# Educating and Training the next Generation
# An Education Action Plan to 2020

Plants for the Future
European Technology Platform

IV.

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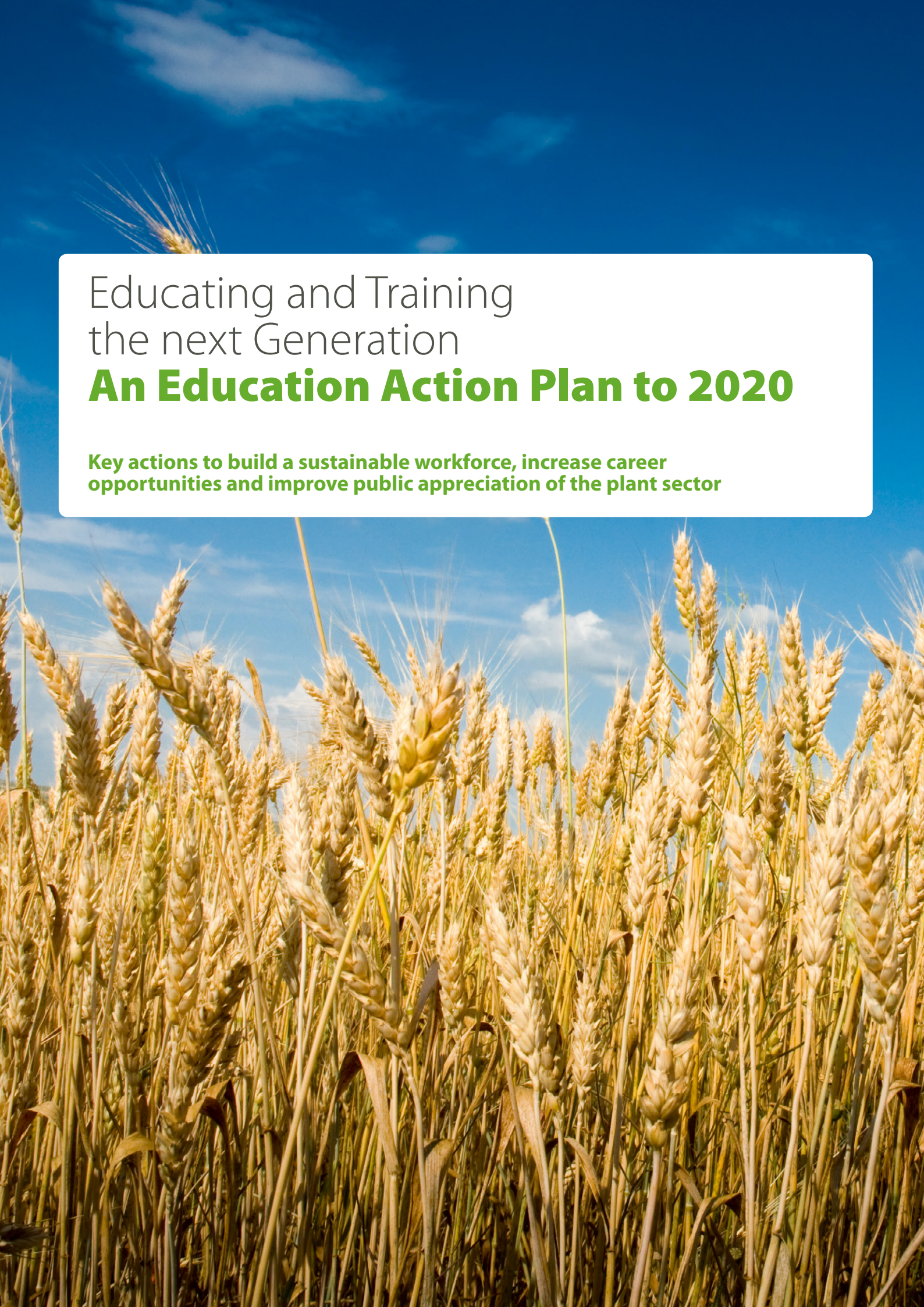
*The Education Action Plan is part of four documents: Part I - Summary of Action Plans, Part II – Innovation Action Plan, Part III – Research Action Plan and Part IV – Education Action Plan. All documents can be downloaded from the website www.plantetp.org*



# Educating and Training the next Generation

# An Education Action Plan to 2020

**Key actions to build a sustainable workforce, increase career opportunities and improve public appreciation of the plant sector**

# Summary of Key Actions

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 European Technology Platform ‚Plants for The Future' (Plant ETP) has developed three Action Plans based on the pillars of innovation, research and education of which each action plan is part of an integrated strategy for the plant sector to build industrial leadership, boost research and educate the next generation.

Within the Education Action Plan, Plant ETP identified three key actions to educate and train the next generation, which are important for the future workforce in the plant sector. Without a skilled, well-trained workforce, the sector cannot blossom and make its full contribution to a productive and sustainable bioeconomy.

## Actions to educate and train the next generation:

**Action 1 -** Build a sustainable workforce for the plant sector

**Action 2 -** Foster the future of the plant sector through research, education and training

**Action 3 -** Increase public appreciation of the plant sector

# Introduction

Now more than ever, the plant sector is at the heart of efforts to meet the grand societal challenges facing European and global societies. It is the foundation of the bioeconomy and is vital to assure food security and safety, improve the nutritional value of food products and underpin sustainable agricultural production under changing climatic and environmental conditions, as well as providing renewable raw materials for bioenergy and bio-based products. The plant sector is composed of universities and research institutes working on plant science, farmers in the arable sector, horticulture, forestry and industrial sectors including agro-chemistry, plant breeding, seed and plant biotechnology.

