Plants for the Future

Stakeholder Proposal for a Strategic Research Agenda 2025 Including Draft Action Plan 2010

Part III

Draft Action Plan 2006 - 2010

9th August 2005

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Document layout
The Agenda is divided into three parts:

- Part one provides a brief and general overview of the **Plants for the Future** Technology Platform and its Strategic Research Agenda for a general readership, including policy-makers, non-specialist scientists, and interested members of the general public and other stakeholders. Part one contains a concise summary of the four challenges and how the Platform proposes to address them.
- Part two contains a detailed exposition of each of the four challenges. For each challenge, it covers an in-depth introduction to the issues pertaining to it, the goals the Platform plans to achieve, and deliverables and research activities for the next two decades. Owing to its length and technical nature, it is likely to be of primary interest to specialists in the particular field covered. However, all stakeholders are invited to read Part two or the sections of it that draw their attention.
- Part three compiles the proposed activities for the period 2006-2010 as the 'Draft Action Plan 2010'.

In the following sections, the research activities for the period from 2006 to 2010 are listed as developed in Part II of this proposal for a Strategic Research Agenda.
Activities referring to a different time frame are cited as such.

Challenge one: Healthy, safe and sufficient food and feed

Goal one: Develop and produce safe and high quality food

Deliverable one: Plant raw materials with improved composition in major storage compounds

- Analysis of regulatory pathways controlling the accumulation of storage compounds in different crops. Identification of the steps to be modified for the improvement of global composition.

Deliverable two: Plant raw materials with improved characteristics for the production of nutritionally enhanced food

- Analysis of pathways controlling the accumulation of specific metabolites/macromolecules in different crops and contributing to their quality. Identification of the steps to be modified for the improvement of composition. Analysis of specific factors contributing to fruit quality and taste. Development of strategies for their improvement.

Deliverable three: Plant raw materials which are less harmful to food quality

- Analysis of processes leading to the accumulation of deleterious factors. Identification of steps to be modified for the improvement of composition.

Deliverable four: Plant raw materials for food with increased sensory characteristics

- Identification of the molecular components of plant raw materials influencing the sensory characteristics of food. Analysis of the biochemical pathways leading to them as a basis for plant improvement. In this context, close co-operation with food specialists from industry is necessary.

Deliverable five: Plants with improved processing characteristics for food manufacture

- In close co-operation with industry, identify the molecular components of plants that determine food shelf life and the post-harvest characteristics of plant raw materials. Analysis of the biochemical pathways leading to these compounds as a basis for plant improvement.

Goal two: Create food products targeted at specific consumer groups and needs

Deliverable one: Plant raw materials for healthier/functional foods

WP 1.1 Low glycemic food

- Identify and characterise the molecular structures of plant-derived carbohydrates which determine the metabolic rate in humans. Analyse the biochemical pathways leading to these sugars as a basis for plant improvement.

WP 1.2 Food enriched with carotenoids

- Transfer results in model plants to different crop plants.

WP 1.3 Polyunsaturated fatty acids (PUFA)

- Identify all genes which are necessary to transfer the PUFA biosynthetic capability from algae to higher plants. Analyse biochemical pathways leading to PUFAs as a basis for plant improvement.

WP 1.4 Reducing allergenicity/improving tolerance:

- Identify the plant genes for biosynthesis of gluten, especially gliadin. Analyse the underlying biochemical pathway as a basis for plant improvement.

WP 1.5 Food for cancer prevention:

- Identify plant ingredients which positively influence cancer incidence.

Goal three: Produce safe, high quality, sufficient and sustainable feed

Deliverable one: safe feed

WP 1.1 Reduction of mycotoxins:

- Develop high-throughput techniques for mycotoxin quantification (biochemical tools and biological assays). Refine molecular tools and mathematical models to analyse efficiently the diversity and epidemiology of causing agents. Study genetic, molecular and cellular aspects of the plant-fungal interaction in order to decipher the mechanisms regulating mycotoxin production and synthesis. Identify novel resistance genes for the development of transgenic wheat and barley free of mycotoxins. Develop more comprehensive safety data on dose thresholds for adverse effects of mycotoxins to improve risk assessment. Develop *in vitro* tests for anti-Fusarium proteins/compounds that could be used to characterise transgene function. Develop high-throughput methods for the rapid screening of potentially useful antifungal genes. Employ crop genetics and genomic approaches to identify genes encoding anti-*Fusariu*m transgenes that provide a resistance to initial fungal infection (FHB type I resistance) and mycotoxin degradation (FHB type III resistance). Identify promoter sequences to target transgene expression to spike-specific tissues. Develop transformation protocols for elite germplasm of winter and spring wheats, durum, and spring and winter barley.

