

PlantAlliance – Public-private consortium for the plants serving the agriculture of tomorrow

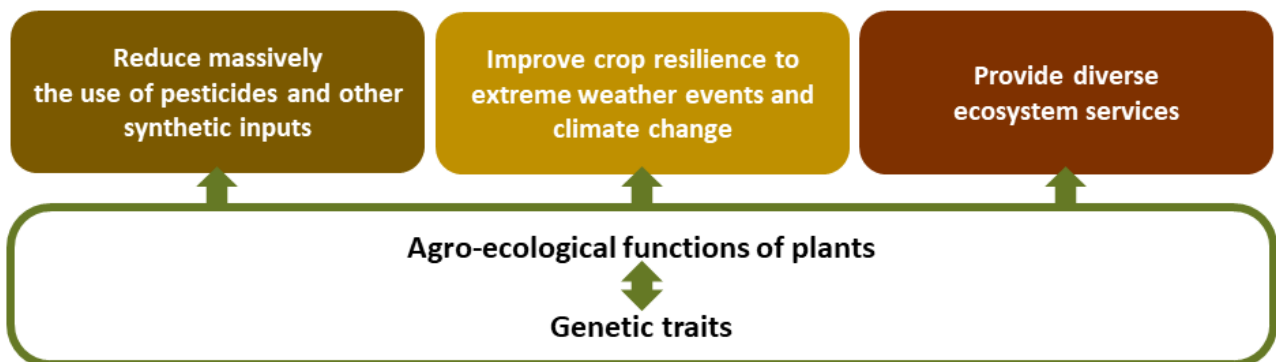
In order to ensure sustainability and productivity, the agricultures of tomorrow will have to meet economic, social, environmental and health requirements, while ensuring recognition and decent income for farmers. This requires rethinking production methods in a context where food demand continues to increase and diversify globally, the effects of climate change are becoming evident, the economic models of farms are changing rapidly and the perception of agriculture by citizens is becoming an increasingly important consideration.

The public and private stakeholders behind this initiative are keenly aware of the evolution in consumer and citizen choices regarding food and environmental protection. These stakeholders also want to support changes in farming practices while allowing farmers to make a decent living from their work. All parties involved in plant science, plant breeding and connected technologies agree that all components of plant production must be mobilised to create the solutions and innovations required to achieve these goals, no matter whether they serve a high quality, healthy and diversified nutrition or multi-facet bioeconomy. They propose implementing a long-term public-private consortium for continued genetic progress of crop plants within a well structured partnership. PlantAlliance perpetuates and enriches the public-private partnership built in Genoplante (1999-2011) and continued in the Scientific Group of Interest "Plant Biotechnology" (GIS BV, 2011-2020).

The shared PlantAlliance objectives are as follows:

- Acquire new knowledge in genetics, genomics and plant science,
- Promote closer links between all plant production stakeholders and disciplines to design and implement integrated research and innovation programmes.

Three priority areas were identified for the scientific roadmap:



The action of PlantAlliance will also address other major areas and, in particular, a high-quality, healthy and varied diet and a bioeconomy using adapted and optimised and plant materials, including microalgae.

By the achievement of its objectives, PlantAlliance will contribute to the evolution of present agricultures. PlantAlliance will be implemented in a regulatory context of massive pesticide reduction and societal demand for low-input agriculture. The aim will be to maximise functional biological diversity for optimised regulation. Crops should be resilient to changes in biotic and abiotic environments caused by major climate change and more frequent severe weather events. Reducing synthetic fertiliser and water inputs will provide ecosystem services by preserving soil,

