Submission to EC consultation

European Plant Science Organisation
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Potential priorities for research and innovation in the 2018-2020 Work Programme of Horizon 2020 Societal Challenges 5 'Climate action, Environment, Resource efficiency and Raw materials'

Brussels, 08.04.2016

EC consultation's aim and request: *Within Societal Challenge 5, research and innovation aims to "achieve a resource – and water – efficient and climate change resilient economy and society, the protection and sustainable management of natural resources and ecosystems, and a sustainable supply and use of raw materials, in order to meet the needs of a growing global population within the sustainable limits of the planet's natural resources and eco-system" and hence to address societal needs and socio-economic priorities.*
Please consider the following questions, citing in support of your response any available evidence such as foresight and other assessments of research and innovation trends and market opportunities, across the six sub-challenges of Societal Challenge 5 (i.e. Fighting and adapting to climate change; Protecting the environment, sustainably managing natural resources, water, biodiversity and ecosystems; Ensuring the sustainable supply of non-energy and non-agricultural raw materials; Enabling the transition towards a green economy and society through eco-innovation; Developing comprehensive and sustained global environmental observation and information systems; Cultural heritage).

EPSO experts on plant science and climate change helped preparing and some of them participated in the European Parliament – Plants for the Future Workshop on "Climate change" in Brussels, 1.12.2015. EPSO now contacted these experts and its Board members to develop the input to this EC consultation.

Q1) What are the challenges in the areas of Societal Challenge 5 'Climate action, environment, resource efficiency and raw materials' that require action under the Work Programme 2018-2020? Would they require an integrated approach across the Horizon 2020 Societal Challenges and Leadership in Enabling and Industrial Technologies?
The overarching challenge is to sustainably produce enough nutritious food and other renewable bioresources for a growing world population while at the same time dealing with the consequences of climate change which increases for instance abiotic and biotic stress for plants. A failure to properly address this challenge will lead to food shortages/famine, dramatically increased food prices and large shifts in global economies. If the EU does not take this challenge seriously and invests in the appropriate technology and expertise, much of the knowledge and innovation that is necessary to produce the food and bioresources required in the future will be developed in other parts of the world such as the US and China.
There are multiple important ways to address this major challenge, two of which are based on plant breeding and agronomy. A major focus in SC5 should therefore be the development of suitable crops that are resource use efficient, resilient and of good quality for food and non-food applications. Most crops cultivated currently produce one (or a few) main product in addition to, sometimes large, waste streams with limited or unexplored economic value. The crops of the future will be developed in such a way that biomass can be fully exploited for the purpose(s) it has been tailored for, including food and non-food applications, whilst minimizing waste and optimizing input without depleting natural resources. The development of such crops requires agronomic research and an integrative breeding approach. Along with this there is the necessity to develop the technologies to address existing yield gaps for a wide range of crops. Closing these yield gaps requires a better understanding of crop performance, and response to multiple environmental factors.

A related challenge is how to reduce GHG emissions to mitigate climate change by keeping the global average temperature increase below two degrees. This will require innovative solutions to reduce emissions from both agricultural, industrial, and the transport sectors; the particular solution depending on the sector. An integrated approach will be required in order to 'balance' emissions across all sectors, but with each sector contributing to emissions reductions. In the agricultural sector there is scope for significant reductions that could be win-win, for instance better and more efficient use of fertilizers would decrease production costs and decrease run-off as well as reducing GHG emissions. One way to address this is through improved precision agricultural techniques that result in the improved spatial application of fertilizers, improving the plant microbiome to better uptake and use nutrients, and the use of cropping systems that use resources more efficiently.

There also needs to be a better understanding of GHG offsetting mechanisms associated with afforestation: the available area that could be used needs to be quantified so that the use of any 'extra' land does not compromise agricultural production and the best tree species and management practices for this purpose are identified. Given that GHG emissions are often linked to plant attributes, there are also opportunities for targeted breeding of crops to reduce GHG emissions – possibly underutilised so far.

An overarching need for the future development of plant science is to see how it will contribute to the mainstreaming of ecosystem services (ES) into agro-ecosystems. Mainstreaming ES into future agriculture requires protocols to replace some of the nonrenewable resources (e.g. fossil fuel-based pesticides and fertilizers) with renewable resources (ES such as biological control of insect pests or nitrogen fixation by legumes) and develop agricultural systems that enable farmland to simultaneously provide food and a range of ecosystem services. Recent research demonstrates that managed systems with these protocols exhibit higher economic value of ecosystem services. This goal will require that plant science moves out of its 'comfort zone' in the laboratory and broadens its research horizons to include these future challenges. Large scale experiments are required to assemble the large data sets needed for climate/agricultural modulation. These approaches require collaboration between societal challenges 5 (climate) and 2 (food / agriculture / aquaculture / biotechnology).

Examples of the impact of plant breeding on food security linked with climate change can be found in the recent report on "The Economic, Social, and Environmental Value of Plant Breeding in the European Union" published 15.3.2016 (e.g. pages 36-43 for past impact, p. 53-54 on future potential impact).

2) What is the output/impact that could be foreseen? Which innovation aspects could reach (market) deployment within 5-7 years?

Depending on the nature of the innovation and the sector(s) involved, there could be various levels of market deployment reached within the proposed time frame of 5-7 years. Normally, plant breeding is a process that takes longer than 5-7 years before the results can be turned into marketable products. However, by building on existing programmes and current variation, new varieties of resource efficient crops with improved quality for food and non-food purposes could be produced that will benefit the agricultural and agro-industrial sector in the EU.