WP 1.2 Reduction of anti-nutritional factors:

- The battery of genetic and genomic tools, including proteomic and metabolomic approaches, could be used to identify plant genes that control the synthesis of proteins or metabolites that have anti-nutritional effects.
- High throughput-screening can be used to identify germplasm lacking the genes (or alleles) specifying the synthesis of anti-nutritional factors.

WP 1.3 Reduction of heavy metals:

Research in fish nutrition and environmental sciences can define the best raw materials and the optimal proportion of plant-derived feed to allow the production of tasty and healthy fish sustainably.

WP 1.4 Reduction of xenobiotics:

Deliverable two: quality feed for quality food

WP 2.1 Plant raw materials with optimised concentration, quality and composition of macronutrients:

- Co-operate closely with agronomists and nutritionists to allow market-relevant assessment of the macronutrient characteristics needed within a plant. Identify germplasm and genes that are important for the trait and introduce them into breeding programmes.

WP 2.2 Plant raw materials with optimised concentration of micronutrients:

- Co-operate closely with agronomists and nutritionists to allow market-relevant assessment of the micronutrient characteristics needed within a plant. Elucidate the biosynthetic pathways of the different micronutrients and identify factors/genes/bottlenecks involved in their accumulation. Analyse environmental effects and agricultural practices on composition for major crops in Europe. Develop an understanding of the cellular and molecular basis of the composition of micronutrients in model plants and major crops.

WP 2.3 Plant raw materials with improved palatability/digestibility:

- Phenotype major feed crops (grains and forages) with regard to palatability/digestibility.

Challenge two: Sustainable agriculture, forestry and landscape

Goal one: Improve plant productivity and quality

Deliverable one: Identify key drivers of plant yield productivity and stability

WP 1-1. Combining improved photosynthesis and carbon dioxide fixation with nutrient and water use efficiency to obtain elite cultivars

Molecular analysis of C metabolism and of N-C nutritional relationships in different crops and trees, the signalling processes involved, and improvement of key coupling factors

WP 1-2. Improving plant architecture and developmental characteristics for better yields

Analysis of the impact of plant architecture and developmental features on yields in different crops

WP 1-3. Analysis and improvement of factors contributing to yield stability

Analysis of the impact of environmental factors on yield stability in different crops. Analysis of factors contributing to hybrid vigour

WP 1-4. Analysis and improvement of tree growth and forest productivity

Analysis of interactions of species and provenances with environmental factors in order to utilise natural potential

Deliverable two: Improve the quality of plant products

WP 2-1. Improve the composition of harvested products in major storage compounds

Analysis of regulatory pathways controlling the accumulation of storage compounds in different crops. Identification of the steps to be modified, for the improvement of global composition

WP 2-2. Improve the quality of harvested products as starting points for the production of healthy food and feed

Analysis of pathways controlling the accumulation of specific metabolites/macromolecules in different crops and contributing to their quality. Identification of the steps to be modified for the improvement of composition. Analysis of specific factors contributing to fruits quality and taste. Development of strategies for their improvement

WP 2-3. Reduce the negative impact of factors deleterious to quality issues

Analysis of processes leading to the accumulation of deleterious factors. Identification of steps to be modified for the improvement of composition.

WP 2-4. Molecular and conventional tree improvement

Characterisation of the genetic diversity of forest trees, adaptive traits, genes of known function and QTLs from provenance trials and conventional breeding programmes

Deliverable three: Improve plant tolerance to non-biotic factors

WP 3-1. Improve tolerance to water limitation and drought

Analysis of drought tolerance processes. Improvement of tolerance to water shortages through molecular breeding and/or transgenic approaches in different crops and ornamental plants.

