

Growing a Prosperous Future for the European Union

Summary of Action Plans to 2020



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Part II – Innovation Action Plan to 2020

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Part IV – Education Action Plan to 2020

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The Summary of Action Plans is part I of four documents: Part II – Innovation Action Plan, Part III – Research Action Plan and Part IV – Education Action Plan. All documents can be downloaded from the website www.plantetp.org

Growing a Prosperous Future
for the European Union
Summary of Action Plans to 2020

Summary

Securing a sustainable global supply of high quality food and feed, and supplying renewable biomass for the production of bio-based products and energy are key priorities for both European and global society. In the coming decades, the European plant sector will play a central and essential role in meeting this challenge and achieving this will depend strongly on the generation and transfer of new knowledge, and greater innovation in the plant sector.

The ETP 'Plants for the Future' (Plant ETP) has developed action plans based on the pillars of innovation, research and education to deliver a sustainable supply of food, feed and renewable biomass. Each action plan is part of an integrated strategy that seeks to nurture research and innovation potential and ensure societal mechanisms are in place to implement improvements and develop new knowledge. This Summary of Action Plans document outlines the key elements of the three action plans and summarises a strategic vision for the European plant sector (Figure 1).

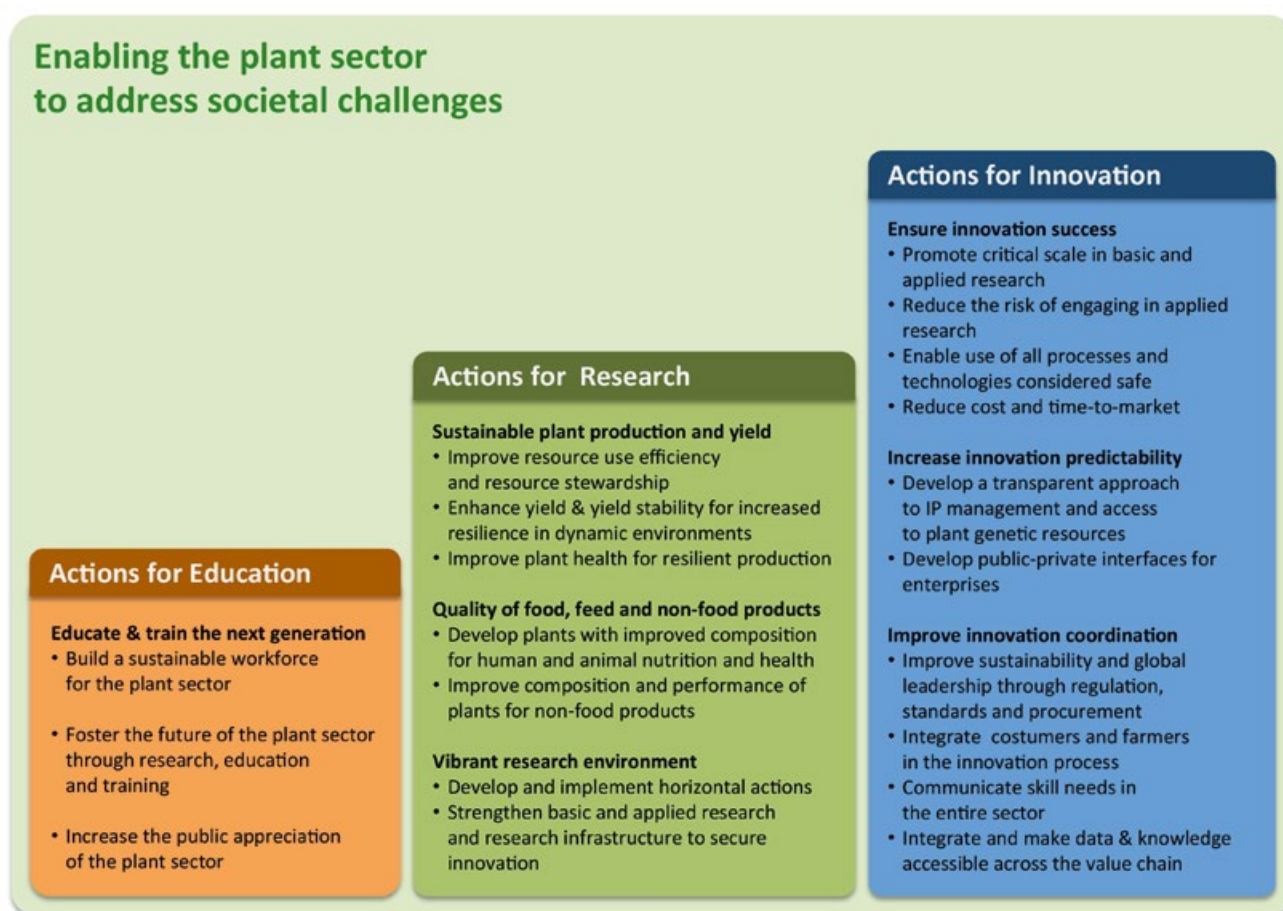


Figure 1: Key actions on innovation, research and education in Europe for the plant sector for 2015 – 2020.

Introduction

Feeding a global population set to reach 9 billion by 2050 will require a 70% increase in global agricultural output. At the same time, there is a growing demand for plant-derived biomass beyond livestock feed to support the bioeconomy. In the face of climate change and finite natural resources, there is an additional requirement for the plant sector to reduce input use and GHG emissions. Europe can contribute to this global challenge by decreasing its imports and reducing regional environmental impact.

The plant sector is a cornerstone of the European economy. Today, the combined agricultural and food sectors account for 30 million jobs (13.4% of total employment) and for 3.5% of total Gross Value Added in the EU-28³. Advances in science, technology and IT enable modernization of all aspects of agriculture. The farming sector is exploring the use of big data to improve productivity and plant breeding (including biotechnology), plant protection and management techniques (including precision agriculture); all build upon state-of-the-art research to develop advanced, resilient, sustainable, environmentally friendly solutions for agriculture.

