New Research Infrastructure (RI) development

Forest ecosystem adaptation to global changes

IN SYLVA EUROPE

A long-term, forest-focused, pan-European and distributed RI for tailoring adaptation strategies towards sustainable forest management

Lead Country & Institution	**France**		**INRAE** ECODIV Dpt
			CIRAD
			URN
Co-coordination	**Finland**		**LUKE**
Co-coordination	**Denmark**		**IGN**

Coordinator – L. Saint-André
Laurent.saint-andre@inrae.fr

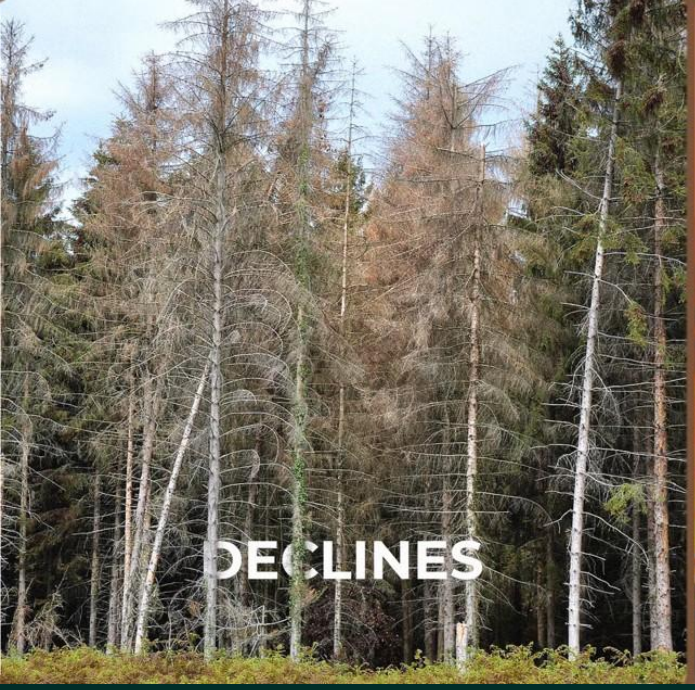
Project Manager – J.-F. Trontin
Jean-francois.trontin@inrae.fr

Coordination team
INRAE C. Meredieu, C. Pichot, L. Pâques, Z. Mao, C. Robin, H. Jactel
URN L. Vincenot
CIRAD L. Brancheriau
Luke S. Sorvari Sundet, V. Alenius, T. Aronen, M. Kurttila
IGN A. Bastrup-Birk, T. Nord-Larsen

ESFRI **ESFRI application submitted 8th April 2025**

ENVIRONMENT

October 9th, 2025
Workshop
GRACE collaboration and synergies with International Organizations and RIs



Can we maintain the multiple services provided by Europe's forest ecosystems in the face of global change?

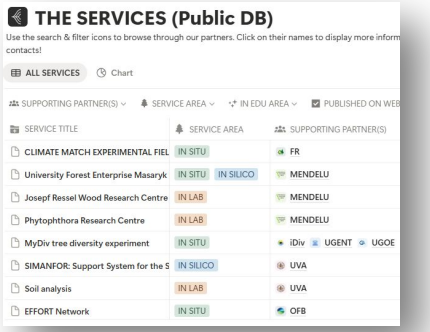
IN SYLVA EUROPE

Structuring forestry R&D services around <u>EXPERIMENTATION</u> to drive innovation (thematic RI)