WP 3-2. Improved tolerance to cold temperatures and frost

Analysis of cold adaptation and tolerance processes

WP 3-3. Improve salt tolerance

Analysis of salt tolerance processes

WP 3-4. Characterise and improve the tolerance of tree species to abiotic conditions

Provenances trials to investigate the genetic control of tolerance against various abiotic conditions. Understanding the molecular basis of tolerance and adaptability to various abiotic conditions

Goal two: Optimise agriculture to further reduce its environmental impact

Deliverable one: Development of less impacting methods of crop protection

WP 1-1. Perform a systematic and well balanced assessment of the environmental effects of agrochemicals.

Setting up of monitoring tools for the half life of phytochemicals and their breakdown products in plant and in the environment

WP 1.2. Real time monitoring of epidemic events

Setting up of disease-monitoring tools (biochip-based, etc.)

WP 1-3. Development of environmentally friendly alternative practices for crop protection

Development of crop-targeted methods of delivery of protective agents. Evaluation of the impact of different agricultural practices on pest and pathogen control

WP 1-4. Identifying new, environmentally friendly weeding tools and practices

Evaluation of the impact of different agricultural practices on weed control. Identification of putative targets for new herbicides

Deliverable two: Improve tolerance and resistance to pathogens and other biotic factors

WP 2-1. Identification and analysis of genes contributing to pathogen and pest resistances in crops and forest tree species

Inventory of genes contributing to host and non-host disease resistance

WP 2-2. Identification and analysis of genes contributing to pathogen and pest resistance in related wild plant species

Inventory of genes contributing to host and non-host disease resistance in other plant species

WP 2-3. Management of genes contributing to pathogen and pest resistance in the field

Determination of crop management methods that avoid resistance/tolerance from a single gene

Deliverable three: Improve the interaction of beneficial biotic factors

WP 3-1. Inventory of beneficial /symbiotic micro organisms in the rhizosphere

Inventory of beneficial micro-organisms, including nitrogen fixing micro-organisms

WP 3-2. Inventory and exploitation of molecules released by plants and which play a role in their fitness in the environment

Inventory of bioactive metabolites and their role

WP 3-3. Development of biological control strategies

Inventory of organisms of interest to biological control issues, and analysis of their mechanisms of action

Deliverable four: Reduce the utilisation of water resources and fertilisers

WP 4-1. Develop monitoring tools and adapted agricultural practices to reduce the need for fertiliser and water

New 'real time' monitoring tools. Modelling of uptake, storage and utilisation of water and fertilisers by crops

WP4-2. Identification of the limiting steps in nutrient use efficiency and breeding crops for improved N nutrient efficiency

Molecular analysis of the basis of nutrient utilisation efficiency in different crops

WP 4-3. Transfer the N fixing ability of legumes to other crops

Molecular analysis of the basis of symbiotic processes in N-fixing plants

Deliverable five: Reduce the environmental impact of feed

WP 5-1. Decreasing inputs in feed crop production

WP 5-2. Increasing the use of legume crops

WP 5-3. Increasing the sustainability of herbivore farming systems

For WP 5-1, WP 5-2, and WP 5-3 :

Use comparative genomics (and of the genome sequencing of rice and model legumes) to facilitate the genetics of polyploid and allogamous species and breeding of diverse forages.

Goal three: Enhance biodiversity

Deliverable one: Characterise and maintain biodiversity

WP 1-1. Setting up protocols for biodiversity assessment in representative farming practices

Setting up of monitoring tools

WP 1-2. Model field ecosystems and their relations to surrounding areas (wild/farm/urban)

Exploitation of data existing in the literature to build first generation models

WP 1-3. Provide farmers with protocols of good agricultural practices

Selection of a set of agricultural practices expected to have a positive impact on biodiversity

WP 1-4. Forest ecosystem monitoring, including links to open landscape development

Data gathering; identification of gaps; most model components are available

Deliverable two: Characterise pathogen and pest biodiversity, and their impact on crops