The plant sector already makes a vital contribution to society. It addresses challenges and mega trends of global relevance, which are also included in European strategies and programmes, such as the Bioeconomy Strategy⁴, Horizon 2020 and the Juncker Investment Plan⁵ as well as global reports from IPCC⁶, FAO², EASAC⁷, etc.

The question is: is this enough? The plant sector must make an even greater contribution to the increasing demand for safe and sufficient food supplies. The projected growth of the world population, the expected increase in global welfare, the need for environmentally safe and sustainable agricultural production, the finite

acreage available for agriculture, the growing scarcity of natural resources and the consequences of climate change are all interrelated and together pose a major societal challenge. The development and timely uptake of innovative solutions in the plant sector will depend strongly on novel research findings, efficient knowledge and technology transfer, greater investment in innovation by venture capital, and appropriate regulation.

'Plants for the Future' is the European Technology Platform for the plant sector (Plant ETP) and has identified a number of challenges affecting the progress of this sector. The stakeholder groups of the Plant ETP, which represent the industrial, academic and the farming communities jointly developed three action plans, covering innovation, research and education, to address these challenges. Each action plan is part of an integrated strategy that seeks to nurture research and innovation potential and ensure societal mechanisms are in place to implement improvements and develop new knowledge.

How to build on the science base and translate knowledge into commercial reality is the key objective of the **Innovation Action Plan** (Plants for the Future: *Building Sustainable Innovation Leadership in European Agriculture*). Key success factors at the scientific level that address the challenges identified by the Plant ETP are outlined in the **Research Action Plan** (Plants for the Future: *Boosting Research for a Sustainable Bioeconomy*). Education of the skilled plant sector workforce of the future is then essential for sustainability of the flow of innovation to the market. This is dealt with in the **Education Action Plan** (Plants for the Future: *Educating and Training the next Generation*).

1 The plant sector is composed of the public sector - universities and research institutes working on plant science, and the private sector with arable farming, horticulture, forestry as well as agro-chemistry, plant breeding, seed and plant biotechnology industries.