None of these grand societal challenges can be met without a strong commitment to research and innovation. The rapid expansion of technology has created unprecedented opportunities in plant biology, drastically shortening the path between basic research and market applications. This is supported by a research-intensive private plant sector, investing up to 20% of its annual turnover in R&D and dedicating a quarter of its 50,000 strong workforce to this.

But who are the plant scientists and farmers of the future? Who will be carrying out the research necessary to deliver new plant varieties that meet the needs of farmers, growers and consumers? Which key plant science skills does the European plant sector need to develop and maintain to ensure an economically sustainable 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 European Technology Platform 'Plants for the Future' (Plant ETP) has addressed these important questions by conducting three consultations (in 2012 and 2013, Annex I) among all sectors of its membership: (1) Seed and agro-industries (large and small companies) mainly covering plant breeding and trait development; (2) Academic institutions active in plant science (universities and research institutes) covering the whole plant sector (including forests); and (3) the farming community (via national farmers' organisations).

The feedback collected from the industrial, academic and farming communities provided valuable information, which the Plant ETP has used to develop this Education Action Plan. The document sets out actions for the European Union, national and regional governments as well as for the plant sector as a whole. The next generation of plant scientists and farmers needs a unique degree of knowledge and flexibility to react to rapidly changing environments, consumer preferences and political frameworks. Assuring an appropriately qualified and skilled workforce for the plant sector is critical to the future success of plant breeding, production and protection in the agricultural, horticultural and forestry sectors.

Three key actions that are important for the future workforce in the plant sector emerged from these surveys and are described in details in this Education Action Plan:

## Actions to educate and train the next generation

**Action 1 –** Build a sustainable workforce for the plant sector

**Action 2 –** Foster the future of the plant sector through research, education and training

**Action 3 –** Increase public appreciation of the plant sector

**Addressing these three key actions will:**

- Help to build a more self-sufficient Europe, more resilient and better equipped to compete and cope with future challenges associated with food security, food safety and climate change.
- Give a better match between the needs of industry and the training and education courses available.
- Increase awareness of the wide range of rewarding careers in the plant sector.
- Boost the rural economy by attracting highly skilled workers to these regions.
- Improve career prospects for plant science students, making them more employable and better suited to the needs of industry.

The Plant ETP is convinced that the grand societal challenges can only be tackled by considering and interlinking all three elements: innovation, research and education. Therefore, the Plant ETP has developed an Innovation Action Plan and a Research Action Plan in addition. All three actions plans are part of an integrated strategy and are linked to each other.

# **Action 1** – Build a sustainable workforce for the plant sector

**Concrete measures need to be put in place to train and develop the future workforce to ensure Europe can meet and balance the challenges of food security, food quality and sustainable agricultural production.**

*"It is more and more difficult to find young breeders in the „field breeding" sector, which remains a key skill for our business" (Company, France)*

Agricultural supply industries encompass seed breeders, biotechnology and trait specialists, crop protection manufacturers and suppliers and other companies providing material or knowledge inputs to farmers. An understanding of plants and an interest in their characteristics and performance in the farmed environment is therefore essential, whatever the techniques or technologies used. However, with universities offering a wide variety of courses specialising in different scientific disciplines and especially in newer areas of biology, there is a concern that students are not sufficiently aware of fundamental techniques and do not have a basic knowledge of plant science.

To correct this, all plant science courses should offer students the opportunity to study both classical and new plant biology, with a focus on plant breeding and agronomy, to provide a well-trained workforce.

*"Most importantly we need people that are able to work in a multidisciplinary team. We need integrators of new technologies, rather than mere specialists." (Global company)*

*"Students are looking to future employment so it should be made clear to them that balanced training increases their employment prospects." (University, UK)*

Agricultural supply companies increasingly depend on a multi-skilled and highly trained workforce, and have a clear need for more plant scientists qualified to Masters or PhD level in the coming 5-10 years. But while there is a growing need to develop and implement techniques based on new developments in biology, practical experience remains a key skill necessary to bring new and better adapted plant varieties to market. The huge potential offered by research, education and training in new areas of plant biology, needs to be balanced by the acquisition of skills in such fundamental areas as plant physiology, breeding, cytology and biochemistry.

*"To build a strong innovative farming sector, there is a need to provide individuals with a firm grip of the practical issues and a solid understanding of the pragmatic constraints and areas for practical solutions needs. This needs to be firmly under-pinned with an understanding of the need for profitable outcomes." (Farmer, UK)*

Basic agricultural education normally attempts to cover a wide range of arable and livestock farming knowledge. Although this gives a broad understanding of farming topics, it cannot do justice to the full knowledge base within each subject area. There are of course also opportunities at a higher level of specialisation, but many of these are at too advanced a level for the traditional agricultural student who wants to work on a farm after college. However, a small number of individuals may take the opportunity to develop specific areas of interest, as long as they see a potential beneficial career outcome.