WP 2-1. Collect/exploit existing collections of plant pathogens and pests, and assess their virulence/pathogenicity on crops

Choice of relevant species (viruses, bacteria, fungi, insects, nematodes, etc.) and inventory of their pathogenicity on representative crop accessions and related wild species in different physiological conditions

WP 2-2. Identify virulence and pathogenicity genes

Choice of genomes to be sequenced and their shotgun sequencing

WP 2-3. Analyse genetic diversity of pathogens at the molecular level

Analysis of factors affecting the biodiversity of pathogens

Deliverable three: Characterise the biodiversity of plant genetic resources in agriculture

WP 3-1. Core collections established for major crops

Genotyping of all accessions

WP 3-2. Phenotype analysis of all relevant traits, including biochemical traits

Metabolome and storage compounds

WP 3-3. Linkage disequilibrium analysis of biodiversity components

Coverage of the genome with an optimal number of SNP markers, and genotyping of the core collection

WP 3-4. Creating segregating populations from core collections and mapping agronomic traits through QTL analysis

Selection of accessions of interest and generation of recombinant material. QTL analysis of traits of interest: This may concern physiological traits, such as salt tolerance, but also biochemical traits, such as seed content in specific nutrients of interest to food quality

Deliverable Four: Improve crop biodiversity by introgressing traits from wild relatives

WP 4-1. Creating advanced back cross populations

Inventory of wild relatives of a crop and analysis of cross fertility

WP 4-2. Obtaining sets of substitution lines

Advanced back cross material available

WP 4-3. Introgression of specific loci in elite varieties

2015: Introgression of QTL bearing loci in elite varieties

Deliverable five: Domesticate new crops

WP 5-1. Evaluating the potential of new crops and trees

Survey of traits of interest

WP 5-2. Exploit synteny to identify/modify domestication genes

2015: Screen for performing alleles by TILLING or by genetic transformation

WP 5-3. Perform conventional breeding for yield and agronomic performance

2015: Conventional breeding for yield and various agronomic traits

Deliverable six: Characterise the biodiversity of plant genetic resources in forestry

WP 6-1. Functional genomics – transcript discovery and profiling

Further development of comparative expressed sequence tag (EST) sequencing; suppressive subtractive hybridisation (SSH); differential display; serial analysis of gene expression (SAGE); expression arrays and other relevant techniques (proteomics) to identify genes of special interest

WP 6-2. Evolutionary genomics

Further development of different types of (preferably adaptive) genetic markers (closely linked to WP 6.1)

Goal four: Enhance the aesthetical value and sustainability of the landscape

Deliverable one: Develop ornamental plants for pleasure and decoration

WP 1-1. Explore, catalogue and preserve biodiversity of flower and ornamental crops at the genetic and genomic levels

2020: Catalogues and collections described and related

WP 1-2. Develop communication and demonstration materials and events to celebrate the range, history, regional aspects and future potential of plants for ornament and other uses

Implementation of communication material (brochures, videos, etc…) and organisation of road shows providing tools to implement the working package

WP 1-3. Analyse the risks of ornamental and indigenous plants including trees and shrubs for local and regional biodiversity

Identification of the most valuable ornamental and indigenous plants, in economic terms, and the characterisation of the genetic diversity of their wild relatives

Deliverable two: Develop product and services to enhance environment and the natural world

WP 2-1. Genetic, population ecology and systems analysis of semi-natural and cultivated regional landscapes

2030: Model systems including soil types. Linkage of models at different levels. Measures: successful eradication or control of invasive species; successful restoration or establishment of new areas.

