CropBooster-P

In perspective; where did we come from?

European Commission
Horizon 2020
European Union funding
for Research & Innovation

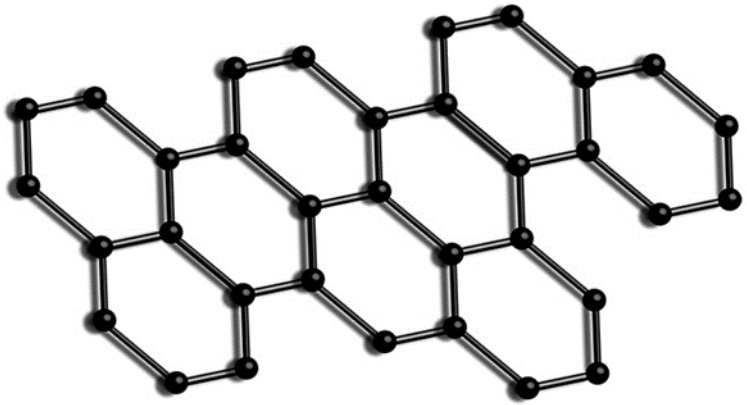
Photosynthesis 2.0; History of the initiative (1)

- Towards BioSolar Cell; Dutch National Photosynthesis Program
- Internal discussion rounds at Wageningen UR to set-up a European photosynthesis research initiative, mid 2014 – mid 2015
- Writing of the White Paper "Euro-Photosynthesis: Unleashing the Engine of Life on Earth. September – November 2015
- Presentation of the White Paper to Robert Jan Smits, Director-General of DG Research & Innovation by Louise Fresco, President of the Executive Board of Wageningen UR, November 2015
- Invitation by DG Research & Innovation to present in June 2016 a proposal that "potentially could qualify as a FET-Flagship", December 2015

GRAPHENE FLAGSHIP

"The Graphene Flagship is tasked with bringing together academic and industrial researchers to take graphene from the realm of academic laboratories into European society in the space of 10 years, thus generating economic growth, new jobs and new opportunities".

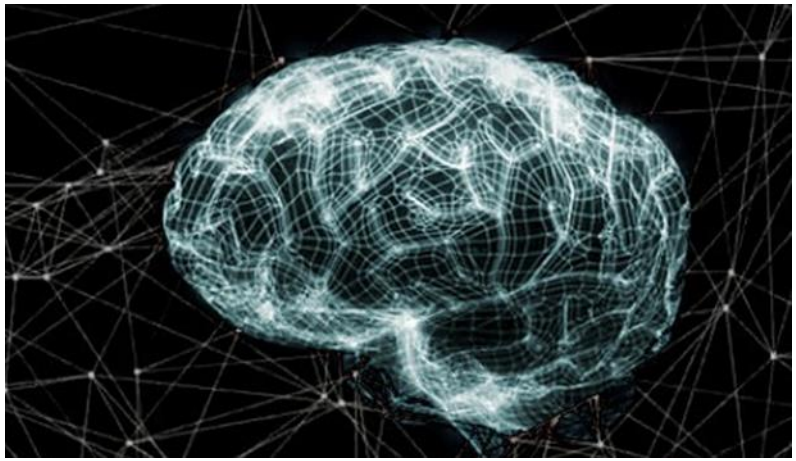
- Run time: 10 yr# Partners: > 150
- # Countries involved: 23
- Budget: 1,0 billion Euro



Human Brain Project

"The Human Brain Project aims to put in place a cutting-edge, ICT-based scientific research infrastructure that will allow scientific and industrial researchers to advance our knowledge in the fields of neuroscience, computing and brain-related medicine. The Project promotes collaboration across the globe, and is committed to driving forward European industry".