**It is important therefore for courses to integrate all disciplines associated with the plant sector while ensuring that classical disciplines are not neglected, as well as providing basic education in agribusiness**

**and market applications. Encouraging study with a realistic and appropriate end goal remains the best preparation for a career in the plant sector (including agriculture, horticulture, forestry) more generally.**

More interaction at the departmental, institutional and regional levels is needed so that both specialised and multidisciplinary courses can be developed and jointly promoted. In countries where classical plant disciplines are not well supported, action should be taken to cluster them to ensure that there is at least one university centre of excellence teaching, for example, taxonomy, cell biology and agronomy. The development of networks of agricultural universities and biology faculties should also be encouraged to give opportunities to increase students' practical experience.

These clustering activities should also be considered at an EU-wide level, particularly among small neighboring countries or at transnational level where relevant. In particular, in view of the expansion of the agricultural supply industry's activities in Eastern Europe, there is a strong need to raise the levels of training and education in those countries; this may be achieved through partnerships between Higher Education institutions across Europe.

***A regional cluster: Bioeconomy Science Center, North Rhine-Westphalia, Germany***

*The Bioeconomy Science Center (BioSC), supported by the regional government of North Rhine-Westphalia, is a scientific centre of excellence focusing on research and education on topics relevant to the sustainable bioeconomy, using an integrated, interdisciplinary approach. The centre includes the Forschungszentrum Jülich, the Universities of Bonn and Düsseldorf and the RWTH Aachen University, and is based on a joint strategy involving numerous pre-existing scientific networks and collaborations in research and education programmes.*

**In order to maximize education and training opportunities for the future workforce in the plant sector, clustering of plant science and agricultural disciplines is crucial.**

**To build a sustainable workforce for the plant sector, objectives to be met are:**

- Develop a skilled, sustainable workforce to ensure that Europe can meet the challenges of delivering sustainable food production, excellent food safety and optimal crop management while protecting biodiversity.
- Promote plant science courses to students and ensure that plant science modules are an option for students who study biology degree programmes. These need to offer students the opportunity to study both classical and new plant biology (i.e. bioinformatics, molecular biology, various –omics and mathematical biology). Knowledge and skills across the spectrum of plant biology are needed for an understanding of the practical constraints and challenges of the sector.
- Encourage an interdisciplinary culture to build and combine knowledge of plant science with the management skills essential for the agricultural supply industry.
- Optimise training opportunities for the next generation of scientists by encouraging 'clustering' of plant science disciplines (both classical and new plant biology) amongst universities and at regional and national levels, to make better use of existing structures.

# **Action 2** – Foster the future of the plant sector through research, education and training

**Investment in research, education and training in agricultural and plant science must become a priority for both the public and private sectors. Increasingly, universities and academic institutions will be under pressure to educate and train the future plant sector workforce, while also carrying out pioneering research in plant science.**

The European plant sector makes vital contributions to building the bioeconomy, meeting the challenges of food security and safety, mitigating climate change and maintaining employment in Europe.

*"There is a disproportionate amount of funding in biomedical research compared to plant science research (usually only 1 – 5% of total biology goes to plant science). Because of this, even if there was more plant science on e.g. maths courses, most biologically interested mathematicians would go into biomedical fields" (Research Institute, UK)*

A better use of existing structures, together with public and private funding to support academic institutions, is essential to guarantee excellence in plant science research and develop future generations of plant scientists, if the important challenges ahead are to be addressed. The recently published UK Plant Skills Report focusses on this point[1]. But availability of funding is a direct consequence of policy choices and it is very clear that there has been an under-appreciation of the importance of research, education and training in plant science. Even in the USA, the alarm has been raised about academia currently not producing sufficient plant science PhDs to solve the crop production challenges facing a growing population[2]. This low level of funding for research in plant science also influences the number of academics available to teach plant science. In the UK, plant science is hardly taught anymore because there are not enough students interested in taking the courses and universities have naturally cut them back. There is a need for much better promotion of the image of the plant sector (including agriculture, horticulture and forestry) and demonstration of its opportunities. This should start in schools; the poor image of the sector is established very early in the education process.

**There needs to be the political will to invest more across the range of plant science activities, from basic research, to applied science, through to knowledge exchange and innovation. This needs to apply across the range of disciplines, from new plant biology to the more classical approaches.**

A few existing examples show that clustering of institutes and partnering with industry can provide additional ways to tackle this problem. These initiatives make interesting case studies which can inspire the development of others across Europe. There is a general awareness in the plant sector that more effort needs to be put into education and training to ensure that students get enough practical experience while studying and also achieve appropriate qualifications to ready them for careers in the sector.

1 *UK Plant Science – Current Status & Future Challenges. Report by UK Plant Sciences Federation, Jan 2014.*
2 *Jones, 2014: Opinion – the Planet needs more Plant Scientists*

