3rd July 2020

Launch of CAPITALISE: a European collaborative research project exploiting biodiversity to boost the efficiency of photosynthesis for better crops

Project Summary:

- ✓ Plant scientists and crop breeders receive €8.6M from the EC Horizon 2020 research programme to improve future crops through the CAPITALISE project;
- ✓ 19 organisations from EU countries, the UK, Israel, and Ethiopia are pooling knowledge and resources to design high yielding crops for the future;
- ✓ The target is to improve photosynthesis: Researchers aim to increase the efficiency of how plants use light energy to convert carbon dioxide and water into sugars to boost yields in key crops;
- ✓ Combines state of the art science and the natural biodiversity of plants to find new ways to use natural genetic diversity to make future crops more efficient and increase yield;
- ✓ CAPITALISE will consult with citizens, industry, scientists, and other stakeholders to develop a roadmap for future photosynthesis driven crop research and breeding programmes.

The CAPITALISE crop research project has been granted 8.6 million Euros from the EC to exploit ground-breaking technology to radically increase crop yields in Europe and beyond. This is part of a new Green Revolution to address the expected future food crisis. By 2050 the world population is expected to rise above 9 billion people, food security experts estimate an increase of 110% in current crop productivity is needed. But current yield improvements are only around 1% per year, and the productivity increase of some key crops, including wheat and rice, has stalled in some major production areas. Despite clever crop breeding programmes and agricultural practices, new innovations are needed now. CAPITALISE led by Wageningen University (Netherlands) is driving an international multidisciplinary team of plant breeding companies, a phenotyping technology developer and academic plant scientists to develop high yielding 'Climate Smart' crops.



Scientists and crop breeders will work on the model crops barley, maize and tomato.

The efficiency of photosynthesis in crop plants is well below the theoretical maximum for the process, this implies there is scope for improving this engine of agricultural productivity. Plant scientists have discovered that improving photosynthetic traits to increase the efficiency of photosynthesis can results in significant increases in plant productivity. Based on this work, three very promising candidate strategies have been identified to improve the efficiency of photosynthesis in crop plants:

1. **Tuning of the Calvin Cycle**: The Calvin Cycle involves a series of chemical reactions in a step-wise process to convert carbon dioxide into the carbohydrates that are the basic building blocks used for plant for growth and development. Research has identified specific reactions in this cycle that will be targeted for improvements.
2. **The kinetics of photosynthetic responses to changes in irradiance**: Photosynthesis is a light-driven process. Increases and decreases in light intensity produce increases and decreases in photosynthesis. These changes in photosynthesis do not optimally track light-intensity making photosynthesis less efficient. Our work will identify how these slow responses to changes in light intensity can be accelerated, producing increases in photosynthetic efficiency.
3. **Tuning leaf chlorophyll content**: In nature, plants compete for the resources they need to live and grow, this includes light. Plant leaves both trap the light needed for their own photosynthesis, and also deprive competitor plants of light through shading. This means that light distribution in a plant canopy is sub-optimal for photosynthesis. We aim to tune the profile of light absorption in a canopy by adjusting leaf chlorophyll levels, and reducing shading effects, to improve the efficiency of how plants capture and use light energy.

Although scientists have made significant advances to date, this knowledge has not been readily translated into crop breeding programmes. CAPITALISE will develop new plant breeding tools based on the selected strategies to (i) increase the rate of CO2-fixation into sugars and (ii) improve response time of photosynthesis and (iii) optimise the profile of crop canopy light absorption. The project will improve photosynthesis by identifying and using naturally occurring variation for these traits in three representative crop plants: tomato, barley and maize.

Jeremy Harbinson, CAPITALISE project coordinator explained “The natural variation seen across diverse crop plant species has enormous potential to allow us to increase photosynthesis. Modern non-GM plant breeding methods will be used to introduce these favourable traits identified in crop species and their near-relatives into crop plants, to produce high yielding non-GM crops”.

Leaders in Europe’s crop breeding industry BASF, KWS and Limagrain bring expertise in translating scientific results into elite crop breeding lines. The companies will advance the most promising results into crop breeding programmes and field trials using tomatoe, barley and maize. The CAPITALISE knowledge base is expected to open up new avenues of crop research and identify priorities for a European Roadmap for crop yield improvement in the next decade.