Run time: 10 yr
Partners: 112
Countries involved: 24
Budget: 1,2 billion Euro



Photosynthesis 2.0; History of the initiative (2)

- Building a Consortium of European Academic Institutions. January – April 2016

Composition of the Photosynthesis 2.0 consortium

UK
- Queen Mary University of London
- Imperial College London
- University of Leeds
- University of Essex
- Lancaster University
- University of Nottingham
- University of Cambridge
- James Hutton Institute

Denmark
- University of Copenhagen

Sweden
- Umeå University
- Uppsala University

Finland
- University of Turku

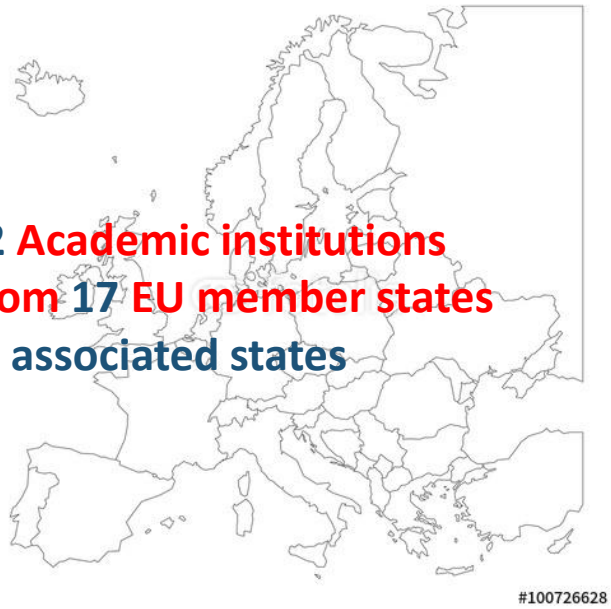
Lithuania
- Vilnius University

Estonia
- Estonian University of Life Sciences

The Netherlands
- Wageningen UR
- VU University Amsterdam

Belgium
- University of Liege
- VIB

France
- CEA Cadarache
- CEA Saclay
- CEA Grenoble
- INRA Montpellier
- Institut de Biologie Physico-Chimique - CNRS
- Station Biologique de Roscoff – CNRS
- ACTA



52 Academic institutions
From 17 EU member states
or associated states

Germany
- Heinrich Heine University Dusseldorf
- LMU Munchen
- Forschungszentrum Jülich
- MPIMP Golm
- Julius Kühn Institute

Switzerland
- ETH Zurich
- University of Zurich
- University of Neuchatel
- University of Lausanne

Czech Republic
- University of South Bohemia
- CEITEC
- ELI-Beamlines

Hungary
- Biological Research Centre
- ELI-ALPS

Israel
- Hebrew University of Jerusalem

Portugal
- Universidade nova de Lisboa

Spain
- Universidad de les Illes Balears
- Universitat Autonoma de Barcelona
- CREAF
- CSIC

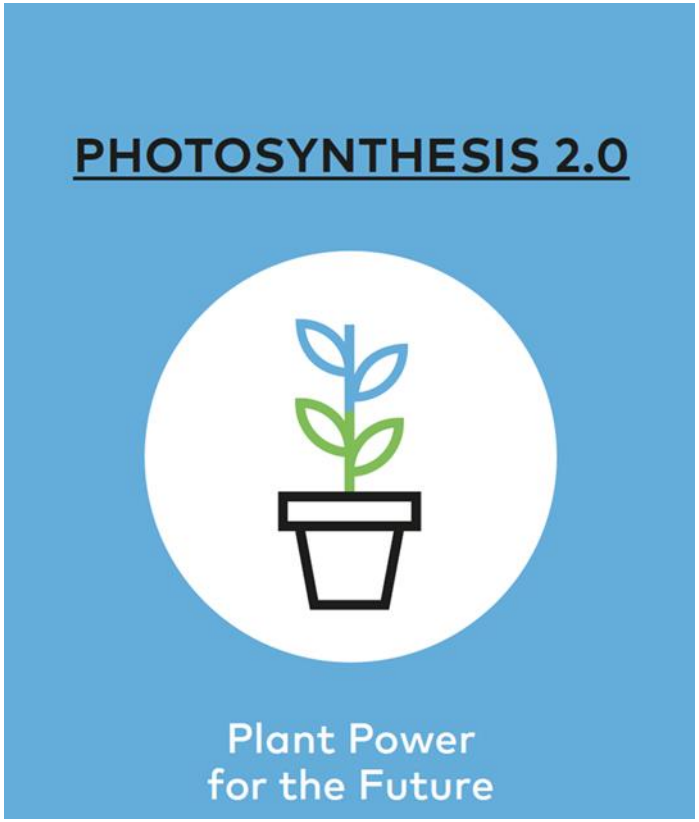
Italy
- CNR
- University of Verona
- ENEA
- CREA
- Politecnico di Milano
- ITT
- University of Padua