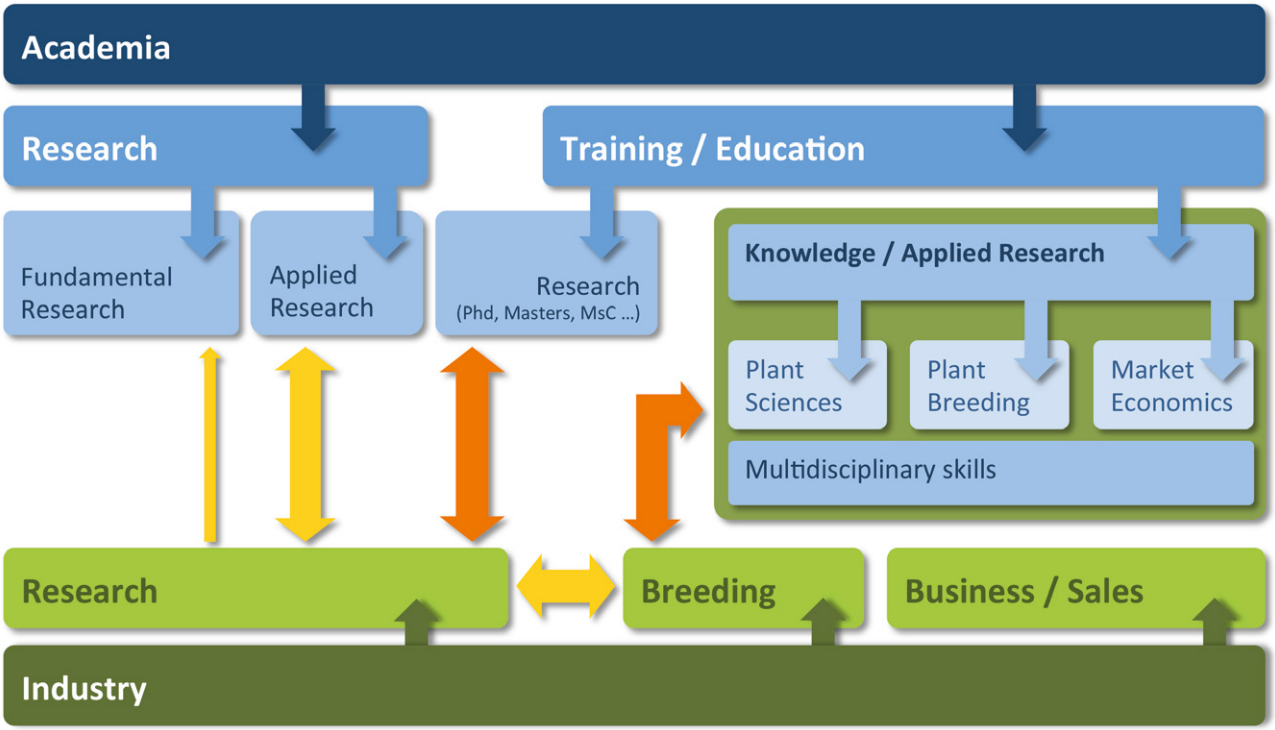



*Figure 1: Mechanisms for collaboration and cooperation between academia and the agricultural supply industry.*

***Transnational public/private cooperation: Nordic Plant Improvement Network***

*Six universities and some breeding companies in Denmark, Sweden, Norway, Finland and Iceland collaborate in this programme. The drivers of this initiative were the lack of sufficient resources in individual countries to provide a good education in the sector, expertise in each country being too specialized to provide a broad education and insufficient resources in each breeding company to provide continuous training of breeders.*

In addition, postgraduates could receive more useful training for a career in the plant sector by integrating industry-related topics into education programmes. Suggestions in the surveys included offering internships, professionals from the private sector teaching on some postgraduate courses and having industry-sponsored Masters, PhDs and placements. The European Plant Breeding Academy[3] is a good example of a training programme which targets working professionals who want to become fully trained plant breeders. Recently, a new initiative for plant breeding education was established jointly by the Polytechnic Institute of LaSalle Beauvais (France) and Ghent University (Belgium). In response to a strong demand from public and private institutions involved in plant breeding and the food sector, this Masters in Plant Breeding[4] addresses the significant need for professional plant breeders with knowledge of both conventional techniques and plant biotechnology.

**Further measures to stimulate public-private cooperation in research, education and training will increase investment in the plant sector and attract high calibre students to the area. Good current examples at the European level include Marie Curie Actions linking universities and business[5] and the Erasmus+ Programme, where Masters/PhD students are placed in a working environment[6].**

***EPS, The Netherlands***

*EPS is a national school in which all Dutch groups active in Experimental Plant Science (EPS) participate. It involves 8 universities and 2 institutions. EPS educates about 200 PhDs and is responsible for the training programme. As the Dutch agricultural supply industry appoints about 40 plant scientists/*

*3 The Plant Breeding Academy PBA in Europe – Class III*
*4 Masters in Plant Breeding*
*5 Initial Training Networks – Marie Curie Actions*
*6 Erasmus+ Programme Guide*

*year, it is a major potential employer for the students. This need is well illustrated by a recent initiative from the breeding companies and academic institutions in The Netherlands. Together, they have convinced the Dutch Science Foundation to support a national graduate programme for Experimental Plant Sciences, since it is an excellent tool to attract the best possible students to study plant sciences, to train them in state-of-the-art plant biology and to enhance the visibility of the plant sector. A large consortium like EPS is also a good instrument to provide courses during a PhD studentship to tailor the education towards the needs of the private sector.*

Europe has a track record of first-rate research in plant science and has numerous centres of excellence for students. However, it is increasingly difficult to retain this talent after graduation, as more and more companies are moving their R&D facilities out of Europe because of the increasing regulatory pressure and high barriers to market access for agricultural technologies. At the same time, the students themselves lack awareness of career prospects both in industry and in academia. The plant sector (including agriculture, horticulture and forestry) is notoriously difficult to enter due to the large amount of capital needed to get started. These careers are seen as being unrewarding and poorly paid, in comparison, for example, to careers in the medical field. Salaries should be adapted to reflect the level of skill, education and training required. Job security and social recognition are two important components to be considered by young students. Academic students should be given an adequate background in the practical needs and rewards of working at farm gate level. A system of prizes and awards or greater use of role models could be implemented to attract more students to the sector. Also, attracting highly skilled workers to rural areas where most agricultural supply industries are located could boost rural development. Regions may use the opportunity offered by the EU initiative RIS3 (Research and Innovation Strategy for Smart Specialisation) to further support their innovation strategies.[7]