2 FAO, 2009. *How to Feed the World in 2050*. Discussion Paper

3 Food for Thought Coalition. http://www.ecpa.eu/files/attachments/FoodforThought_2014-04-25.pdf

4 "Innovating for Sustainable Growth: A Bioeconomy for Europe", EC 12th Feb 2012

5 An investment plan for Europe, Brussels, 26.11.2014, COM(2014) 903 final, <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0903&from=EN>

6 5th Intergovernmental Report on Climate Change Working Group II – Summary for Policymakers – Effect on Food Supply, 31.3.2014

7 EASAC report: *Risks to plant health*, 10.03.2014

The integration of the action plans of the Plant ETP is fully in-line with the approach of the European Commission. Here, innovation, research and education are defined as integral parts of an overall concept that requires strong cooperation and linkages for success (Figure 2).

More details of the three action plans developed by the ETP 'Plants for the Future' are given in the following sections

Figure 2: Triangle of innovation, research and education as an integral part of an overall concept for contributing solutions to grand societal challenges



Building sustainable innovation leadership in European agriculture

An Innovation Action Plan to 2020

Innovation actions (IA) to meet the demand for increased, improved, economic and responsibly produced plant-based food, feed, fuels, and materials

European agriculture has a strong track-record in innovation. The Plant ETP believes that all stakeholders should build on this and maximise efforts to shape Europe's future to turn challenges into opportunities and deliver sustainable innovation leadership across the plant sector.

Although knowledge creation and exchange is the basis for progress, research goals need to be firmly oriented towards the real needs of farmers and end-users. At the same time, the regulatory environment must encourage innovation by stimulating new products to enter the market and lowering barriers to market access. While product safety is vital, it is also essential that regulatory processes are evidence-based, built on the latest knowledge of the biological sciences and enable the best use to be made of biological diversity, including the protection of natural biological resources. A systematic approach is required, in which regulatory processes and research outputs are well connected to overcome obstacles to market access and capture the full value of research and investment.

It is important that a coordinated European innovation effort is composed of short-, mid-, and long-term deliverables due to the large range of R&D timelines (1 to 20 years) in the different innovation areas of the plant sector, and the variable lag-time for product delivery following adoption of new European regulations. It will be essential to determine the impact that innovation in specific improvement areas will have on tackling the societal challenges, and over what time-frame benefits may be expected. The Plant ETP is committed to facilitating this activity and will assist in resolving this multi-tier, complex challenge into defined areas for targeted improvement.

There are many areas for major improvements across the entire plant production chain. Some of the actions which are essential for creating improvements are already widely recognized, and some of them are already being (partially) addressed. However, others need attention, not only from the sector itself, but also from society and policymakers. Key actions required to deliver sustainable innovation leadership in European agriculture have been identified in this Innovation Action Plan and have been clustered below. The actions are clustered according to their impact on innovation success, predictability and coordination.

Ensure innovation success

IA1 - Promote critical scale in basic and applied research to sustain productivity growth after 2020.

Developing innovation potential for the plant sector requires vision and a long-term commitment to investment. Basic research in plant science must therefore remain a high priority for programmes at both the European Union and Member State level.

IA2 - Reduce the risk of engaging in product-oriented applied research.

A large number of European companies in the plant sector, especially SMEs, are unable to fully fund innovation activities. A number of solutions need to be explored: shared risk models or in-kind contributions of public research, transparent processes for access to IP, and financial instruments for product development and demonstration plants, in combination with new regulatory approaches.

IA3 - Enable use of all processes and technologies considered safe.

New techniques and technologies should be regulated in a fair and transparent manner, on the basis of an independent, objective safety assessment and without political interference. With plant-based innovation needing long-term investment, legal certainty is vital to encourage research and market uptake of new products.

IA4 - Reduce cost and time-to-market for innovative technologies and products. Europe has opportunities to launch initiatives that reduce cost and time-to-market for stakeholders. These opportunities include access to pre-competitive research, development of standards for description and quality of results from public research, establishment of a predictable environment for IP management, access to IP, regulation and safety, shared centres for discovery and testing of novel product opportunities, novel cultivation methods and novel instrumentation.

Increase innovation predictability

IA5 - Develop a transparent approach to Intellectual Property (IP) management and access to plant genetic resources. Plant-based innovation is a time-consuming and high-risk business. The end-result of research and development is biological material, which is particularly easy to copy and reproduce. Therefore, organisations require a strong and effective system which, on one hand, enables effective protection of plant varieties of all genera and species in order to obtain a return on investment and, on the other hand, provides access to protected plant material for research and breeding purposes.