IN SYLVA EUROPE

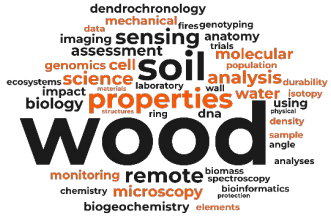
IN SITU

Field site networks
Experimentation



IN EDU

Knowledge transfer
Impact, education & training

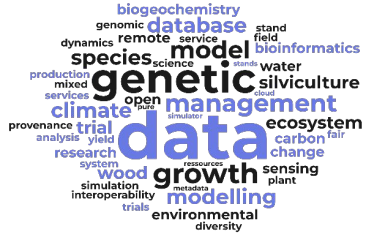


IN LAB

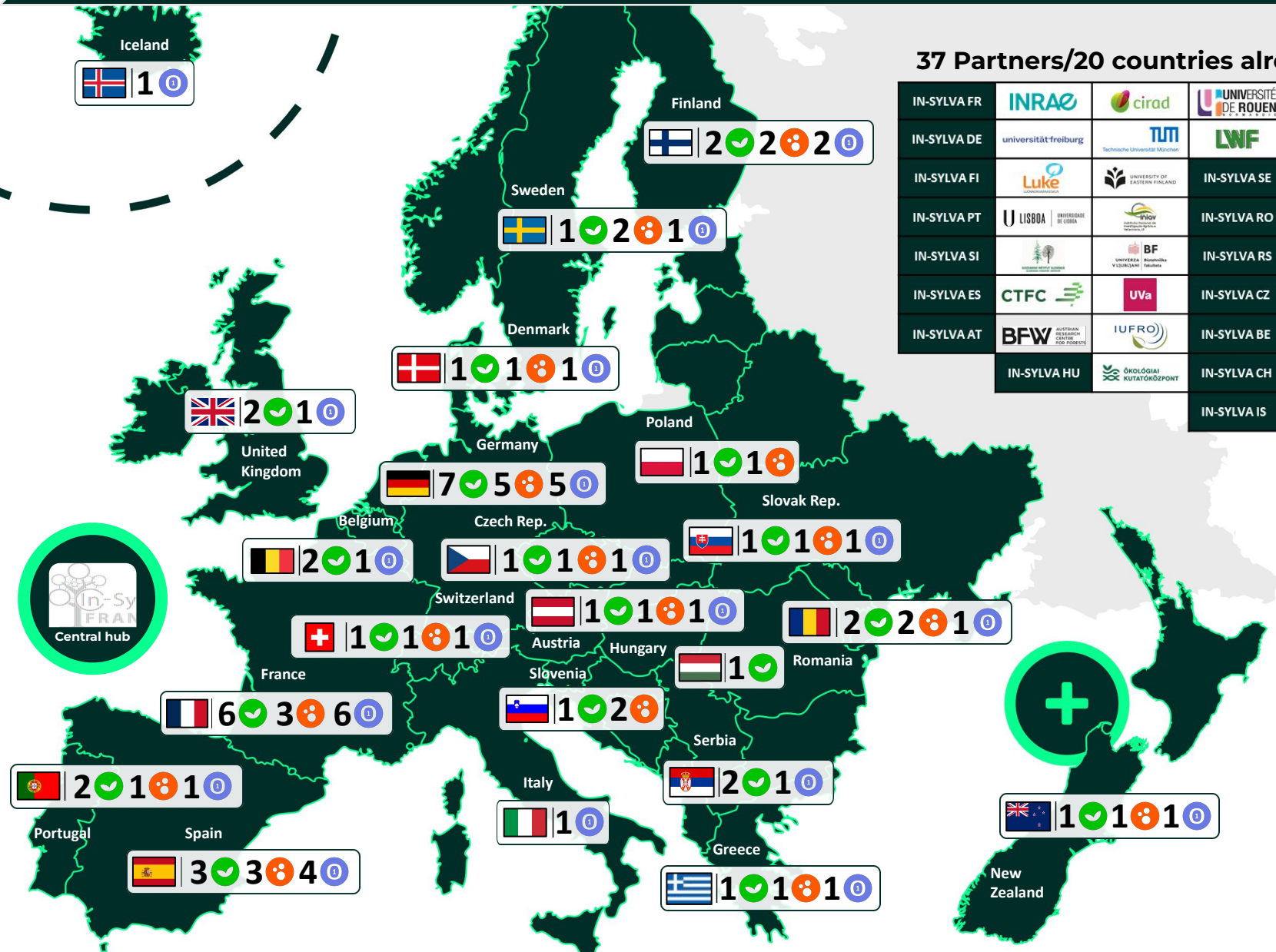
Analytical platforms
Pheno & envirotyping

IN SILICO

Data analysis
Info., modelling & simulation



Joining forces from a large international partnership providing over 200 in situ, in lab, in silico Services



37 Partners/20 countries already signed the MoU

IN-SYLVA FR	INRAE	cirad	UNIVERSITÉ DE ROUEN NORMANDIE	iefc	Homo Silvestris Europae	INRAE transfert
IN-SYLVA DE	universität freiburg	TUM	LWF	UNIVERSITÄT GÖTTINGEN	THÜNEN	
IN-SYLVA FI	Luke	UNIVERSITY OF EASTERN FINLAND	IN-SYLVA SE	SLU	RI. SE	
IN-SYLVA PT	U LISBOA	INIAV	IN-SYLVA RO	Universitatea Transilvania din Brașov	ICAS	
IN-SYLVA SI		BF	IN-SYLVA RS	UNIVERSITY OF BELGRADE		
IN-SYLVA ES	CTFC	UVa	IN-SYLVA CZ	Mendelova univerzita v Brně	IN-SYLVA DK	UNIVERSITY OF COPENHAGEN
IN-SYLVA AT	BFW	IUFRO	IN-SYLVA BE	UCLouvain	IN-SYLVA UK	Forest Research
IN-SYLVA HU	ÖKOLÓGIAI KUTATÓKÖZPONT	IN-SYLVA CH	WSL	IN-SYLVA SK		
			IN-SYLVA IS	Landbúnaðarháskóli Íslands	IN-SYLVA PL	IBL
					IN-SYLVA NZ	Bioeconomy Science Institute

IN SITU (39)

IN LAB (28)

IN SILICO (32)