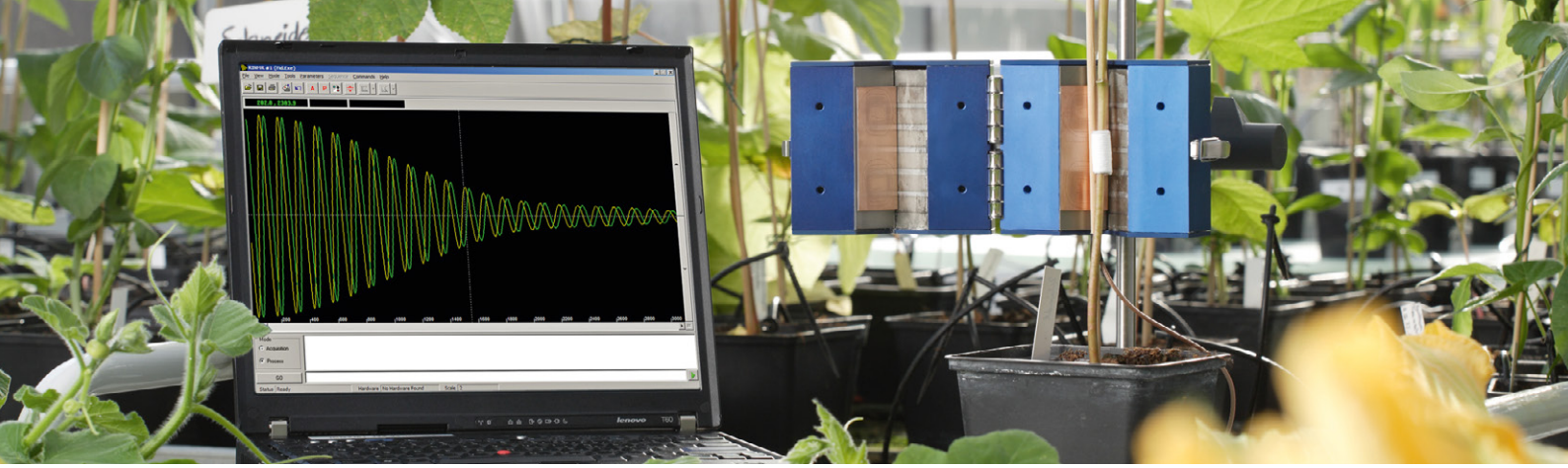
Regions may also profit from the European Agricultural Fund for Rural Development (EAFRD), aimed at ensuring the sustainable development of rural areas to create opportunities for young people. Achieving a balanced regional development of rural economies and communities, including the creation and maintenance of employment, is one of the objectives[8]. These funds are made available to the Regions, which have to develop Rural Development Programmes (RDPs) on the basis of the priorities identified by this Regulation.

*"If you need good field trial plant breeders, salaries should be as high as for the financial, legal, MBA, etc. positions. You will have no difficulties in staffing" (Company, NL)*

**Employers are urged to promote career opportunities in the plant sector, in particular in rural areas. There are lessons to be learned from the interesting initiative by the GNIS (the professional body representing the French seed sector[9]), which highlights the different careers a student can find in the seed sector. Measures to support the development of prizes and awards in the field of plant science would also help attract and retain talent.**

Finally, exchange of knowledge is essential in order to improve the effectiveness and quality of research upstream, as well as the practical implementation of research results downstream and at the farm gate level. Farming is reasonably well linked with both public and private research, depending on the country. Many farmers take advantage of significant local and national R&D carried out by both private and publically funded organisations. Additionally, independent R&D takes place

*7 National/Regional Innovation Strategies for Smart Specialisation (RIS3)*
*8 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0487:0548:en:PDF*
*9 http://www.gnis-pedagogie.org/metier-semences-vocation-semencier-visite.html*
*10 HGCA is the cereals and oilseeds division of the Agriculture and Horticulture Development Board*
*11 Instituts Techniques Agricoles*



through organisations like the HGCA[10] in UK or "*Instituts Techniques Agricoles*"[11] in France, which are set up and overseen by growers and end-users (e.g. farmers). However, it is often knowledge exchange that creates some of the greatest challenges, because there are so many different ways in which engagement takes place at the farm gate level. A strong network needs to be created that works in both directions: both for knowledge development and knowledge exchange. An understanding of the right balance between basic research and applied research is also needed. There is a notoriously wide gap between them, especially in agriculture, which has already been highlighted in the development of the European Innovation Partnership on Agricultural Productivity and Sustainability (EIP-AGRI). At the moment, this mechanism seems to be in a very early stage of development in Europe and needs to be improved. In this framework, universities and research institutes use extension and advisory services to reach out to the farming community and play an important role in transferring knowledge. In order to coordinate all relevant scientific areas (both basic and applied science) more effectively with the needs of industries and farmers, incentives and opportunities such as, for instance, the NIAB Innovation Farm in the UK[12], should be created and given long term support.

