Reducing environment footprint of agriculture without decreasing yield

The European and Global challenge of growing agricultural productivity, quality and diversification to meet societal needs whilst decreasing the environmental footprint of farming is widely understood and acknowledged. However, delivering economically viable, durable and sustainable solutions to these challenges requires a fundamental change in our approach to agri-food production systems.

Our agri-food systems have become increasingly complex as the challenges arising from population growth, diversification of demand, multiple regulatory environments and climate change combine. At the same time, new opportunities are arising through the translation of advanced technologies, novel practices, integration of big data and new business models. The challenge and complexity around the agri-food production systems is further compounded by the prolonged timeframes often involved for societal acceptance of many of the novel technologies that may deliver solutions in this sector.

Tackling these diverse stimuli smartly demands a **holistic whole-systems approach and smart interaction between different stakeholder groups**; representing policy-makers, civil society, industry, academia and the farming community. The future agri-food value chain need to deliver not only benefits to society, by ensuring consumers access to a wide range of safe, nutritious, reliable and affordable goods, but also to offer stakeholders along the value chain a proper return to invest in further innovation and employment within the sector.

Innovation, in science, practice and policy, is key to tackling these challenges and, for the long-term, solutions need to deliver increases in yield potential, yield stability and quality without compromising on reducing the environmental impact of our food production systems. Such innovation also has to deliver in the context of sub-optimal and often changing agri-environments where multiple, and highly variable, climatic stresses are expected to occur more frequently and with greater intensity.

European companies and public research institutes have played, and continue to play, a prominent role in providing innovative solutions with advanced technologies and new concepts for the improvement of both food and non-food crops. Priorities for the plant research and plant breeding sectors providing continued innovation to enable the development of new varieties with high yield and lower environmental footprint include:

- ✓ Improving **resource use efficiency** and **resource stewardship** – such as land, soil, nutrients, and water;
- ✓ Improving **yield and yield stability** – combining abiotic stress resistance with a focus on mitigating water and temperature stress and sustainably increasing marketable yield;
- ✓ Improving **plant health** by tackling ongoing and emerging pests, weeds and diseases;
- ✓ Developing **plants with improved composition for animal and human nutrition** & lowering environmental footprint;

- ✓ Developing **plants adapted to new sustainable production methods** (mixed cultivation system);
- ✓ Further understanding **plant-microbe interactions,** and the role of the microbiome in increasing crop quality and productivity, and reducing greenhouse gas emissions.
- ✓ Further understanding plant-ecosystem interactions to develop **new sustainable solutions for crop protection** (e.g. biocontrol)

Through **a better understanding of the ecological, physiological and genetic requirements of our crops**, the plant sector will be able to develop crops and varieties specifically adapted to diverse conditions which are less vulnerable to environmental stresses. To achieve this, we will need to utilise innovations in plant science and breeding to efficiently introduce genetic diversity from outside of the currently used gene pools and, in some cases domesticate entirely new crop species, for food and/or industrial purposes in a relatively short timeframe. Detailed analysis of a wide range of quantitative genetic traits, of the epigenetic control of plant traits, and more comprehensive phenotyping are also needed for a thorough understanding of the potential for improved plant adaptation and yield resilience. Such efforts will help to increase the range of varieties available to farmers and enable improved resource use efficiency and resource stewardship across the board, as well as enabling the optimisation of production systems for marginal land.

Along with novel breeding methods, **efficient and sustainable production methods** must also be developed. Mixed cultivation systems (for example, of cereals and associated legume crops) may also help to diversify plant production, and thus increase resilience throughout the entire system. However, we need to improve our understanding of management systems and integrated plant production in different regions of Europe to overcome the loss of agricultural diversity during recent decades, which has made our production systems increasingly vulnerable. European research should help to develop production systems that are adapted to regional conditions. In addition, **regulatory systems conductive to bringing regional innovation to the market** should be available to facilitate the development and use of new varieties by SMEs and a wide range of farming communities.

Farmer adoption of new technology and varieties is crucial if innovations from the plant research and breeding sectors are to be effective. It is therefore essential to ensure early in the R&D process that both farmer and market demand are in place for a given intervention and that knowledge exchange and technology transfer mechanisms are in place to ensure effective uptake and communication for new technologies and practices. **Early involvement of farmers in the innovation process** is particularly important where local and regional knowledge of specific crops/ varieties / wild relatives (and their biology), and agronomic conditions and agricultural practices is required if appropriate solutions and interventions are to be developed.

Advances in plant varieties also need to be considered in the overall context of advances in remote-sensing, increased biological knowledge and increased access to agricultural and environmental data which are all enabling rapid advances in autonomous precision-farming. **The combination of remote sensors, robotics, large-scale and real-time data analytics**

has an enormous potential to enable timely and precise interventions to significantly increase the sustainability of farming by applying inputs where and when they are required, create the best possible growing conditions and ensure optimal harvesting and transportation of goods. Current technological progress in this area which promote precision farming, includes:

- ✓ Remote sensing – enabling autonomous collection of agricultural data from distance and provides early warning on crop and soil status, e.g. soil moisture, nutrient deficiency in plants, and detection of pests and diseases;
- ✓ Geomapping – enabling the analysis and visualisation of agricultural environments and workflows e.g. production of nutrient maps, soil typographies (erosion/ remediation), land-use maps, forecasting yield, and harvest dates etc;
- ✓ Robotics – enabling in-field imaging, autonomous fertiliser application, precision soil management, automated weeding, harvesting, and pest control etc.

Achieving the integrated goal of food and nutritional security with sustainable production in the coming decades is technically possible through the application of appropriate soil, resource and environmental management, combined with diverse and optimised crops and microbiomes supporting diverse diets through stable and resilient production systems. It will require a common vision and an integrative systems approach from academia, industry, farmers and policy makers, supported by society.

From a technological perspective, a substantially better aligned, and increased public and private investment in agricultural research, and development would already make a significant difference, both in Europe and globally.

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About ETP Plants for the Future - www.plantetp.org
The European Technology Platform 'Plants for the Future' (Plant ETP) is a stakeholder forum for the plant sector that brings together members from industry, academia and the farming community. The industrial sector is represented by the European Seed Association (ESA) which represents itself the totality of the European seed industry (more than 7,000 companies, 90% of which are SMEs) active in research, breeding, production and seed marketing. A number of individual companies are also direct members of Plant ETP. The academic sector is represented by the European Plant Science Organisation (EPSO), an independent academic organisation with over 220 research institutes and universities as institutional members and 3,300 Personal Members, representing over 27,000 people working in plant science. The farming sector is represented by Copa-Cogeca, the European organisation for farmers and their cooperatives. Copa represents over 13 million farmers whilst Cogeca represents the interests of 38,000 agricultural cooperatives.