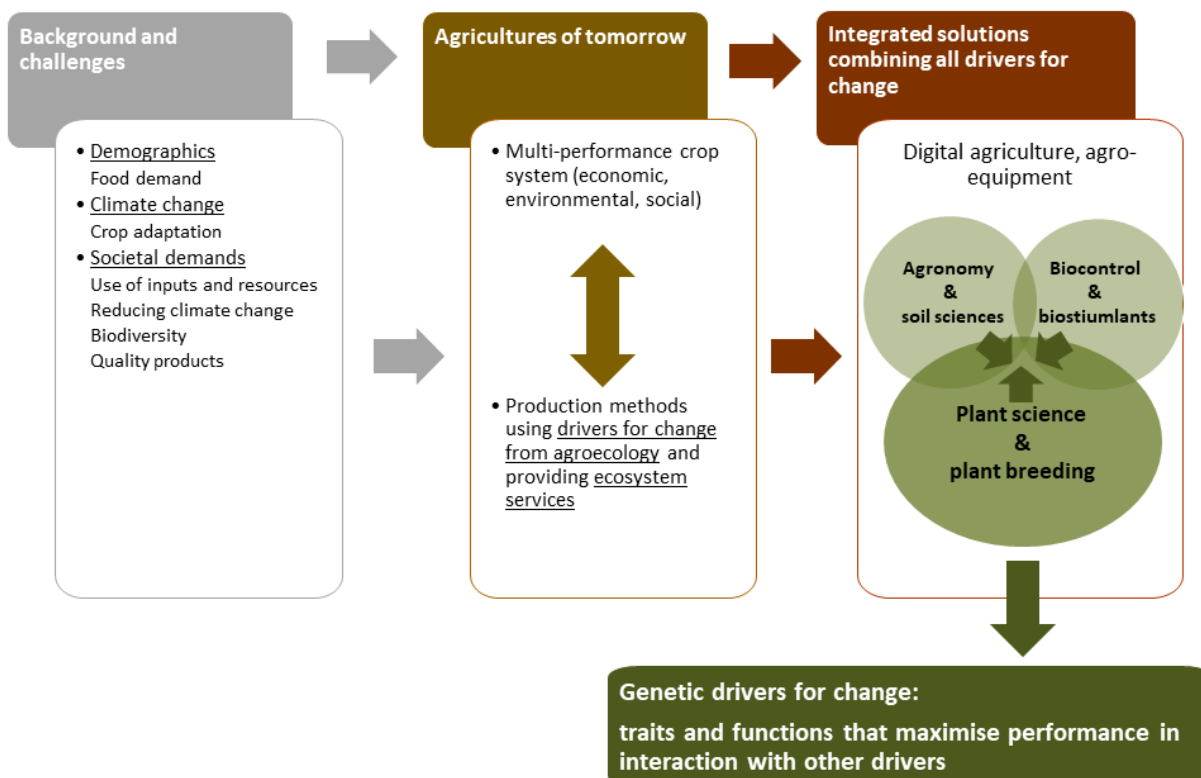
groundwater and biodiversity, while limiting greenhouse gas emissions and burdens on farmers. Improved integrated photosynthesis will capture atmospheric carbon and contribute to the bioeconomy (bioenergy, biomaterials). The diversification of metabolites produced by plants will improve plant protection and enhance product quality. Thereby PlantAlliance will contribute to virtuous circles.

A new scientific approach: addressing genetic progress through an integrated approach

The aim of the consortium is to improve the knowledge available to its members to facilitate the creation of pertinent plant varieties, grown alone or in mixes, using (or not) cover crops and/or combinations, as well as their insertion into novel culture systems. The objective will be to understand the functioning of genes, genomes and the plasticity of their responses to biotic and abiotic constraints and agronomic practices.

The agricultures of tomorrow need to be supported by innovative concepts and uses of genetics. The actions undertaken will take into account the knowledge of plant genes and genomes, detailed phenotyping of plant traits, the characterisation of biotic and abiotic environments and the management, integration and exploitation of the big data generated and made accessible according to FAIR¹ recommendations.

Integrated approach to genetic progress to create the agriculture of tomorrow



¹ Findable, Accessible, Interoperable, Reusable

The initiative will involve regular consultation and active collaboration with the research and R&D communities in the areas of biocontrol, biostimulation, agronomy and soil sciences in the first instance.

The three thematic priorities of PlantAlliance are the following:

Genes and genomes - Fundamental plant biology & plant breeding

Knowledge on gene function and genome structure of crops and their wild relatives will be gained by the following studies:

- a. Genetic and/or epigenetic determinism of the traits of interest,
- b. Potential of the pan-genome for plant breeding, by exploiting the distributed genomes found only in certain varieties, compared to the core genome, which is found in all varieties of a species,
- c. Genetic variability in crops and wild relatives, considering both lines and non-fixed populations.

Plant breeding methods will be renewed by:

- d. New pre-breeding methods, practices and technologies for the mobilisation of natural and induced genetic variability,
- e. Accelerated domestication of wild relatives for crop diversification and protection by the use of new tools for translational biology,
- f. Study and implementation of new breeding tools, in particular with regard to the control of reproduction and recombination,
- g. Continuation of research in genome editing, in particular for the creation of new alleles,
- h. Enrichment of genomic selection by taking into account structural variants, epistasis, an extended diversity and interactions with the environment.