*"An overall increase in the profitability of agriculture would encourage more farmers to invest in some newer technologies and therefore create greater demands on R&D. Need is the mother of invention" (Farmer, UK)*

Extension and advisory services could be involved more closely in university degree courses, in order to increase the amount of practical knowledge acquired by students. Agricultural R&D needs should be driven from the bottom up to achieve practical and relevant outcomes; this approach has the greatest chance of achieving greater engagement with the farming community.

*12 https://www.innovationfarm.co.uk/*

**In order to maximise research, education and training in plant science, more funding is required, as well as more public-private cooperation and greater engagement with stakeholders throughout the agricultural production chain. Particular attentions must be paid to attracting and retaining talent.**

**To foster the future of the plant sector through research, education and training, objectives to be met are:**

- Improve funding and support for research, education and training in plant science across all its sub-disciplines (both classical and new plant biology).
- Capitalise on potential support structures and mechanisms to facilitate partnerships between academia and industry so that people can cross from one to the other.
- Put in place incentives to attract and retain high calibre students in the plant sector. Boost rural development by attracting highly skilled workers to these regions.
- Facilitate knowledge development and exchange via better and more effective communication mechanisms between the end-user (e.g. farmers) and the research community.
  - Promote greater awareness in the research community of the practical needs of industry and farmers.
  - Promote greater awareness of the benefits of research developments to farmers by developing appropriate materials and communication forums.

# **Action 3** – Increase public appreciation of the plant sector

**Public appreciation of agriculture and plant science must increase and awareness should be promoted more widely to the public and at school level, so that it becomes as highly regarded as other more fashionable bioscience-related sectors.**

*"Visibility and appreciation are not optimal. The reputation of the sector is that it is somewhat old-fashioned." (Company, France)*

*"Working with plants is part of the solution to help to address the major grand challenges" (University, Spain)*

There is little public recognition of the fact that the production of sufficient and safe food in a sustainable manner requires state-of-the-art research and a strong agricultural supply industry. The lack of attractiveness of plant sciences and agriculture begins at school. Neither teachers nor the curriculum champion real knowledge of or promote interest in the new plant sciences; thus, the majority of students who embark on a university biology degree are primarily interested in the biomedical or ecology sectors.

More effort is needed to convey the high tech, innovative nature of the plant sector and the worthwhile career opportunities they can offer. There is a need to put plant science and agriculture into a broader context so that students are better able to see their relevance to, for example, the global challenges of food security and safety and climate change, as well as their key role in the rural economy and the bioeconomy.

Several initiatives have been put in place to improve the public appreciation of plant science, plant biotechnology and agriculture. Below are a few examples of best practice which may be transferable to a European-wide platform, and could be used as starting point for other similar activities. These and other new initiatives need to be seen as long term activities.

***Seed Valley***

*Seed Valley refers to an area in the province of North Holland which is home to dozens of companies specialising in the breeding, production and sale of high-quality seeds and basic plant material. The mission is to reinforce the companies' competitiveness and anchor the cluster in North Holland. Seed Valley hopes to achieve this by investing in its image, the influx of skilled workers, innovation and the sharing of expertise. Twenty-one companies are collectively focusing on the future and want to position Seed Valley as a sustainable, vital, high-quality and innovative business sector – a fascinating sector to work in, which contributes greatly to the economy and which is located in an attractive living environment.*

## A. Outreach to the general public

**Fascination of Plants Day (FoPD)[13]**

The FoPD initiative, which was launched by the European Plant Science Organisation (EPSO) in 2012 across Europe, has become a global event. It promotes plant sciences to the general public, politicians and research councils. It is

13 Fascination of Plants Day: http://www.plantday12.eu

a great success in terms of the number of events organized in university departments, institutes, botanic gardens and public places, interacting with and inspiring the public and schools with a diverse range of activities. However, resources for outreach are currently underfunded both at European and national levels. This, and other initiatives that increase awareness of the importance of plants for life, needs to be supported and sustained. The most efficient way is to have more coordination and long term commitment.

Initiatives such as the FoPD need to be better supported so that engagement and long term commitment can be increased and their reach 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 (up till now, this has been marginal) so that interaction between industry, academia and farmers is improved.

**Plant Science Panel – Sense about Science[14]**

The Plant Science Panel is an initiative of Sense about Science (UK) which promotes around 4 to 5 plant science themes throughout the year. Members of the public are able to put questions to an expert panel of plant scientists across the world. It has been successful in reaching disparate groups such as the bee keepers and patient societies (e.g. coeliacs).

This initiative is supported by academic organizations and should be expanded to a European-wide platform.

**Promoting farming, food and the Common Agricultural Policy[15]**

Copa-Cogeca, the European association of farmers and agro-cooperatives, organizes an annual public event in the heart of Brussels to celebrate the future of agriculture and raise public awareness of food and farming. Many activities and quizzes are organized to help people learn more about farming and the agri-food sector, with gifts of high quality produce and regional specialities.

Similar initiatives should be further encouraged at national level. Current examples include the LEAF (Linking Environment and Farming) initiative in the UK[16], promoting sustainable food and farming to the wider public.

*14 Plant science panel – Sense about Science*
*15 http://www.copa-cogeca.be*
*16 http://www.leafuk.org*

**Deans' Conference of Biological Faculties of Polish Universities**

The Deans' Conference of Biological Faculties of Polish Universities is an informal body, currently with representation from 22 universities. The Conference formed an umbrella under which Biologists' Night – a completely new, nationwide outreach activity – was developed in 2011, attracting almost 20,000 visitors. For the 2014 Biologists' Night (held in January) 26 research institutions prepared hundreds of activities to disseminate biological knowledge.

