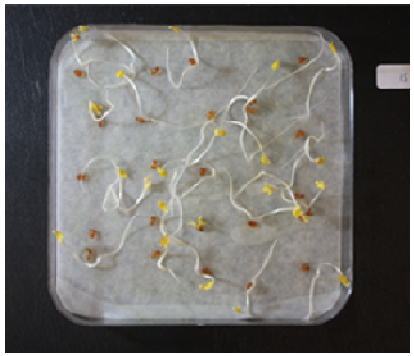
Agriculture uses…

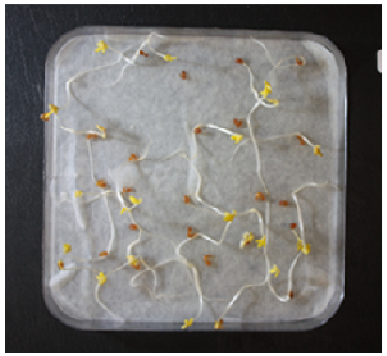
Microalgae strains: selection

Collection	Strains	Biostimulants	Biopesticides	Aquaculture	Selected
SZE	21 freshwater green microalgae	10	5	5	3
	24 freshwater cyanobacteria	5	5	0	2
BEA	10 seawater green microalgae	5	2	8	3
	10 seawater cyanobacteria	3	3	2	2

Biostimulant effect on watercress seed germination

Control





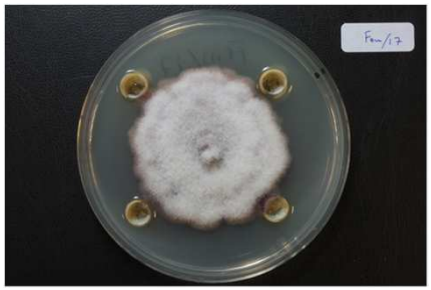
EUROPEAN JOURNAL OF PHYCOLOGY, 2018
https://doi.org/10.1080/09670262.2018.1441447

Endogenous brassinosteroids in microalgae exposed to salt and low temperature stress

Wendy A. Stirk[a], Péter Bálint[b], Danuše Tarkowská[c], Miroslav Strnad[c], Johannes van Staden[a] and Vince Ördög[a,b]

Antagonistic effect against phytopatogens

Control



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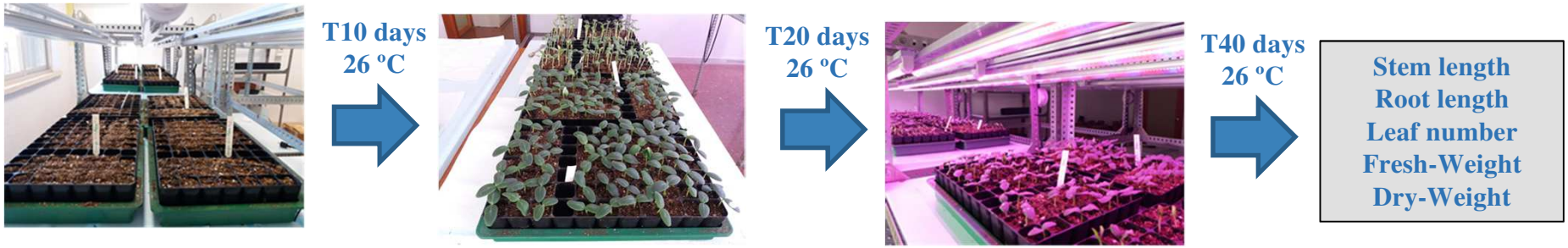
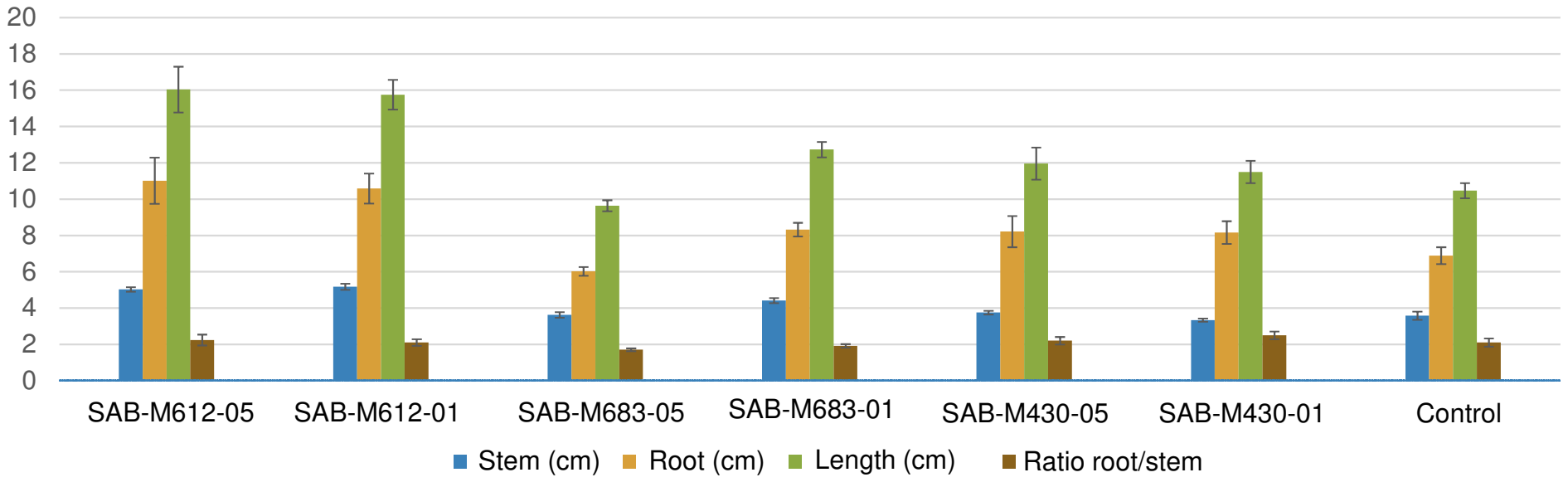
Agriculture uses…