CAPITALISE brings together plant breeders with academic plant geneticists and germplasm experts, physiologists, biochemists, bioenergeticists, computational biologists and modelers, social scientists, and instrument developers. This multi-disciplinary approach breaks down existing innovation “silos” and will develop a focused research agenda and road map for policy makers, funders and the research community. The team is made up of 19 research organisations and companies come from across Europe, the UK, Israel, and Ethiopia.

Additional Quotes for use:

Dr Matteo Dell’Acqua (SSSA, IT) Germplasm Work package leader:

"*Natural variation is key to the project. New photosynthetic traits may be sourced from untapped populations of tomato, maize and barley. We will search for these traits in thousands of genotypes collected across the world and spanning from the Ethiopian highlands, to the Fertile Crescent in the Middle East, and laboratories across Europe and the United States.*";

CAPITALISE H2020 Project-PR July 2020

"*The CAPITALISE project makes use of broad collections of untapped genetic materials, including traditional landraces, mutants, and breeding lines. By leveraging their diversity, we aim to open new pathways to photosynthesis improvement complementing work done to date*.".

Dr Astrid Junker (IPK, DE) CAPITALISE Work Package Phenotyping leader "*I'm really excited to be part of this big multi-disciplinary consortium which will foster photosynthesis research for crop improvement throughout Europe and beyond*!". *We will use comprehensive automated plant phenotyping infrastructures for the integrated and dynamic assessment of plant performance and physiology across the consortium. This includes trials in the novel IPK Plant Cultivation Hall for phenotyping under controlled, simulated field-like conditions".*

"Bridging the modern phenotyping approaches for photosynthetic performance with plant breeding, genomics and molecular-physiological analyses, underpinned with FAIR data management and integration procedures, will enable to identify key targets for photosynthesis improvement in some of Europe's key crops".

Dr Johannes Kromdijk (University of Cambridge, UK) "*Important for CAPITALISE is the realization that under the fluctuating light conditions within the leafy crop canopies that produce our food, photosynthetic efficiency can often be much lower than what seems attainable from constant light conditions. Performance under changing conditions is therefore particularly relevant for crop productivity. CAPITALISE will characterize natural genetic variation in non-steady state photosynthesis in mapping populations of tomato, maize and barley to find specific alleles that might be beneficial to increase crop photosynthesis under field conditions*"

Dr Ritchie Head (Ceratium BV, NL) CAPITALISE project manager*: "This is one of the most exciting projects I have been involved with. Europe has world leading expertise in photosynthesis, we will now translate this science to improve key crops". "CAPITALISE combines cutting edge research on three core elements of photosynthesis with new understanding of genetic variability in how relatives of crop species perform these functions. This will drive new crop breeding programmes to deliver more efficient, higher yielding plants".*

Further Information:

Project Coordinator - Dr Jeremy Harbinson (jeremy.Harbinson@wur.nl / +31 317 483660);

PR Contact for further information and photographs - Ritchie Head (ritchie.head@ceratium.eu / +44 7503969795).

Ceratium BV are working with project Coordinator Wageningen University and an international consortium to deliver cutting edge plant science and a roadmap for crop improvement focused on the processes of photosynthesis.

The consortium includes:

Organisation	Country
Wageningen University,(Coordinator) Vrije Universiteit Amsterdam;	NL

BASF Nunhems BV; Limagrain Nederland BV; Ceratium BV	
PSI (Photon Systems Instruments) spol. s r.o.,	CZ
Julius Kühn-Institut; IPK Leibniz Institute of Plant Genetics and Crop Plant Research; University of Potsdam; KWS SAAT SE & Co KGaA	DE
Commissariat à l'énergie atomique et aux énergies alternatives	FR
Sant'Anna School of Advanced Studies (SSSA)	IT
The Agricultural Research Organisation of Israel; Ben-Gurion University of the Negev; The Hebrew University of Jerusalem	IL
University of Cambridge, University of Essex; University of Lancaster	UK
Amhara Regional Agricultural Research Institute	Ethiopia

CAPITALISE and Horizon 2020

The CAPITALISE project is funded by Horizon 2020 under grant agreement number 862201.

Horizon 2020 is the European Commission's biggest EU Research and Innovation programme ever with nearly €80 billion of funding available over 7 years (2014 to 2020). See https://ec.europa.eu/programmes/horizon2020/what-horizon-2020.

The project was funded under the BIOTEC-02-2019 call - Boosting the efficiency of photosynthesis (RIA) call https://cordis.europa.eu/programme/id/H2020_BIOTEC-02-2019/en.

The project overall budget is €8.917.646, with an EC H2020 grant contribution of €8.573.895.