Deliverable three: Sustainable, multipurpose landscape management

Identification of agricultural economic subsidy measures best suited to achieving environmental stewardship goals

Establishment of best practice networks to encourage multiple-use strategies on low-grade farmland

Development of public education strategies and campaigns on the societal importance of environmental stewardship and conservation, together with the potential for synergies with production-based strategies

Deliverable four: Preserving cultural landscapes from abandonment by promoting innovative and sustainable land-use strategies

2015: Validate typical products; development of innovative and sustainable production chains; innovative methodologies for renewable energy production; recycling methodologies in the productive chain

Deliverable five: Develop plants with the ability to decontaminate land of pollutants

WP 5.1: Undertake microbial gene discovery to identify useful genes for transfer into plants for phytoremediation

New genes enabling metabolism of a greater spectrum of environmental toxins

WP 5.2: Identification of crop and forestry species with best attributes for use in phytoremediation systems and gene transfer technologies established for them

2015: Plant species of high utility and transformation systems in place

WP 5.3: Analysis of gene combinations *in planta* to optimise phytoremediation in field conditions

***2020*:** New varieties designed and agronomically optimised for large-scale cultivation

Challenge three: Green products

Goal one: Develop advanced plant-based raw materials and pharmaceuticals

Deliverable one: Plant-based raw materials with new and improved functionalities

WP 1-1. Prioritise plant-based raw materials with new and improved functionalities

Targets, assays and screens to identify new functionalities and compounds leading to a priority listing of plant-based raw materials

WP 1-2. Systems biology know-how of metabolic pathways

Forty prioritised pathways, in line with the outcome of WP 1-1, understood at the level of participating genes

WP 1-3. Modification of metabolic pathways for the production of new plant-based raw materials

- Initiation of activities aimed at meeting the research objectives outlined below
  - Modification of 20 prioritised pathways by on/off switches at all control points and introduction of foreign genes with new functions
  - Sophisticated modification of first set of pathways by introducing evolved genes through experimental gene replacement

Deliverable two: Pharmaceutical products from plants

WP 2-1. Recombinant pharmaceuticals

- Technologies for optimising the expression and accumulation of recombinant proteins in plants
- The development of new transgenic production strategies
- First generation regulatory pathways for products derived from genetically modified plants
- cGMP manufacture of products from genetically modified plants and entry into human clinical trials

WP 2-2. Natural plant pharmaceutical products

- Genomic knowledge base for selected plant species
- Coordinated programmes for the discovery of metabolic pathways and products
- Establish collaborations with international developing country partners to work on screening programmes of indigenous flora for pharmaceutical purposes

Deliverable three: New enabling technologies to produce new and improved plant-based raw materials and pharmaceuticals

WP 3-1. Developing efficient molecular evolution technology

- Efficient molecular gene evolution technology applicable to genes involved in the pathways selected under Deliverable one.

WP 3-2. Developing gene replacement technology (as in Goal two, Deliverable three**)**

- Gene replacement technology applicable to broad range of plants

WP 3-3. Developing chemical switch technology (as in Goal three, Deliverable three)

- Chemical switch technology with the potential of meeting commercial performance standards

Goal two: Plants as energy production systems

Deliverable one: Improved production of first generation, plant-based bio-fuels

WP 1-1. Improved plant-based biofuel production

- Improved plant-based biofuel production

Deliverable two: Economically competitive plant systems for energy production

WP 2-1. Development of new high-energy plant biomass production systems with minimal energy input requirements

Within five to ten years, this should result in the prototype development of three prioritised high-energy plant biomass production systems with at least 50% lower energy input requirements (per energy unit of output) than current best production systems.

WP 2-2. Development of new high-energy plant biomass production systems with higher energy retention

Within five to ten years, this should result in the prototype development of three prioritised high-energy plant biomass production systems with forecasted twofold higher energy retention than today's best performers. Within ten to twenty years, two high-energy plant biomass production systems with at least fivefold higher energy retention than today's best performers should be available.

WP 2-3. Development of new high-energy plant biomass production systems combining minimal energy input requirements with increased energy retention

- *Activities for this WP are expected to start after 2010.*

Deliverable three: New enabling technologies to optimise plant biomass production systems

WP 3-1. Developing gene replacement technology

- Gene replacement technology applicable to a broad range of plant species
- Development of few approaches to targeted genome modification

Goal three: Convert plants into production factories

Deliverable one: Know-how to optimise production and extraction of selected compounds

WP 1-1. Identification of key plant production systems with targets for improvement

- A short list of plants qualifying for compound production as identified in 3.2.1. WP1-1
- Candidate plants to serve as starting point for conversion into green factories.
- Improvement targets for the plants listed above