Microalgae strains: in vivo trials

Biostimulation *In vivo*: Application of algal extracts (Cucumber, Melon, others..)





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Agriculture uses…

Microalgae strains: field trials

		Regular	High	Premium
Biostimulants	€/L	5	10	20
Biopesticides	€/L	10	15	25

Major requirements:

- No large volumes requested, medium size facilities
- Enhanced biomass containing target compounds
- Demonstrate the bioactivity in real field conditions
- Safety and sustainability of produced biomass

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Aquaculture uses…

In vivo feeding trials

1.- Senegalese sole juveniles
2.- Seabream juveniles
3.- Seabream larvae

	COM	CT	TISO	NAN	SCE	*p*
Initial body weight (g)	11.4±0.26	11.4±0.20	11.4±0.43	11.4±0.12	11.4±0.39	0.9984
Final body weight (g)	29.8±2.77a	**47.9±3.62b**	**47.7±4.95b**	**45.2±0.28b**	**45.7±4.87b**	0.0006
Daily gain (DG, mg day^{-1})	0.22±0.03a	0.43±0.04b	0.43±0.05b	0.40±0.01b	0.40±0.05b	0.0003
Specific growth rate, SGR (%)	1.12±0.09a	1.69±0.08b	1.68±0.08b	1.63±0.01b	1.63±0.08b	<0.0001
Feed efficiency ratio (FER)	0.52±0.05a	0.81±0.06b	0.78±0.04b	0.77±0.01b	0.80±0.05b	0.0001
Feed conversion ratio (FCR)	1.92±0.18b	1.24±0.08a	1.28±0.06a	1.30±0.02a	1.26±0.08a	<0.0001
Protein efficiency ratio (PER)	0.95±0.09a	1.47±0.10b	1.42±0.07b	1.40±0.02b	1.45±0.09b	0.0001
Survival (%)	96.8±2.75	88.9±5.50	90.5±0.01	92.1±5.50	95.2±0.01	0.1129

Values are mean ± SD of triplicate determination. Values in the same row with different lowercase letter indicate significant difference ($p < 0.05$)

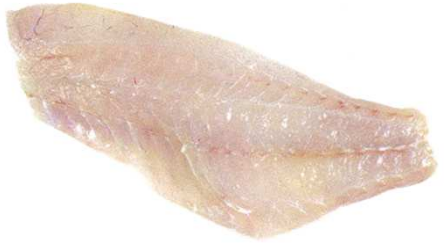
	Microvilli length (µm)				Microvilli diameter (µm)				Number of microvilli µm^2				Total absorption surface per microvilli (µm^2)			
CT	1.38	±	0.17	a	0.10	±	0.01		61.93	±	12.12	a	28.80	±	3.25	a
TISO	**1.57**	±	**0.16**	**b**	0.10	±	0.01		**76.60**	±	**10.17**	**b**	**39.14**	±	**3.44**	**b**
NAN	**1.99**	±	**0.25**	**c**	0.10	±	0.01		**70.57**	±	**9.80**	**ab**	**45.93**	±	**3.68**	**c**
SCE	1.35	±	0.25	a	0.10	±	0.01		**66.78**	±	**15.66**	**a**	26.30	±	10.41	a
p	<0.0001				0.0616				<0.0001				<0.0001			