Photosynthesis 2.0; History of the initiative (2)

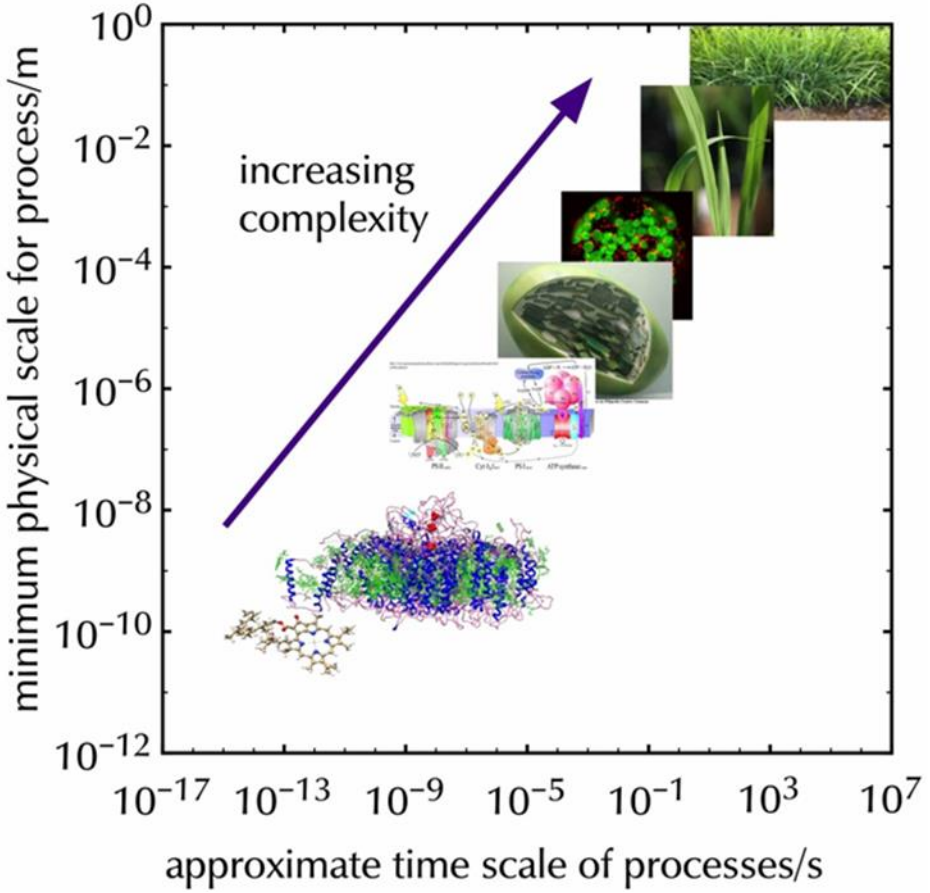
- Building a Consortium of European Academic Institutions . January – April 2016
- Writing of the Draft Research Program Photosynthesis 2.0, Plant Power for the Future

Photosynthesis 2.0; a “Flagship-like” program

“To develop the future crop varieties to double global agricultural production”



Photosynthesis 2.0; integration over scales



7 Scientific sub-programs

4 Technology development subprograms

Photosynthesis 2.0; History of the initiative (2)

- Building a Consortium of European Academic Institutions . January – April 2016
- Writing of the Draft Research Program Photosynthesis 2.0, Plant Power for the Future
- Presentation of Photosynthesis 2.0 to the European Commission, July 2016

Hmm, that was unexpected!

Photosynthesis 2.0; History of the initiative (3)

- Presentation of Food 2030 policy; European Research and Innovation for Food and Nutrition Security. October 2016

Photosynthesis 2.0; History of the initiative (3)

- Presentation of Food 2030 policy; European Research and Innovation for Food and Nutrition Security. October 2016
- Second round of discussions with the European Commission. November 2016

Proof of concept; Yes, we can!

