

Strategy for building a cell wall research knowledge infrastructure “PlantWallKNet”



The need and purpose of an integrated knowledge infrastructure

Plant cell wall research is inherently multidisciplinary and relies on an exceptionally broad spectrum of experimental approaches, ranging from genetics, biochemistry, and molecular biology to advanced microscopy, spectroscopy, biomechanics, computational modelling, and artificial intelligence. These methods are applied across a wide diversity of plant models, from *Arabidopsis* and crop species to trees, mosses, algae, and extremophile plants, using highly specialised instrumentation that is often available only in selected laboratories.

As a result, knowledge about available methodologies, analytical tools, molecular probes, instrumentation, expertise, and best practices is scattered across individual research groups, institutions, and disciplines, making it difficult for researchers—particularly newcomers—to identify the most appropriate approaches or establish new collaborations. The lack of an integrated overview also limits the dissemination and wider adoption of innovative methods, reduces opportunities for methodological standardisation and interoperability, and can lead to unnecessary duplication of effort or lack of reproducibility.

The COST Action PlantWallK presents a valuable opportunity, as it already involves a large community of end users who can develop this infrastructure (called PlantWallKNet) as a shared resource to address specific scientific questions and enhance the community's collective ability to tackle complex, interdisciplinary challenges in plant cell wall research.

In an ideal scenario, a user could search for a biological question or technical challenge—for example, *"How can I visualise homogalacturonan in living tissues?"* or *"Which laboratories can measure cell wall mechanics in crop species?"*—and receive integrated information on suitable probes, protocols, instrumentation, software, expert laboratories, training opportunities, and key publications.

Such an infrastructure would transform PlantWallKNet from a network of collaborating researchers into a **living knowledge ecosystem** in which expertise is continuously shared, curated, and expanded by the community. This approach has proven successful in infrastructures such as ELIXIR and Euro-BioImaging and could become one of the lasting legacies of the COST Action, extending its impact well beyond the project's duration.

Initial vision, results from the survey and first steps

The initial vision of the Core Group during the Action preparation phase was to establish a shared knowledge infrastructure—or, in layman's terms, a "database"—that would connect researchers with expertise, protocols, specialised facilities, and validated research tools. Such an infrastructure would strengthen the plant cell wall research community by facilitating interdisciplinary collaborations, accelerating technology transfer, and promoting more efficient, reproducible, and impactful research.

As a first step towards this goal, the Core Group proposed **creating an inventory of available plant cell wall probes**, including antibodies, dyes, and other molecular recognition tools. Even a simple spreadsheet-based inventory was considered a suitable proof of concept, serving as the foundation for a more comprehensive knowledge infrastructure.

From the outset, however, it was recognised that developing such an infrastructure would be both labour-intensive and resource-demanding. It also became evident that its design should be driven by the community's needs through broad discussions with future end users.

During the initial discussions, participants suggested extending the inventory beyond molecular probes to include biochemical methods for plant cell wall analysis. After careful consideration, however, it was concluded that such an expansion should not be part of the initial implementation. **Developing a comprehensive inventory of methodologies would require a substantial effort and, given the diversity of available techniques, would greatly broaden the project's scope.** Moreover, many specialised methods are used by only a limited number of laboratories, which may be unwilling to share detailed protocols before publication, as methodological innovations often constitute valuable intellectual output and contribute to the scientific evaluation of their institutions. Such incentives cannot be provided within the framework of a COST Action.

These discussions highlighted that defining the scope, structure, implementation strategy, and long-term sustainability of the inventory is itself a major task that will likely require the full four-year duration of the Action. Nevertheless, participants at the Kick-off Meeting strongly endorsed developing the inventory and identified it as one of the Action's key long-term objectives.

The large-scale survey conducted in June-July 2026 among the PlantWallK members suggested that respondents are not primarily asking for *more scientific information*—they already have access to publications. Instead, they are looking for a way to **connect information with people, capabilities and tools**. The highest-value infrastructure would therefore combine:

- **Knowledge** (protocols, tutorials, standards),
- **Resources** (equipment, datasets, software),
- **People** (expertise, facilities, collaborators),
- **Opportunities** (training, exchanges, projects, stakeholders).

Initial steps:

Consequently, during **Grant Period 1** (GP1), a basic prototype of the inventory was developed. Its purpose is not to serve as the final product but rather to provide a concrete starting point for further community discussions and strategic planning.

At the beginning of **Grant Period 2** (GP2), a dedicated in-person workshop will be organised to define the future direction of the inventory. The meeting will focus on establishing its scope and structure, identifying priorities, determining which types of information should be