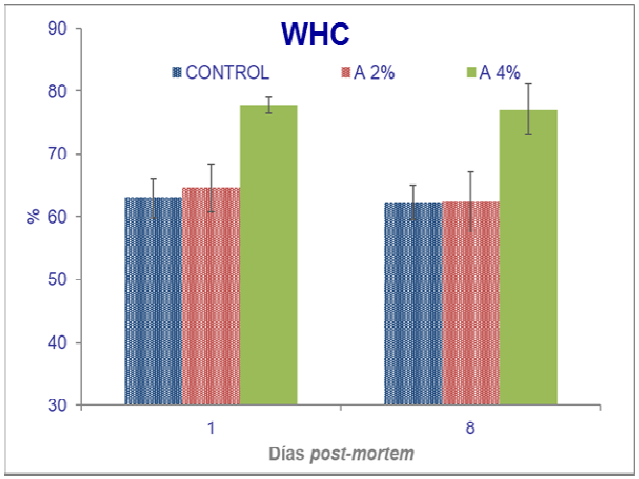
This project is funded by the European Union

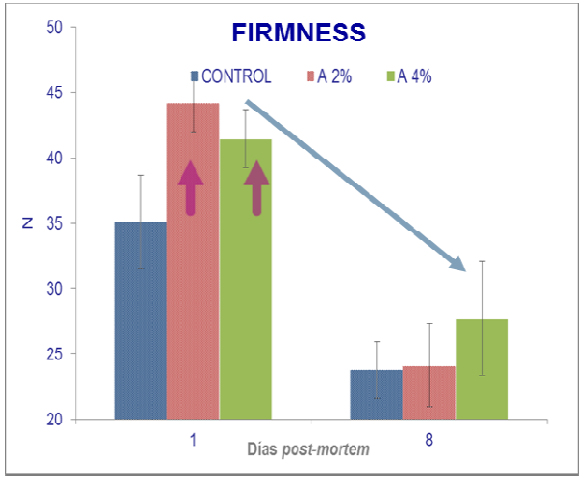
Aquaculture uses…

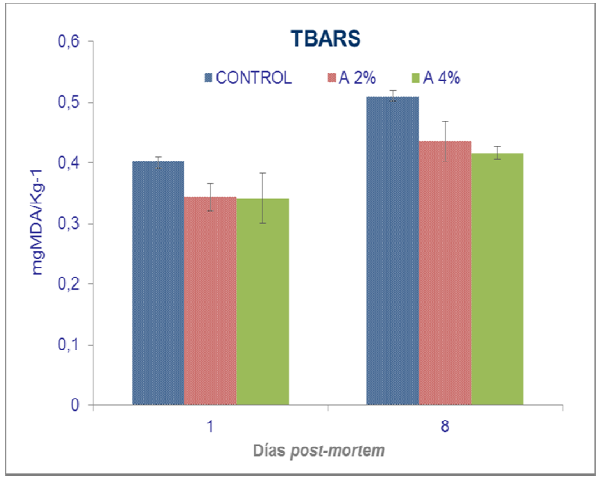
In vivo feeding trials

Effect of fish flesh quality







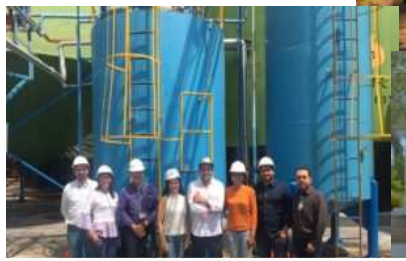


- Help to preserve Water Holding Capacity (WHC) in fillet, even during storage.
- Texture Profile Analysis (TPA): Increase in firmess of fish fillet.
- Lower level of lipid peroxidation in fillet, even during storage for eight days