WP 1-2. Technology development for improved accumulation and storage of prioritised compounds

- Compound accumulation and storage technology

WP 1-3. Technology development for improved transport and secretion of prioritised compounds

- Compound transport and secretion technology

WP 1-4. Technology development for improved extraction of prioritised compounds

Ten to twenty-five years: Compound extraction technologies for commercial use and applicable to multiple plants and plant cells

Deliverable two: Plants or plant cells designed for compound production

WP 2-1. Development of improved gene expression technology for selected mainly non-food plants

- Improved plant gene expression technology for selected mainly non-food plants: mRNA production, translational performance of mRNAs, protein folding, post-translational modification technology

WP 2-2. Optimisation of mainly non-food plants or plant cells for compound production and extraction

- Compound production and extraction know-how

WP 2-3. Development of plants or plant cells for fermentor-like applications

Ten years: Activities for this WP are expected to start after 2010.

Deliverable three: New enabling technologies for plant-based production factories

WP 3-1. Transfection technology development for high-level compound accumulation

- Transfection technologies for high-level compound accumulation applicable to five mainly non-food plant species

WP 3-2. Developing gene replacement technology

- Gene replacement technology applicable to five plant species

WP 3-3. Developing chemical switch technology (as in Goal one, Deliverable three)

- Chemical switch technology with perspectives to meet commercial performance standards

WP 3-4. Development of manufacturing strategies and building of production capacity

- Development of new manufacturing strategies (for production, extraction and processing)
- Development of small-scale manufacturing infrastructure and capacity to facilitate entry into initial human clinical trials (e.g. containment greenhouses and bioreactors)

Challenge four: Competitiveness, consumer choice and governance

Goal one: Vibrant basic research

Deliverable one: genome sequencing and biodiversity

WP 1-1. Sequencing target species and analysing biodiversity in crop species

Acquisition of genome sequences from selected model and bridging species and development of systematic functional genomics resources and databases for these species.

Deliverable two: plant systems biology

WP 1-2. Systems biology of basic biological processes

The definition of the regulatory logic of simple biological systems.

Deliverable three: development of improved tools and processes

WP 1-3. New tools and processes

Improved technologies for basic and industrial research and development/

Deliverable four: genetic systems for crop improvement

WP 1-4. New crops and improved crops and industrial processes

Delineation of the molecular basis for genetic systems underlying 'simple' traits, such as flowering time. Development of new and improved research concepts for industrial uses of plants.

Goal two: Human resources, Infrastructure, and networking

Deliverable one: Human resource training and skill management

WP 1-1. Training platforms and a virtual training centre in plant science

WP 1-2. Scientist mobility programmes

For WP 1-1 and 1-2:

Virtual training centre in plant science for PhD students. Exchange grants for a transition between academia and industry established in selected Member States. First landing grants for scientists from new Member States.

Deliverable two: research infrastructures

WP 2-1. High-throughput genomics infrastructure

Notice : In progress

WP 2-2. Genetic resource centres

Notice : In progress

WP 2-3: Bioinformatics and database infrastructure

Notice : In progress

Deliverable three: networks – co-operation and coordination

WP 3-1. Virtual centre for plant science research

Develop detailed, modular structure and a financing plan for the virtual centre. Seek financing to build modules and maintain centre.

WP 3-2. Transfer of knowledge between academia and industry

Grants and programmes for 'transfer' seminars between academia and industry: patenting and intellectual property protection; industrial processes and cGMP regulations; economic environment and commercial clients in plant biotechnology.

WP 3-3. International co-operation with developed and developing countries

Identification of international collaborative projects for genome sequencing of model and crop species and functional genomics projects focusing on model species.