IA6 - Develop public-private interfaces tailor-made for SMEs and large enterprises. Specific instruments need to be implemented to increase the efficiency of knowledge and technology transfer from discovery in plant sciences to farmers and into the market. These implementations will address the problems of inefficient technology transfer, which clearly hamper European competitiveness today.

Improve innovation coordination

IA7 - Improve sustainability and global leadership through regulation, standards and procurement. For successful innovation to take place there is a need for an innovation-friendly, consistent framework of regulation, appropriately targeted incentives, steadily rising safety and performance standards, procurement initiatives, clarity on business risks etc. In such a landscape, attractive employment opportunities are created in existing and start-up companies, and organisations can leverage Intellectual Property and deliver a proper return on investment.

IA8 - Integrate customers and farmers in the innovation process. In the plant sector, the time-to-market from research to product launch is more than 10 years for many breeding programmes and other agricultural products. For the plant production value chain to operate effectively it is therefore essential to have an understanding of the current and future demands of consumers, farmers and other customers so that product development can be tailored to market needs.

IA9 - Communicate short-, mid- and long-term skill needs in the entire sector. The plant sector has a complex setting. Plant raw materials find their way in different value chains: food, feed, fibre, bio-based products and bio-energy as well as related public goods. There is a need to increase output, and to develop sustainable ways of producing plant raw materials, within the limitations of a number of serious constraints. There are also enormous opportunities in the sector and, on the horizon are novel approaches to managing farmland and greenhouses, novel agronomic practices, innovative ways to conduct breeding and other agricultural R&D, improved instrumentation, etc. Consequently, assuring an appropriately qualified and skilled workforce is critical



to the future success of the entire plant sector.

IA10 - Integrate and make data and knowledge accessible across the value chain. The use of big data in agriculture may rejuvenate the sector. The development of big datasets, data management and handling, and data access and analysis specifically for agriculture all come at a cost. This presents specific challenges, in particular for SMEs, which are less able to invest in these technologies. Making big data platforms accessible and affordable would greatly enhance the innovative capacity of all stakeholders in agriculture.

FIRST ACTION 2015/2016 from the Innovation Action Plan

Development of a European Public-Private Partnership in Integrated Crop Production

Public-private partnerships for open innovation in the plant sector can support translational research and ensure the effective transfer of knowledge into products and uptake of innovative new developments by end-users. The ETP 'Plants for the Future' advocates the allocation of a dedicated budget for plant innovation via a European public-private collaboration that can leverage additional private funds as necessary. Such an initiative should be long-term and focused. Priority research and innovation needs in the plant sector should be identified and the initiative should serve to promote the excellence of European plant science. This will attract further talent and skills to Europe. As the main agri-food exporter in the world and the largest net importer, Europe must take a leadership role in order to promote quality agricultural products for consumers, competitiveness for farmers and sustainability for society at large.

Boosting research for a sustainable bioeconomy

A Research Action Plan to 2020

Research actions (RA) to boost plant research to address global food and nutritional security and sustainable production of plant-based products

An active, cutting-edge programme of research is a key requirement of a strong plant sector that is able to contribute fully towards a sustainable European bioeconomy. The sector has already made great contributions towards the success of modern societies. Improvements in our knowledge of genetics, physiology and agronomy have underpinned significant increases in plant productivity over the last 50 years and have provided greater access to food on a global scale. Unfortunately, current innovations and growth rates in agriculture are insufficient to meet the dramatically increasing demand for food anticipated in the decades ahead. As a major agricultural producer, the European Union has a key role to play in meeting the food security challenge both within and beyond its borders if we are to ensure sustainable and increased food, feed, bio-based material and fuel production.

European plant scientists are among the leaders in their field and we need them to remain in the forefront of their disciplines. Major innovations and more effective, efficient use of recent advances in plant breeding and management practices are required to unlock the potential of a rapidly-advancing science base and increase agricultural productivity while improving the efficiency and resilience of the entire food system. Such innovation will enable the EU to generate a higher proportion of its domestic plant-based demands while devising solutions to deliver this increased productivity in an environmentally sustainable manner.