Plants and the environment: phenotyping & enviro-typing

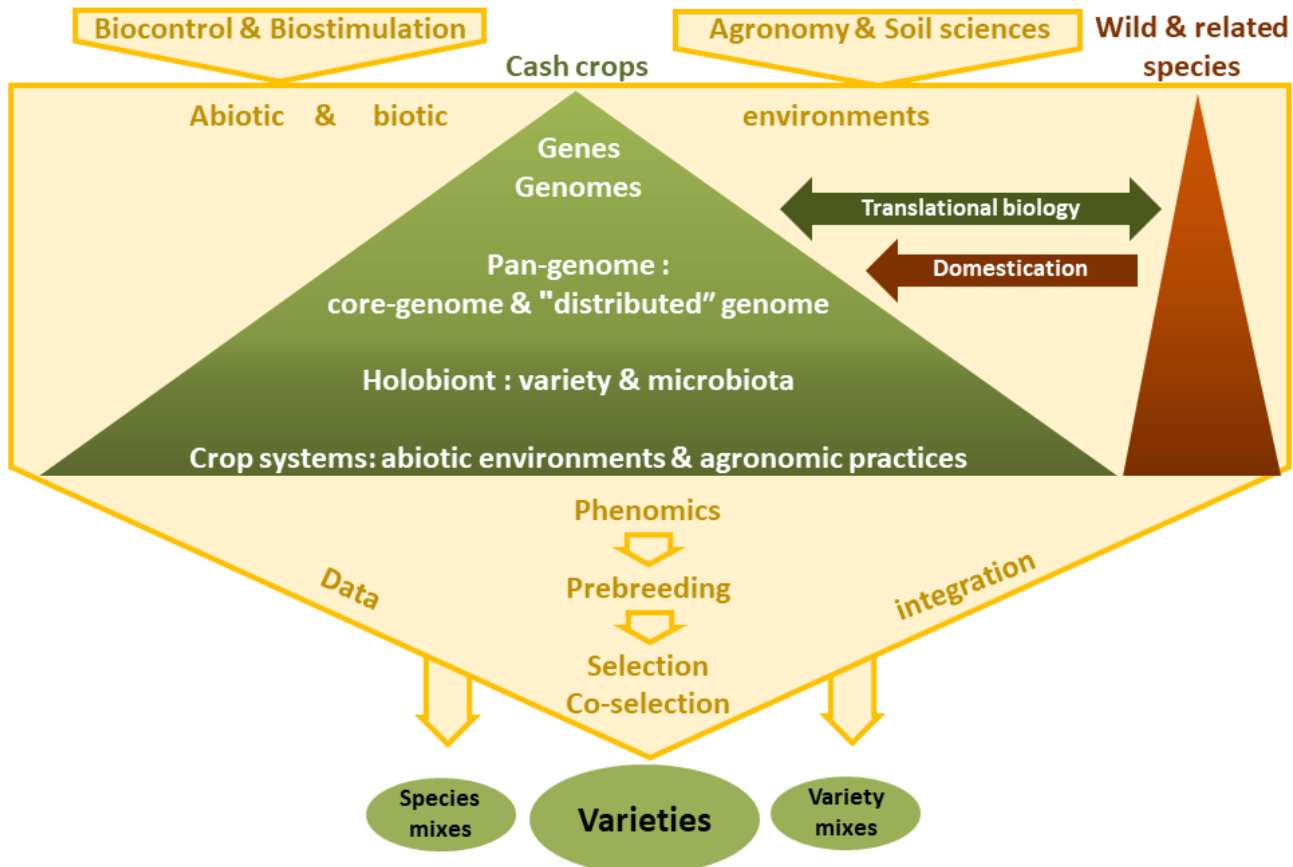
Technologies for plant phenotyping and environmental characterisation will be mobilised to adapt plants to diverse environments and culture systems by the following studies:

- a. Identification of relevant measurements that are correlated with a trait or phenotype, and the development of detection methods and sensors,
- b. Molecular phenotyping, including of a wider range of metabolites, to provide product quality markers and new resources for plant defence,
- c. Biotic, physical and chemical characterisation of the environment,
- d. Effect of the microbiote (rhizosphere and phyllosphere) on plant growth, development and vigour,
- e. Interactions between crop pathogens/pests and their host plants to explore new ways to manage these organisms,
- f. Multiscale models to predict their behaviour of crop plants in varying environments,
- g. Evaluation of varieties, mixtures and populations in innovative cropping systems.

Interdisciplinary approaches for ecosystem services

Public and private stakeholders are aware of the need to build the foundations for the interdisciplinary research and development that will occur over time during the period of PlantAlliance. By “ecosystem services”, the members of PlantAlliance mean the restoration and preservation of biodiversity, the preservation of soil and water quality in production areas, carbon sequestration and reduced carbon release in the atmosphere as part of agricultural practices. Items underneath will be studied:

- The contribution of genetics to the implementation of biocontrol solutions and novel agricultural practices
- The integration of all disciplines including genetics, to provide ecosystem services
- Socio-economic studies to facilitate the coexistence of various types of agriculture and the sustainability of new practices.