This project is funded by the European Union

Dissemination

Training-Center: International Courses



International Summer Course 2017 Almeria (Spain)
International Summer Course 2018 Almeria (Spain)
8th Symposium on Microalgae and Seaweed Products on Plant/Soil Systems 2017 Mosonmagyarovar (Hungary)
International training course GAP'17 held in Trebon (Check Republic)
EUALGAE Training Course 2017 Almeria (Spain)
Symposium Biotechnology of microalgae 2017 Guadalajara (Mexico)
Training course Biotechnology of microalgae 2017 La Paz (México)
Workshop Microalgae production for aquaculture uses 2017 Coquimbo (Chile)

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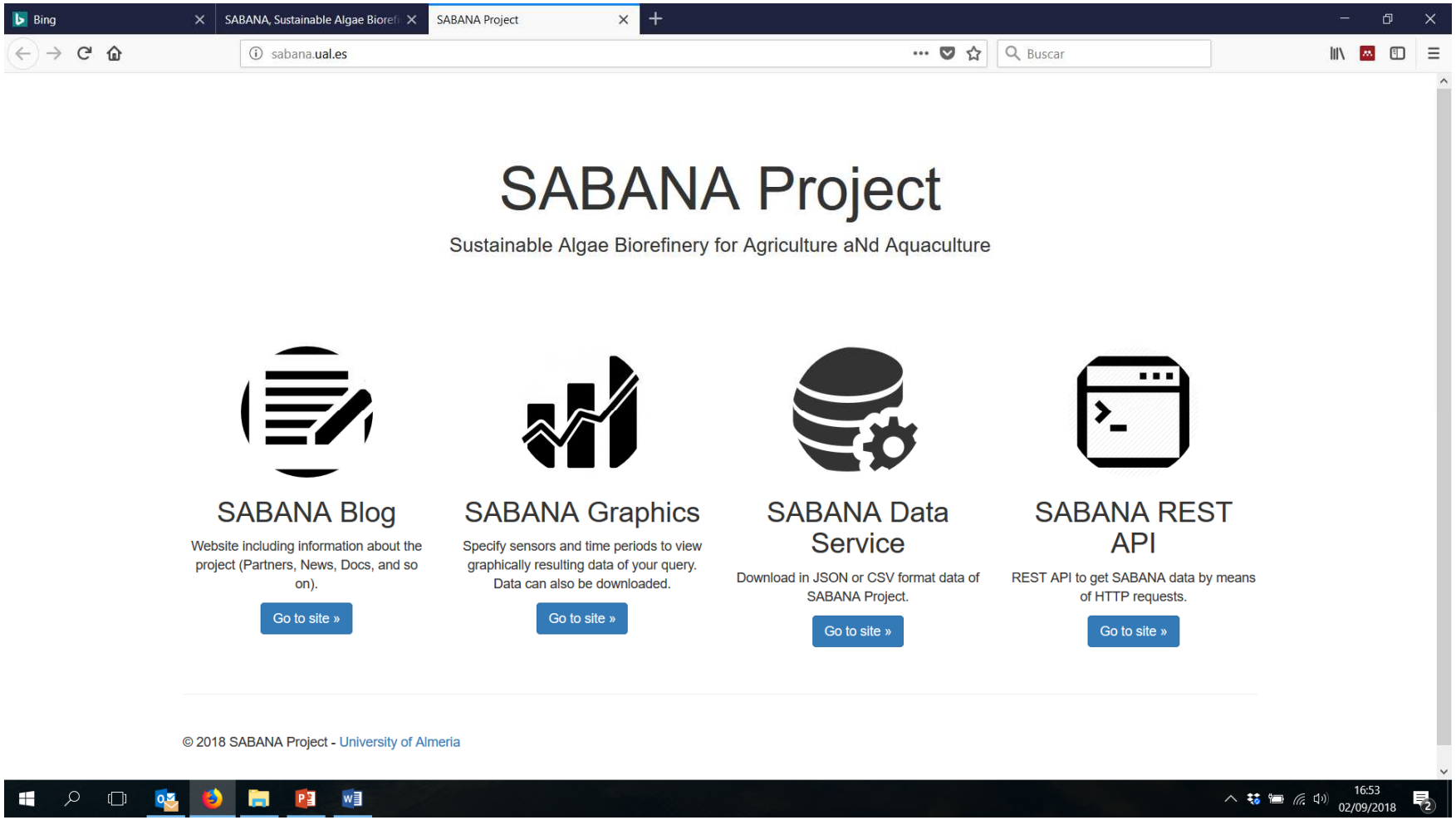
Dissemination