Based on these facts and challenges, a series of actions have been identified within the Research Action Plan for the plant sector. The key actions underpinning the Research Action Plan are outlined below, grouped in three thematic areas.

Sustainable plant production and yield

RA1 - Improve resource use efficiency and resource stewardship. Production of biomass for food, feed, bio-based materials and chemicals, and bio-energy depends on the utilisation of increasingly scarce and unevenly distributed resources, including water, nutrients, arable land and energy. The analysis, preservation, use and generation of a wider range of genetic diversity to improve the resource use efficiency of plants and integrated agricultural production systems with appropriate management practices (including closed nutrient cycles) will lead to an overall improvement in resource-use efficiency. This improved efficiency, together with resource stewardship and the improvement of biodiversity and its use, will have a major economic and ecological impact both in Europe and beyond, including developing countries.

RA2 - Enhance yield and yield stability for increased resilience in dynamic and adverse environments. Increasing yield and yield stability will be essential to ensure the global competitiveness of European agriculture. It is predicted that extreme weather conditions will be a more frequent occurrence in years to come. Coping with this challenge will require new and genetically improved cultivars as well as highly flexible and resilient plant production systems. In addition to greater abiotic stress tolerance in plants, combining resilience to both abiotic and biotic stresses needs to become a focus in coming decades, bringing together both new and existing knowledge from both areas.



RA3 - Improve plant health for resilient production.

Plant pathogens may become more potent with climate change, leading to greater yield losses and poorer quality. To address this challenge, plants that are tolerant or resistant to pests and diseases need to be developed, the knowledge about and use of beneficial microbes must be improved, smart plant protection products must be developed and all these measures must be combined with better management systems for farming and production. The development of healthy, resilient plants will reduce economic as well as ecological risks.

Quality of food, feed and non-food products

RA4 - Develop plants with improved composition for human and animal nutrition and health. The consumption of healthy and nutritious plant-based foods is an important factor in improving human health. A particular example is tackling chronic non-communicable diseases, which are currently increasing because of a combination of unhealthy diets, changing lifestyles and increasing life expectancy. Reducing or eliminating potentially harmful compounds will improve the safety of food and feed. Plants with an improved nutritional profile will help to reduce the economic burden on societies and will improve the health and quality of life of

Europeans. This is relevant during the entire life span, especially for an aging European society. Nutritional quality is equally important for animal feed and animal health. In addition, animal feed has an impact on greenhouse gas emission from animal husbandry, one important target being the reduction of methane emission.

RA5 - Improve composition and performance of plants for non-food products. European agriculture will need to become more integrated in the future, supplying both food and non-food products. On one hand, large quantities of plant biomass with controlled composition and enhanced processability are needed as feedstocks for integrated biorefineries for efficient production of bio-based commodities including bulk chemicals, fibres and biofuels and speciality and high value products (such as fine chemicals, enzymes, recombinant proteins) on an industrial scale. On the other hand, plants and plant cell cultures will play an important role as production systems of new recombinant, non-food proteins, such as biopharmaceuticals (e.g. antibodies), enzymes or other valuable natural products (e.g. flavours, agrochemicals etc). The improvement of plant composition, productivity and processability, as well as the identification of cost-efficient plant production platforms, will make significant contribution to the development of competitive bio-based industries.

Vibrant research environment

RA6 - Develop and implement horizontal actions.

Human resources and the provision of a flexible, well-educated and open-minded workforce are increasingly important factors and have to be secured if the European plant sector is to remain competitive. This requires long-term, proactive approaches and better career options that allow balanced approaches to knowledge transfer as well as a focus on implementation. In addition, scientists, companies and farmers must be able to take an active part in policy discussions (e.g. with the European Parliament) and engage constructively in an open dialogue with society (e.g. via Fascination of Plants Day), directed towards a better appreciation of the relevance of the sector both for solving the major challenges and in everyday life. Due to economic competition in Europe and the current and future political situation, the European Union has the potential and responsibility to play a role in global programmes, including taking a lead in some cases. These global initiatives would cover such important issues as food and nutritional security in developing countries, digital seed banks and development of global stress resilience systems.