15% dry weight increase

SCIENCE sciencemag.org

PLANT SCIENCE

Improving photosynthesis and crop productivity by accelerating recovery from photoprotection

Johannes Kromdijk,[1*] Katarzyna Głowacka,[1,2*] Lauriebeth Leonelli,[1] Stéphane T. Gabilly,[1] Masakazu Iwai,[3,4] Krishna K. Niyogi,[3,4]† Stephen P. Long[1,5]†

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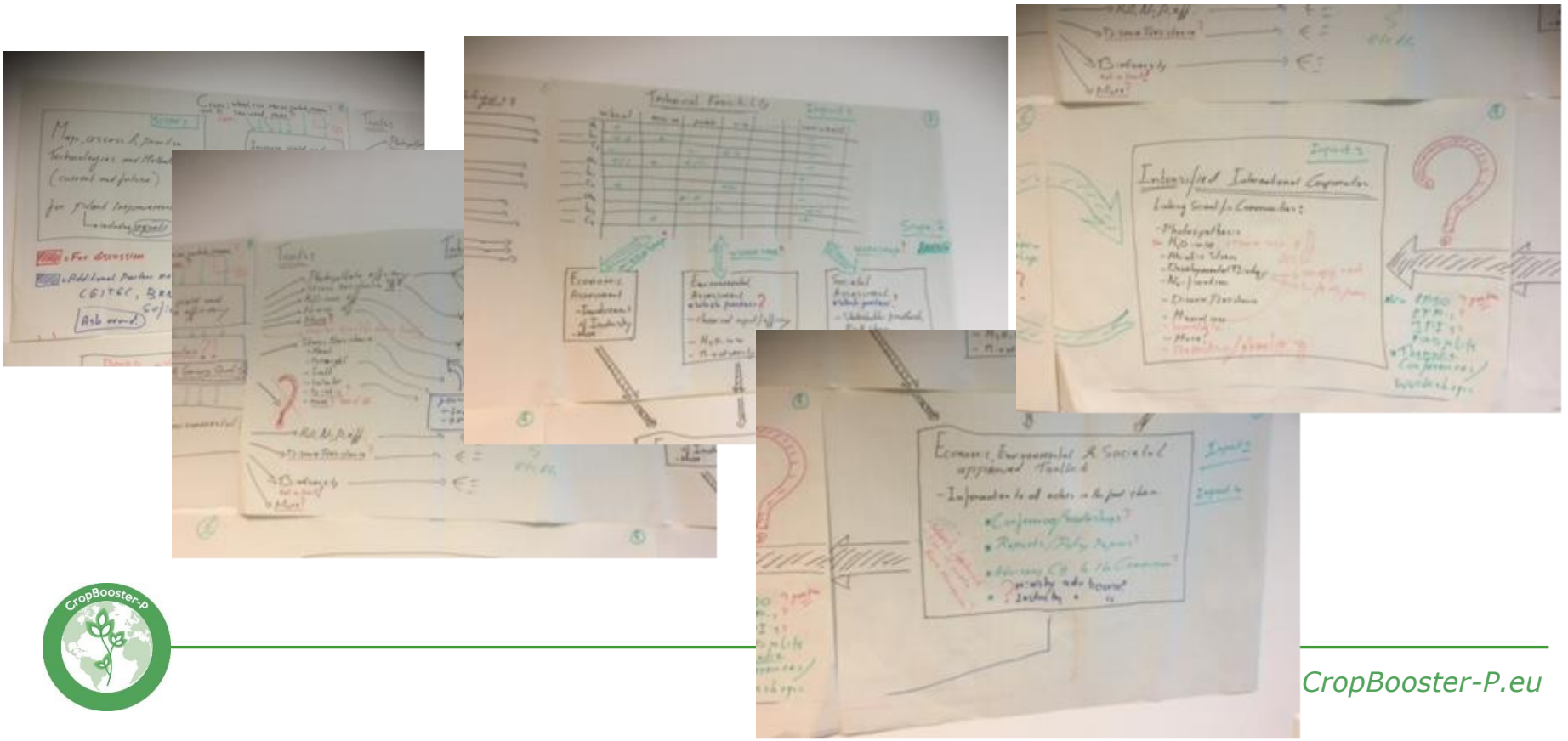
Johannes Kromdijk, Katarzyna Głowacka, Lauriebeth Leonelli, Stéphane T. Gabilly, Masakazu Iwai, Krishna K. Niyogi, Stephen P. Long (2016) **Science 354** 857-861