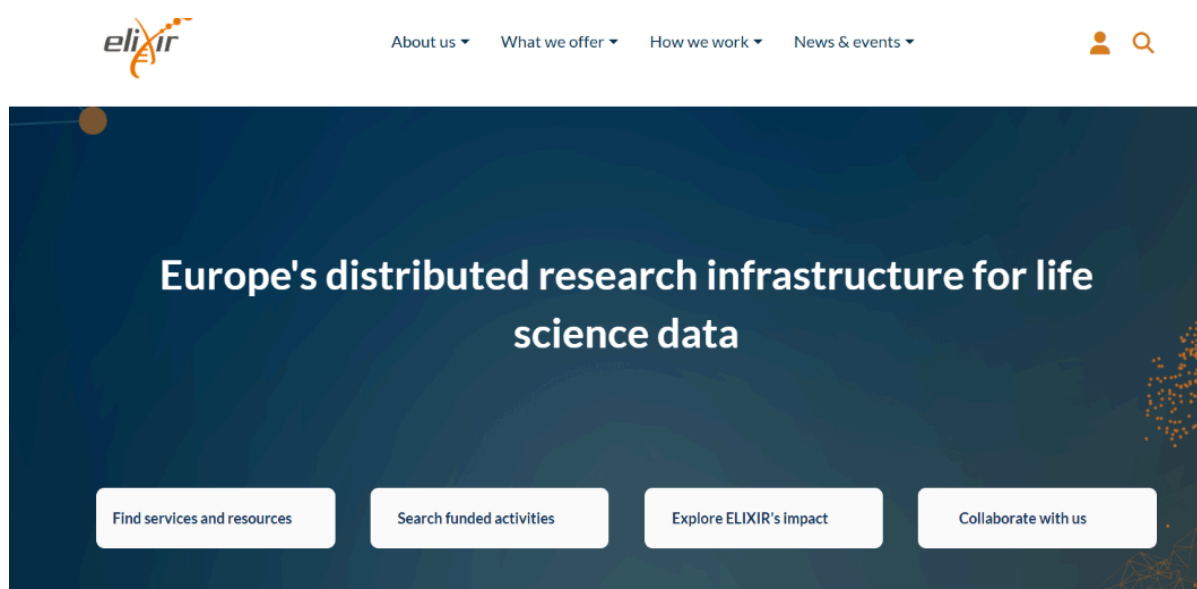
included, and developing a strategy for gradually expanding the inventory and integrating it into the PlantWallK website.

A key strategy for the following grant periods will be to incorporate dedicated inventory-building sessions into all in-person COST events. During these sessions, participants will actively contribute their expertise by identifying resources, validating information, and proposing new content. This collaborative approach is expected not only to strengthen interactions within the community but also to enable the gradual development of a comprehensive, community-driven knowledge resource that reflects the collective expertise of PlantWallK participants.

Ideas for long-term development of the infrastructure

Examples of infrastructures existing in other fields

There are several excellent examples of knowledge infrastructures in biology that go far beyond simple databases. Such an example is **ELIXIR – European life science knowledge infrastructure (Europe)**, which is perhaps the best example of a successful knowledge infrastructure in the life sciences. Rather than being a single database, it is a distributed European infrastructure that connects national bioinformatics centres and integrates biological databases, software tools, computing resources, standards, training materials, and expert communities. Researchers can search for data resources, analysis software, workflows, training courses and computing services through a common portal. ELIXIR also develops community standards to ensure that biological data are interoperable and reusable in line with the FAIR principles. The infrastructure substantially reduces fragmentation by enabling researchers to discover existing resources rather than developing parallel solutions.



Common characteristics of effectively-working knowledge infrastructures

These infrastructures, though serving different scientific communities, share key characteristics and function as an integrated ecosystem of different elements. They are ideally community-driven, with researchers actively adding and curating resources. Standardisation also plays a vital role, as resources are described with common metadata and controlled vocabularies. The most successful and big infrastructures also offer training, documentation, and user support, making advanced methodologies accessible to newcomers and labs lacking specialised expertise. Lastly, they are built around the FAIR principles, ensuring resources are **Findable, Accessible, Interoperable, and Reusable**.

Thoughts on curation and governance of PlantWalkNet

A key trait of successful knowledge infrastructures is their community-curated nature. Instead of depending solely on a central management team, researchers actively contribute new protocols, methods, software tools, probes, and references. Dedicated thematic editors or working groups oversee quality, consistency, and accuracy. This collaborative model keeps the infrastructure up to date and promotes widespread community ownership, allowing it to evolve with scientific advances.

The experience shows that poorly managed infrastructure will quickly become outdated and ineffective. Ensuring long-term sustainability depends on a suitable governance framework and funding. Examples from European research infrastructures like ELIXIR and Euro-BioImaging show that successful knowledge platforms depend on steering committees, thematic working groups, and scientific coordinators. These groups oversee content quality, set community standards, and guide future growth. Coupled with consistent funding and active community involvement, this governance helps keep the infrastructure relevant, reliable, and up to date. For the PlantWalk COST Action, adopting this approach would transform it from just a database into a dynamic knowledge ecosystem that endures beyond the project's lifetime.

Initial and long-term funding

Funding is one of the defining characteristics of successful knowledge infrastructures. **Most are not funded by a single grant but instead evolve through several phases, with different funding mechanisms supporting different stages of development.** This is particularly relevant for a COST Action, whose primary mission is to build networks and lay the foundations for longer-term initiatives.

A realistic funding roadmap could be:

- Phase 1 (**COST Action**) - initial phase: To define the scope. It should start with community mapping, surveys, strategy development, and long-term planning. This is a proof of concept and test stage.
- Phase 2 (**Horizon Europe or national funding bodies**): Development of a searchable federalised knowledge platform which can be continuously expanded with established curation and governance mechanisms.

- • Phase 3 (**Long-term funding**): Distributed maintenance by participating institutions, integrated into established infrastructures, with ongoing community updates and periodic support from European and national programmes.

This staged approach mirrors the development of successful infrastructures such as ELIXIR, Euro-BioImaging and EMBRC, all of which began as collaborative networks before evolving into mature, sustainably funded European research infrastructures.

At the **European level**, the most appropriate funding source is **Horizon Europe**, particularly the **Widening Participation and Strengthening the European Research Area (ERA)** and **Research Infrastructures** programmes. In addition, the COST participants will be asked to review potential national funders and other opportunities which can be used.