RA7 - Strengthen basic and applied research and research infrastructure in the plant sector to secure innovation based on scientific knowledge and understanding. Basic research in plant science underpins innovation in the sector and, therefore, must remain a high priority for research programmes in individual as well as collaborative projects at both the European Union and Member State level. Stimulating basic research from applied challenges (and vice versa), and supporting both

branches of research, are key requirements for the development of products for the plant sector. Research in the plant sector should include sectorial and multi-disciplinary research. The development and use of scientific infrastructure and enabling technologies in plant and agricultural sciences are important elements to maintain and increase the innovation capacity of the sector in Europe. They must be part of research programmes.

FIRST ACTION 2015/16 from the Research Action Plan

The Plant ETP proposes the following themes for the Horizon 2020 work programme 2016/17 as first actions which should be implemented in the short-term:

- (1) Crops and trees tolerant to abiotic stress in changing climates
- (2) Address emerging and increasing risks in plant health in Europe
- (3) Plants for human nutrition and health (tailored plant raw materials, model foods, cross-sectorial networking)
- (4) Plants for more sustainable aquaculture (fish feed; energy)
- (5) Green bioactive molecules (small green molecules; green proteins)
- (6) Outreach to policy and society; engage in global actions (European Parliament; Fascination of Plants Day; Global Plant Council)

Educating and training the next generation

An Education Action Plan to 2020

Education actions (EA) to build a sustainable workforce, increase career opportunities and improve public appreciation of the plant sector

Research provides the knowledge base for innovation and an innovation-friendly regulatory framework allows companies to translate this into market-leading products. The next generation of plant scientists and farmers will need significant levels of specialist knowledge and the flexibility to react to rapidly changing environments, consumer preferences and political frameworks. Without a skilled, well-trained workforce, the sector cannot blossom and make its full contribution to a productive and sustainable bioeconomy.

But who are the plant scientists and farmers of the future? How can higher education institutions provide the best education in plant sciences to produce graduates with the knowledge, skills and training relevant to the needs of the plant sector? The Education Action Plan addresses these important questions and sets out education actions for the European Union, national and regional governments and the plant sector as a whole.

Educate and train the next generation

EA1 - Build a sustainable workforce for the plant sector. It is vital that plant science courses continue to be promoted to graduated students and that biology students have the option to study plant science modules. It



is equally important that both classical and new plant biology topics are included and that an interdisciplinary culture is actively encouraged to build and combine knowledge of plant science with the management skills essential for the plant sector. More interaction at the departmental, institutional and regional levels is needed so that both specialised and multi-disciplinary courses can be developed and jointly promoted. The development of networks of agricultural universities and biology faculties should also be encouraged to give opportunities to increase students' practical experience.

EA2 - Foster the future of the plant sector through research, education and training. This needs both improved funding and support for plant science research, including forging partnerships between academia and industry by capitalising on potential support structures and mechanisms to encourage interchange of people and by promoting joint training schemes. High calibre students need to be encouraged to consider studying plant sciences, which would be made more attractive by employers promoting career opportunities. In addition, vocational farmer training schemes integrated with research institutes and universities would greater link up both communities. Encouraging a better mutual understanding between farmers and the research community would help both to develop appropriate knowledge and to apply it usefully and profitably at the farm gate level. This requires greater and more efficient channels for communication between them.

EA3 - Increase the public appreciation of the plant sector. Many members of the public either take the plant sector for granted or consider it old-fashioned. Therefore increasing the public appreciation requires all stakehold-

ers to be encouraged to engage with the public to raise awareness of plants and their importance (e.g. to the bio-economy and human life), and improve the attractiveness of the plant sector as a career choice. It is important to inspire students at all levels to take an interest in and engage with plant science and farming and to enter plant-related employment.

FIRST ACTION 2015/16 from the Education Action Plan

Fascination of Plants Day (FoPD)

Initiatives such as the Fascination of Plants Day (FoPD) have been shown to be successful concepts, able to reach a broad range of target groups, like the general public, school children and policymakers as well as stakeholders in the plant sector itself. However, initiatives such as the FoPD need to be better supported so that engagement and long term commitment can be increased and their impact and coverage widened. EU funding should be provided for coordination of all the activities. National programmes should provide resources for events in their country with increased participation of industry and the farming community (to-date, this has been marginal) so that interaction between academia, industry and farmers, as well as the appreciation of plants and plant sciences by the public will be improved at all levels (school children, students, adults).