Goal three: Public/consumer involvement

Deliverable one: Knowledge of plants
Deliverable two: Improve mutual trust between the public and the plant science community
Deliverable three: Plants are fun
For deliverables 1-3: the work packages and their deliverables, by their nature, somewhat overlap

WP 1. Increased awareness among plant scientists of public 'holistic' thinking
Promote understanding of plant science information
- Pilot: Analyse and contact plant information user groups
- Extend pilot across EU; establish review process for materials

Core documentation for primary school
- Identify organisations involved in curriculum development and assess their openness to assimilating information from professional plant scientists
- Gather and analyse the current treatment of plants and plant science within school curricula; design mechanism for updating syllabuses with the latest plant science information

TV programming
- Prepare scripts and outline 'treatments'; identify 'presenters'; engage programme makers

Stock of copyright-free downloadable background documentation, Powerpoint slides and plant images
- Assemble copyright documentation; establish editorial board for QC; establish site and mirrors; publicise collection and site amongst plant community
- Publicise use of site among plant science professionals; establish editorial board for school material; publicise amongst school groups

Plant science lectures to schools
- Establish database of speakers

Plant science lectures to citizens' and hobby groups
- Establish database of organisations and speakers

Enable teachers to engage with plant science
- Engage with governments over continuous syllabus development
- Participate in mechanisms to update science teaching continuously

WP 2. Increasing the involvement of the public in setting the research agenda – democratisation of plant science
Published articles in science and other media promoting the 'democratisation' idea
Workshop on democratisation involving selected leading plant institutes and plant science funders (could include industry groups)
Development of a model scheme for democraticisation
Pilot schemes in three Member States to test models for democratisation and to assess wider feasibility on a wider scale
Extension of democratisation to include at least 50% of EU Member States and EU plant science research
A developed model with results that could be applied in other disciplines
Develop and adapt for local (national) use materials appropriate for primary and secondary education

WP 3. Re-humanisation of plant scientists
Plant science lectures in schools
Establish database of speakers
Training course on public interaction aimed at young researchers
A series of talks given to the public by trained young researchers
Feasibility study on making public interaction a requirement of plant science PhDs
Where possible, making public interaction a requirement of PhDs
Increased inclusion of public streams as part of professional plant science meetings
Increased broadcast programming on plants and plant science

Goal four: Ethics, safety, legal and financial environment

- **Ethics**

Deliverable one: building a wider academic forum to consider plant science, research and development and cultural, ethical and social issues
Deliverable two: enabling a wider discussion amongst experts (academic, industry and legislative) and society around plant science, research and development and use
Deliverable three: through the development and delivery of appropriate teaching materials in primary and secondary schools, to build a greater awareness amongst society of the importance of plants, plant science, and agriculture, forestry and the environment
For all three deliverables:

- Establish forums where plant science researchers and developers can better interact with the academic community studying cultural, religious and social sciences
- Establish forums where the plant science, social science and public sectors can engage in open and transparent dialogue about plants and plant science

- **Legal environment, including legislation relating to safety and coexistence**

Safety-based legislation
Deliverable one: achieve a better understanding of safety-based regulation as it applies to plant science research, development and use

Establish communication mechanisms readily available to EU citizens that simply and clearly show that human, animal and environmental safety of innovative plant products is ensured through the EU regulatory system that requires pre-market safety assessment and approval

Safety considerations and coexistence research, tools and technologies
Deliverable one: Competitive options for crop management
WP 1-1. Improved control measures and refined farming practices
Collate available information and develop comprehensive database on pollen flow and resulting pollination events for the different crop species in different European agroecological zones

Deliverable two: Technologies reducing gene flow
WP 2-1. Develop and improve existing technologies
Evaluate and conduct further research into known biological systems (as described) for their potential to provide consistent and reliable gene flow prevention (containment) mechanisms
WP 2-2. Identify and develop new technologies
2015: Explore the potential of new biological systems that would provide the possibility to have consistent and reliable gene flow prevention (containment) mechanisms

- **Finances**

WP 4-1. Improved public funding
Increased public and private research financing on all levels. Increased coordination between national programmes by bringing together relevant bodies and developing long-term strategies
WP 4-2. Creative public-private partnerships
Identify public-private partnerships for large-scale initiatives and prepare financing plans. Launch the first large-scale public-private partnerships
WP 4-3. Novel private investment

People

For members of the four working groups, please refer to Part I
For a complete list of contributors, please refer to Part II

Glossary

For a short glossary, please refer to Part I
For a more detailed glossary, please refer to
http://europa.eu.int/comm/research/biosociety/library/glossaryfind_en.cfm

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