A better understanding of crop performance and agronomy has a high likelihood of being implemented within a rather shorter time frame. Also, given that the knowledge base and the tools for GHG offsetting mechanisms currently exist and/or are being developed, with forest-related offsetting already under investigation, these approaches have potential for deployment within 5-7 years.

It is nevertheless important to point out that it is absolutely crucial to lay a solid foundation for both plant breeding and agronomic practices that adopts a longer perspective so that this will continue to benefit the EU in decades to come.

3) Which gaps (in science and technology, innovation, markets, policy, financing and governance, regulation etc.) and potential game changers, including the role of the public sector in accelerating changes, need to be taken into account?

Development of new crops and the incorporation of ecosystem services into farming are essential for the success of a vibrant and productive bioeconomy. The EU has world-leading research in this area, but most of the innovations are commercialised elsewhere, in part because of opposition to novel breeding technologies in Europe. With a much more efficient research-to-innovation procedure in e.g. the US and China, the EU is at risk of falling behind unless both the political and financial resources are redirected in order to fully benefit from the

high capacity of European public research institutes and small, medium-sized and large private entities.
Plant breeding for novel crop products, such as biobased industrial materials, is in its infancy and production chains for these crops are lacking. Private investors are thus cautious and often considered it a high risk investment. Public investment in this area is important to make full use of the potential of biobased industrial materials.
There is still a lack of understanding of the benefits of any GHG mitigation/offsetting mechanism to the individual farmer and the economics of any shift away from conventional agricultural production systems. Much of the basic work underpinning these approaches is of little direct economic value for the producer (or user) and would again require public sector involvement.

4) Which areas could benefit from integration of horizontal aspects such as social sciences and humanities, responsible research and innovation, gender aspects, international cooperation?
Development of new crops and agronomic practices for Europe requires international cooperation in order to benefit from larger datasets, genetic resources, research infrastructure as well as the efficient dissemination of results/products. In addition, food and nutritional security interlinked with climate change are global challenges on which Europe should take up its responsibility and be among the leaders in developing solutions not only for Europe but as well for instance for developing countries.
The economics and on-farm benefits of GHG offsetting/mitigation have significant socio-economic consequences and have impacts on farm livelihoods.
All approaches require responsible research and innovation to ensure minimal environmental impacts.
In general, there is a need for capacity building in many aspects of plant science. These areas can include better connections between plant science and the skills needed to make plant science more quantitative and predictive.

5) In view of the recent evolution of the socio-economic and policy context (see point 3 of this document), what are the emerging priorities for Societal Challenge 5?
New breeding technologies, more efficient and sustainable production of bioresources, deeper understanding of which genes and processes increase the efficiency of water and nutrient uptake and utilisation, development of new multi-functional crops, crop adaptation to climate change, use of bioresources to replace energy, chemicals and materials based on fossil fuels, together with basic/fundamental plant biology, genetics research and research infrastructure. All of these investments have huge potential for strengthening the global competitiveness of the EU, promoting growth and creating rural and urban job opportunities, and further stimulate investments from public and private sources. We therefore strongly recommend the inclusion of all the mentioned areas in the development of the 2018-2020 work programme of the Horizon 2020 Societal Challenge 5 in collaboration with Societal Challenge 2.

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Useful links and references
- EPSO: Submission to EC consultation on the Draft "Strategic approach to agricultural research and innovation", 15.12.2015 Submission summary and completed questionnaire, calling to urgently strengthen collaborative basic research in the Societal Challenges, supporting all technologies equally, including improvement of yield and yield stability and plant compounds for human nutrition and health
- EPSO: Fact sheets on New Breeding Technologies, 21.3.2016. Including: Site-Directed Nucleases (e.g. genome editing), Oligonucleotide-Directed Mutagenesis, RNA-directed DNA-Methylation, Cisgenesis, Grafting using GM plants, Reverse breeding, and Agroinfiltration.
- EPSO: Statement on Crop Genetic Improvement Technologies, 18.12.2015.
- EPSO: Submission to EC consultation on the Role of Research in Global Food and Nutrition Security (summary reply), 1.9.2015; completed online questionnaire
- EPSO communications: www.epsoweb.org/epso-communications

- EPSO member institutes and universities: www.epsoweb.org/membership/members
- EPSO representatives: www.epsoweb.org/membership/representatives
- EPSO Board members: www.epsoweb.org/about/board

- Plants for the Future ETP: Study on "The Economic, Social, and Environmental Value of Plant Breeding in the European Union", 15.3.2016
- Plants for the Future ETP: Press Release on the European Parliament-Plant ETP Dinner Workshop 'Climate change - The Role of Plants' that took place on 1st December, 8.12.2015

About EPSO

EPSO, the European Plant Science Organisation, is an independent academic organisation that represents more than 220 research institutes, departments and universities from 28 European countries, Australia, Japan and New Zealand, and 3.200 individuals Personal Members, representing over 28 000 people working in plant science. EPSO's mission is to improve the impact and visibility of plant science in Europe, to provide authoritative source of independent information on plant science, and to promote training of plant scientists to meet the 21st century challenges in breeding, agriculture, horticulture, forestry, plant ecology and sectors related to plant science. www.epsoweb.org