Expanding the knowledge base for the crops of tomorrow

Species: cash crops, secondary species to be promoted and species to be domesticated

France is the world's leading exporter of seeds for several species that make up a major share of agricultural products consumed and used by humans and animals. It must maintain this position while continuing efforts in the agroecological transition via a diversification of breeding objectives and species.

In this context, major targets have already been identified to help meet these challenges. Yield stability remains a major target, based on resistance to bio-aggressors and resilience to variations in the abiotic environment, as well as product quality. The range of species needs to be widened beyond the crops currently being worked on in the first wave of the Investment for the Future Programme (PIA) in the nine projects endorsed by the GIS BV², notably by integrating species that are promising with regard to hardiness and diversification. An indicative list, likely to evolve in the future, is indicated below:

²Aker, Amazing, BFF, Breedwheat, Genius, Peamust, Phenome, Rapsodyn, Sunrise.

- a. **Cereals:** Major species are wheat, maize, barley and rice. Spelt (adapted to low input) and sorghum (drought tolerant) are candidates for diversification.
- b. **Oil-protein crops:** Major species are rapeseed, sunflower, pea and faba bean. Targets for diversification include soybean, flax, pulses (target species for human and soil health,) and camelina (rustic brassicaceae marketable as soil cover).
- c. **Perennials:** Major species are grapevine, temperate and tropical fruit species (apple, pear, *Prunus*, banana). Towards varieties adapted to climate change and resilient to emerging diseases.
- d. **Vegetables:** Focus on tomato, symbol of a tasty and healthy diet and a pivotal species for translational biology in the Solanaceae family (potato, chilli pepper, bell pepper, eggplant). Cucurbits, leaf-vegetables and root-vegetables include major crop and model species, such as melon, lettuce and carrot.
- e. **Industrial:** Major species are sugar beet and potato (starch production). Diversification targets include miscanthus and/or other perennial species for the production of biomass and bio-based materials.
- f. **Pastures:** Varieties adapted to mixtures and to polyculture livestock systems.
- g. **Multi-service cover crops (CIMS):** Composition of mixtures for intermediate and cover crops.
- h. **Ornamentals:** A large variety of species are being worked on by numerous VSEs that rarely have the means to pursue research. Major species are rose bush and bulb plants.
- i. **Microalgae:** Keeping in mind PlantAlliance priority themes, microalgae will play a role regarding biomass, lipids, bio-stimulants and biocontrol products. Microalgae will also be considered as a model to boost carbon capture and photosynthesis efficiency.

A light, responsive and dedicated structure

Based on the strengths and areas for improvement noted in existing and past partnerships as well as the approval of the GIS BV members at the origin of PlantAlliance, three types of actions will be implemented in a light structure composed of a dedicated team.

1. Organise scientific events relevant to the core topics and interfaces of plant genetics

Scientific events are a major and popular way of sharing knowledge, formulating working hypotheses in light of new horizons and opening up possibilities for contact with complementary disciplines or approaches. These events will be accompanied by scientific communications in the form of newsletters, synthesis reports and publications. The tools that can be used are:

- a. Scientific workshops on transverse topics at the forefront of science
- b. Joint brainstorming groups in an open and multidisciplinary coordinated approach with scientists from other areas (biocontrol, agronomy, soil sciences, etc.)
- c. Scientific events on shared topics dedicated to species or groups of species
- d. More technically-oriented events, where the implementation of approaches and/or techniques resulting from joint work can be discussed
- e. A monitoring group to identify funding opportunities at regional, national and European levels and to relay information to potentially interested members.

2. Fund research projects

Based on the priorities shared by members, PlantAlliance will facilitate the emergence and creation of research projects. PlantAlliance will rely on the contributions of members to directly fund one-off projects shared between public and private research communities. These strategic projects will

focus on topics not covered by other funding opportunities. Publication and access to results will be dependent on funding conditions.

3. Providing collective scientific stances to decision-makers and knowledge to the general public

Off the back of research priorities identified through its scientific activities, PlantAlliance will bring these priorities to the attention of decision-makers and funding bodies. Articles outlining stances taken and summary press releases should be written up and, after approval by members, sent to national and European stakeholders who may find potential for further research and guidance in the material.

Bringing the contributions of genetics to the issues and goals defined in the introduction to the attention of the students and to general public as far as possible will contribute to awareness of the discipline.