About the ETP 'Plants for the Future'

The ETP 'Plants for the Future' is a key stakeholder in the agri-food chain, representing those organisations which are active in plant science research, companies investing up to 20% of their annual turnover in plant research and innovation, and farmers keen to access the latest technology adapted to their needs.

The Technology Platform calls upon the European Commission and Member States to take on board the inte-

grated Innovation, Research and Education Action Plans that aim at enhancing plant-based innovation potential and the societal support needed to implement innovation. The Technology Platform is highly committed to assist in bringing stakeholders together (from industrial, academic and farming communities), and participate to the development of a sustainable leadership of European agriculture.

List of Contributors

The following experts have directly contributed to draft the Innovation, Research and Education action plans, and they supported the development of this document Summary of Action Plans.

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Glossary

Abiotic Stress

Non-living environmental factors (such as drought, extreme cold or heat, high winds) that can have harmful effects on plants.

Agri-Food Sector

The sector of the economy that produces agricultural and food products.

Bioeconomy

The bioeconomy encompasses the sustainable production of renewable resources from land, fisheries and aquaculture environments and their conversion into food, feed, fibre, bio-based products and bio-energy as well as the related public goods. The bioeconomy includes primary production, such as agriculture, forestry, fisheries and aquaculture, and industries using and/or processing biological resources, such as the food and pulp and paper industries and parts of the chemical, biotechnology and energy industries.

Biotic Stress

Living environmental factors (such as viruses, bacteria, fungi, insects etc.) that can have harmful effects on plants.

Classical Plant Biology

Classical plant biology includes the traditional plant science disciplines, for example plant breeding, agronomy, taxonomy, physiology, genetics, plant science, agricultural and horticultural subjects needed by industry.

European Technology Platform (ETP)

ETPs are industry-led stakeholder fora that develop short to long-term research and innovation agendas and roadmaps for action at European Union and national level, to be supported by both private and public funding.

Food Security

Food security encompasses the availability of sufficient, nutritious, safe and affordable food.

Horticulture

Horticulture can be defined as the branch of agriculture concerned with plants that are used by people for food, either as edible products, or for culinary ingredients, for medicinal use or ornamental and aesthetic purposes.

New Plant Biology

New plant biology includes modern biological disciplines, for example bioinformatics, molecular biology, various -omics and mathematical biology. These are essential for plant breeding and improvement programmes at the molecular level.

Plant Sector

The plant sector is composed of the public sector - universities and research institutes working on plant science, and the private sector with arable farming, horticulture, forestry and agro-chemistry, plant breeding, seed and plant biotechnology industries. The sector is characterised by activities enhancing and stabilizing yield, food production and nutritional security, environmental benefits and the non-food use of plants and plant biomass for bulk as well as high value products.

Small and Medium Enterprises (SMEs)

Small enterprises have fewer than 50 employees. Medium enterprises have fewer than 250 employees and have an annual turnover not exceeding 50 million euro. In 2012, in the EU-27, some 20 million SMEs provide approximately 86.8 million jobs.

Sustainability

This is an economic, social and ecological concept. A sustainable (bio)economy is one that meets the economic and social needs of the present while minimising the impact on the environment, and without compromising the ability of the future generations to meet their own needs.

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This Summary of Action Plans, as well as the detailed Innovation Action Plan, the Research Action Plan and the Education Action Plan can be downloaded from the website **www.plantetp.org**

Disclaimer

This document outlines the key elements of the three action plans that the ETP 'Plants for the Future' has developed based on the pillars of innovation, research and education for the European plant sector. The three action plans have been drawn up through the collaborative effort of a group of experts representing the various stakeholders of the Technology Platform (industry, academia and farming communities). Whilst each plan represents the outcome of a series of open workshops and discussions, they are neither exhaustive nor comprehensive and cover only selected aspects of broader issues.

Views and information expressed in this document and the three detailed action plans do not necessarily reflect the opinions of any single member, their organisations, or of the European Commission.

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