Data Center: sharing information



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Other related projects

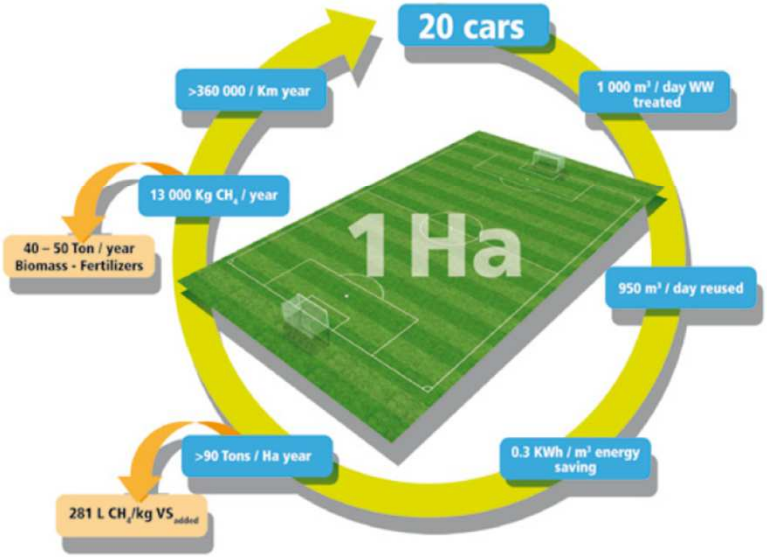
SABANA

All-gas Newsletter




aqualia BDI Fraunhofer HYGEAR University of Southampton

From dream to design to DEMO!



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Areas open to collaboration

- Sustainable wastewater treatment with microalgae
- Nutrients recovery from animal manure or agroindustrial residues
- Improvement of foods production systems by using microalgae-related products

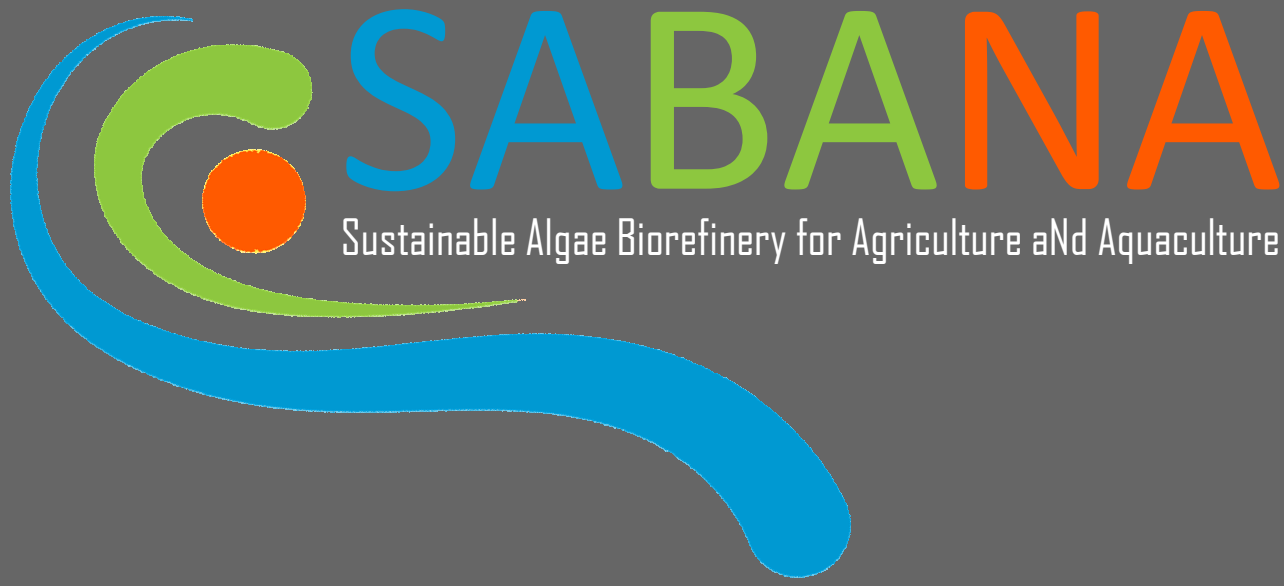
SFS-35-2019: **Sustainable Intensification in agriculture in Africa**

BG-07-2019: **The Future of Seas and Oceans Flagship Initiative - Observations and forecasting**

CE-RUR-08-2018-2019-2020: **Connecting economic and environmental gains - the Circular Economy (CE)**

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

Strategic Research and Innovation Agenda
2018/2028



www.eu-sabana.eu | info@sabana.eu

sabana.eu

@sabana.eu

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