Similar initiatives should be encouraged in other countries.

## B. Outreach to schools at all levels (primary and secondary)

Raising awareness and interest in plant sciences and agriculture has to start early. Currently, children are not often taught about the plant kingdom and the importance of plants to mankind, i.e. a comprehensive overview of plant evolution and adaptation to different environments is completely lacking, and basic aspects of plant taxonomy and nomenclature are absent. Some programmes are in place to promote plant science in primary and secondary schools and for school visits to research institutions and companies, but an integrated view of what a plant biology programme should cover is necessary at all levels of education. For instance, in text books for schoolchildren, the connection between plant biology and agriculture should be clearly made.

Some companies are also inviting high school students for summer training in order to offer them an experience within the sector and help them in their choice of university course.

*"Besides my teaching work at the university, I have organized introductory lessons on plant biotechnology in secondary schools and as professor for teaching new technologies to improve the knowledge of teachers in secondary schools" (Research institute, Spain)*

*"As senior scientist, I would consider it very efficient to spend part of my university teaching duties to promote plant research to high school students. Unfortunately this is not possible" (University, France)*

In the Netherlands, the National Seed Association Plantum launched a campaign entitled "Major Earth" in 2009 aimed at introducing young people (between 14 and 18 years old attending secondary school) to the plant breeding sector. Plantum has set up a campaign with white and black as main colours, to have a minimal link to the colour green and at the same time appear "cooler" and more attractive to the target group. "Major" stands for the link with schools (major and minor subjects) but also links to a large sector, which the word "Earth" also implies. At the same time, "Earth" also reflects the international nature of the sector. Since its launch in 2009, Plantum has developed numerous promotional materials to support the campaign. More information is available on the campaign website[17].

More programmes and activities should be encouraged in order to raise awareness of plant sciences and agriculture at all levels of education and to strengthen plant science education in schools by inspiring the next generation of scientists and supporting teachers to bring plant science to life for all pupils. The National Societies in Portugal, the Czech Republic and Poland recommended the development of guidelines/recommendations for what should be taught about plant sciences in European biology programmes. The same topics could be tackled in all of them. European guidelines could provide a framework which would ensure that a coherent view is given at all levels of education.

*17 http://www.major-earth.com/english/*

## C. Outreach and 'inreach' to undergraduate students

Increasingly, privately funded plant science and new biology courses are being organized and offered to PhD students and researchers to help fill the knowledge gap and correct the skills shortfall. These include "Analysis of high-throughput data analysis", "Photophysiology phenotyping", "Metabolomics bioinformatics for biologists", "How to communicate on pests and alien invasions", "Mapping the epigenomes of plants and animals" and "plant taxonomy and field skills".

Masters programmes should be taught in English to be more accessible to international students. Administrative rules and policies should be relaxed to facilitate collaboration between universities, research centres and engineering schools; there are currently too many formal structures (sometimes redundant and/or competing with each other) which inhibit cooperation.

Furthermore, students or junior plant scientists may not be aware of what opportunities exist within plant science businesses, maybe even believing that there are only minor problems or environmental issues to be solved in the plant sector. For school and university students, good information on career prospects would therefore be of great value.

Concrete measures need to be put in place to inspire students to take an interest in plant science education and training (outreach) and encourage students to choose plant science modules and projects at undergraduate and graduate levels ('inreach'). These measures need also to include information on career opportunities in the plant sector.

**Gatsby Plant Science Summer School**[18]
This initiative "successfully conveys the excitement and potential of plant science to undergraduates" by inviting them to attend a summer school each year. The Gatsby

Plant Science Summer School is scheduled at the start of undergraduate study. It is shown "to have a clear and lasting effect on the attitudes of students toward plant science. Attendance at a week-long residential plant science summer school in the first year of an undergraduate degree resulted in many students changing courses to include more plant science and increased numbers of graduates selecting plant-based PhDs". In this way, it has increased the pool of high-quality plant science-related PhD applicants in the UK.

**Your Future with Plant Science**[19]

This leaflet aims to persuade and inspire undergraduates to choose plant science modules and to progress to postgraduate level or enter plant science-related employment. It is a joint initiative between the Society for Experimental Biology and the UK Plant Sciences Federation.

**Want an exciting career?**[20]

Wageningen University in the Netherlands has developed a booklet to attract students towards a plant science career. It highlights the different careers followed by former students and provides examples of what job opportunities exist in the plant sector.

**EPSO Career Interview Project**[21]

EPSO aims to produce a series of interview videos with a cross-section of people who have taken different career paths after finishing their formal education. These may be in academia, industry, the public sector, the media, or another sector entirely. The interviewees will provide insights into their daily lives, the skills they require to do their job, the decisions they made to take their chosen career path and the prospects in their area.

**EPSO Mid-Career Plant Scientists Network**

EPSO aims to develop a network of mid-career plant scientists coming from its member institutions. The goal of the network is to bring these independent plant scientists more closely together to discuss and link different areas of plant science, and to develop interest in supporting the next generation of scientists.

**To increase public appreciation of the plant sector, objectives to be met are:**

- Encourage all stakeholders to engage with the public to raise awareness of plants and agriculture and their importance (e.g. to the bioeconomy), and improve the attractiveness of the plant sector as a career choice.
- Through outreach activities, inspire students to take an interest in plant science.
- Through 'inreach' initiatives, encourage undergraduate students to choose plant science modules and projects at undergraduate and graduate levels, and enter plant science-related employment.