Photosynthesis 2.0; History of the initiative (3)

- Presentation of Food 2030 policy; European Research and Innovation for Food and Nutrition Security. October 2016
- Second round of discussions with the European Commission. November 2016
- Advice: adapt / amend Photosynthesis 2.0 program to a Crop Yield oriented program. Prepare for POTENTIAL (!) call for "large research initiatives (Missions)" in the area of Food and Nutrition Security in the next Framework Program (Horizon Europe).
- Advice: Make use of a Coordination and Support Action in the final round of H2020 to develop the Roadmap towards the implementation of the Photosynthesis 2.0 program

CropBooster-P

- A brainstorm was organized in Wageningen September 2017 to shape the CSA.
- The CropBooster-P project was granted in June 2018 and has started November 1st 2018; run time: 3 years.



Photosynthesis 2.0; History of the initiative (3)

- Presentation of Food 2030 policy; European Research and Innovation for Food and Nutrition Security. October 2016
- Second round of discussions with the European Commission. November 2016
- Advice: adapt / amend Photosynthesis 2.0 program to a Crop Yield oriented program. Prepare for POTENTIAL (!) call for "large research initiatives" in the area of Food and Nutrition Security in the next Framework Program (2021).
- Advice: Make use of a Coordination and Support Action in the final round of H2020 to develop the Roadmap towards the implementation of the Photosynthesis 2.0 program
- Advice: Make use of upcoming calls in H2020 to start already part of the research ➔ CAPITALISE

CAPITALISE

Overview of Photosynthesis

Crop plant photosynthesis falls into two main classes C3 and C4. These differ in the metabolic pathway employed to fix carbon dioxide (CO2).

In temperate regions C3 photosynthesis is used by most crop types (e.g. wheat, barley, potato and the brassicas). C4 photosynthesis is a supercharged version of C3 photosynthesis which ultimately allows higher concentrations of CO2 to build up. The C4 system is important in many crops in hotter, drier climates, such as maize, sorghum or millet. Warming climates are expected to increase the importance of C4 crops in Europe.

After decades of research we now know photosynthesis is made up of approximately 170 interdependent steps. Recent advances using genetically modified plants, such as tobacco and Arabidopsis, have shown that photosynthesis can be significantly improved, by adjusting some steps, leading to crop yield increases above our 10% target. The photosynthetic rate does not directly extrapolate to whole plant growth rates, there are complex interactions between physiological and environmental parameters. The challenge to translate from laboratory to field now drives multiple international efforts, including Horizon 2020 projects and the Gates Foundation “Realizing Increased Photosynthetic Efficiency for sustainable increases” (RIPE) programme to re-engineer photosynthesis.

Our team will look at natural populations and GM plants as tools to investigate mechanisms to exploit natural

Scope of CropBooster-P

- Our main drivers are food security and climate change
  - How to we feed the global population in 2050?
  - How can we protect agriculture from the negative effects of climate change?
  - How can we transfer from a fossil economy to a bio-economy?

- We will draft a Roadmap to future-proof our crops
  - CropBooster-P explores options to improve plants, including aquatic plants, by breeding and/or by biotechnology.
  - We focus on yield, quality and sustainability

- Broad definitions:
  - Yield = total plant yield or yield of harvestable/edible parts of a plant
  - Quality = nutritional quality (e.g. protein content, carbohydrates, vitamins, minerals) or industrial quality (e.g. fibre composition, THC content, etc.).
    - Out of scope: organoleptic quality (taste, smell, mouth feeling, etc.)
  - Sustainability = resource use efficiency (e.g. water use, nitrogen use, etc) and abiotic stress resistance (e.g. heat stress, drought stress, mineral stress, etc.)
    - Out of scope: biotic stress resistance

- We intent to form a future, large scale consortium to execute the Roadmap
  - Therefor the Roadmap will also propose a blueprint for such a consortium, including its *modus operandi*

CropBooster-P

In perspective; End of Part 1

European Commission

Horizon 2020
European Union funding
for Research & Innovation