*18 Gatsby Plant Science Summer School*
*19 Your future with plant science*
*20 Plantenwetenschappen booklet, Wageningen, NL*
*21 EPSO Career Interview Project*

## 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 integrated 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 industry, academy and farming communities), and participate to the development of a sustainable leadership of European Agriculture.

## List of Contributors to the Education Action Plan

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All the experts have participated to three different workshops organized during the development of this Education Action Plan.

Name of experts highlighted have directly contributed to draft this Education Action Plan.

## Glossary

**Agricultural Extension Services/Advisory Services**
Agricultural extension services are organisations helping to expand the application of scientific research and new knowledge to agricultural practices through farmer education.

**Agricultural Supply Industry**
The agricultural supply industry encompasses seed breeders, biotechnology and trait specialists, crop protection manufacturers and suppliers and other companies providing material or knowledge inputs to farmers.

**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, biotechnological and energy industries.

**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 EU and national level, to be supported by both private and public funding.

**Food Security**
Food security encompasses sufficient, nutritious, safe and affordable food.

**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.

## Annex I – Data Collection

In 2012 and 2013, the European Technology Platform 'Plants for the Future' (Plant ETP) conducted three consultations amongst its members. The full members of the Plant ETP are: (1) the industrial community: the European Seed Association (ESA) and direct members including Bayer CropScience, KWS, Limagrain, KeyGene, Céréales-Vallée, SESVanderHave, Nestlé, Südzucker; (2) the academic community: the European Plant Science Organisation (EPSO); (3) the farming community: Copa-Cogeca, the European Association for Farmers and their co-operatives.

The three surveys have been available on the public website of Plant ETP through the whole period of consultation. The raw results of the surveys are kept confidential.

(1) Seed and agro-industries (large and small companies). The survey was sent out to 38 national seed associations and to 47 individual companies across Europe.
The aims of the consultation with the seed and agro-industries were (1) to identify whether there is a need for excellent plant scientists trained in new plant biology in Europe and to quantify this need and (2) to identify strategically important but vulnerable plant-related skill areas and to quantify future needs.
The questionnaire resulted in feedback from almost 40 companies, which are well spread over Europe and beyond, and are representative of small, medium and large enterprises (including global companies).

(2) Academic institutions active in plant science (universities and research institutes). The survey was sent out to over 220 institutes and universities across Europe, as well as to 10 National Societies across Europe, which are linked to EPSO.
The aim of the consultation with these academic institutions was to identify the needs of academic organizations in order to provide an optimal education in plant sciences and to contribute to the training of scientists that will be recruited by the European agricultural supply industry.
More than 60 responses were received from academic institutions, which are geographically well distributed (ES, UK, FR, IT, PT, RS, NL, DE, CH, DK, SE, IE, PL, AT, BG, HU, SK, NO, CZ).

(3) The farming community. The survey was sent out to 57 national farmers organisations across Europe involved in the training of farmers (both at school and professional levels).
The aim of the consultation with the farming community was to identify how to improve farmers' awareness of developments aimed at bringing new technologies and innovation to the farm gate.
Only three responses in total were received (from Germany, Italy and UK), so that they perhaps only partially reflect the needs of the farming community.

# Annex II – Table Summarising Current Shortage Areas of Weaknesses

**Analysis of the responses to the questionnaires**

| Shortage areas | Possible solutions |
|---|---|
| Important skills | **Statistics** |
| | **Genetics** |
| | **Plant breeding** |
| | **Bioinformatics** |
| | **Data analysis** |
| | Agronomics: plant nutrition; soil science; phytopathology; seed management |
| | Biochemistry |
| | Knowledge of Intellectual Property |
| | Molecular genetics |
| | Cell biology |
| | Field trial experts |
| | Marker specialists |
| | Communication |
| | Management/Business |
| | Entrepreneurial |
| | **Combinations of the above** |
| | **Integrated individuals** |
| How to attract students into sector | Salary |
| | Increase awareness of the industry (at public, school and HE levels) |
| | Strengthen the link between universities and industry |
| | CASE awards |
| | Industrial placements |
| | Rotation programmes |
| | Summer schools |
| | Internships |
| | Increase visibility of industry in education |
| | Specialised masters courses |
| | Industry personnel teaching on masters degrees |
| | Sponsored masters courses |
| | European Breeding Academy |
| | www.seedvalley.nl |
| | **Create a foundation** |
| Educational level | **Graduates, postgraduates** |
| | The need for PhD qualified employees is likely to increase – although well trained in molecular biology, there is a lack of training in basic plant science such as genetics, physiology, pathology. How to apply science to industry – not research for the sake of it. |

## Contact

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This Education Action Plan document, as well as the Innovation Action Plan, the Research Action Plan and the Summary of Action Plans which outlines the key elements of all three action plans can be downloaded from the website-
**www.plantetp.org**

## Disclaimer

This Education Action Plan has been drawn up through the collaborative effort of a group of experts representing the various stakeholders of the European Technology Platform 'Plants for the Future' (Plant ETP) (industry, academia and farming communities). Whilst the Education Action Plan represents the outcome of a series of open workshops and discussions, in which the results of three consultations amongst the Plant ETP members have been implemented, it is neither exhaustive nor comprehensive and covers only selected aspects of broader issues. This Education Action Plan is a living document and will be updated regarding new developments and based on experience from its implementation.

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

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