99 Service nodes supported by Partners

45 Partners
22 countries

Developing strong impact pathways for science-based forest knowledge & technologies

Forests policy | **Innovation in forest management** | **Ecosystem functioning**

Implementation of sustainable future forest trajectories (at different scales)

Impacts

→ **User-oriented tools** → **Practical use cases** → **Educational resources**

Living labs
Knowledge & innovation

Lighthouses
Demonstration

Learning labs
Education & training

Co-constructed solutions
EU landscape | Stakeholders involved

Knowledge transfer
24 universities & high schools

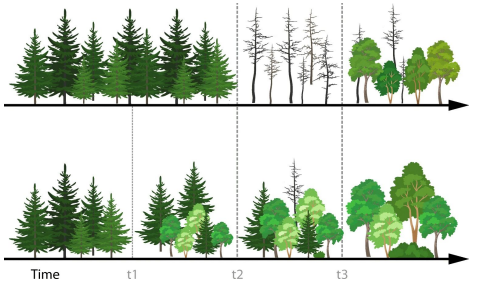
Outcomes

Forest experimentation
2D [Concept] & 3D [Object]

Science - Society
Interactions

Forest adaptation
4D [Evolution scenarios]

Innovative methods | **New approaches**



Jandl et al. 2019. doi: 10.1007/s13595-019-0827-x

Implementation

How do we stand out from other forest-related RI?

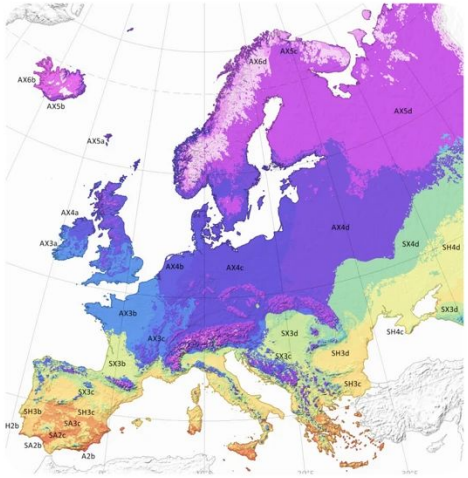
→ Providing large-scale, field site networks dedicated to forest adaptation experiments

Experimentation — Monitoring

ANAEE-ERIC
Biotic & abiotic interactions
anaee.eu

IN SYLVA EUROPE

Forest ecosystem adaptation
Experimentation on replicated sites covering large gradients
europe.in-sylva.com



ICOS-ERIC
Carbon cycle & GHG
icos-cp.eu

eLTER RI
Ecosystem dynamics
elter-ri.eu

ICP Forest
Air pollution effects
icp-forests.net

ENFIN
National Forest Inventories Patterns & trends @ European levels
enfin.info

Small
Highly instrumented

Large
Light instrumentation

Very large
No instrumentation

Number of sites & instrumentation intensity

Covering ecological, management & risk gradients over wide European ecoregions

Genetic diversity
Biodiversity
Fire
Pollution
Pests & diseases
Forest typology
Silviculture gradients
Altitude
Pedoclimatic conditions
Soil fertility
Phytoclimatic units

Testing interactions on replicated sites

Genotype
X
Environment
X
Silviculture

2023 **2026** | 2027 **2030** →Legal status | 2031 **2034** | 2035 **2054**

Design | **Preparation** | **Implementation** | **Operation**

10 y max. — **20 y+**

WE ARE HERE!

- Concept defined, design & feasibility ongoing until 2026
- Consortium of 37 Founding Partners established (MoU signed)
- **ESFRI Roadmap 2026 application (8th April 2025)**

ESFRI

Political support	**10 countries** (BE, DK, ES, FI, FR, NZ, PT, RS, SE, SK)
Financial support	3 countries (France, Spain, New Zealand) 25 research organisations
Expressions of interest	87 stakeholders in 16 countries

Investment plan

Over all RI development phases

ESTIMATED COSTS	TOTAL (M€)	COMMITMENT (M€)	COVERAGE (%)
TOTAL INVESTMENT (from 2023)	**207**	55.15	26.6
DESIGN (2023-2026)	**2**	2.0	100
PREPARATION (2027-2030)	**8**	7.32	91.5
IMPLEMENTATION (2031-2034)	**194**	45.83	23.6
TERMINATION (from 2049)	**3**	0	0
AVERAGE ANNUAL OPERATION COSTS *(from 2034)*	***37***	*19.79*	*53.3*

FORESEEN LARGE INVESTMENTS DURING IMPLEMENTATION

(discussion in progress with partners)

IN SITU — **32.7 M€**

- IoT modular sticks
- Drone squadrons
- Off-road robots
- Upgrade/harmonisation of existing facilities

IN LAB — **23.0 M€**

- High-throughput lab equipment for automatization & scaling-up
- Cutting-edge analytical instruments
- Buildings

IN SILICO — **8.5 M€**

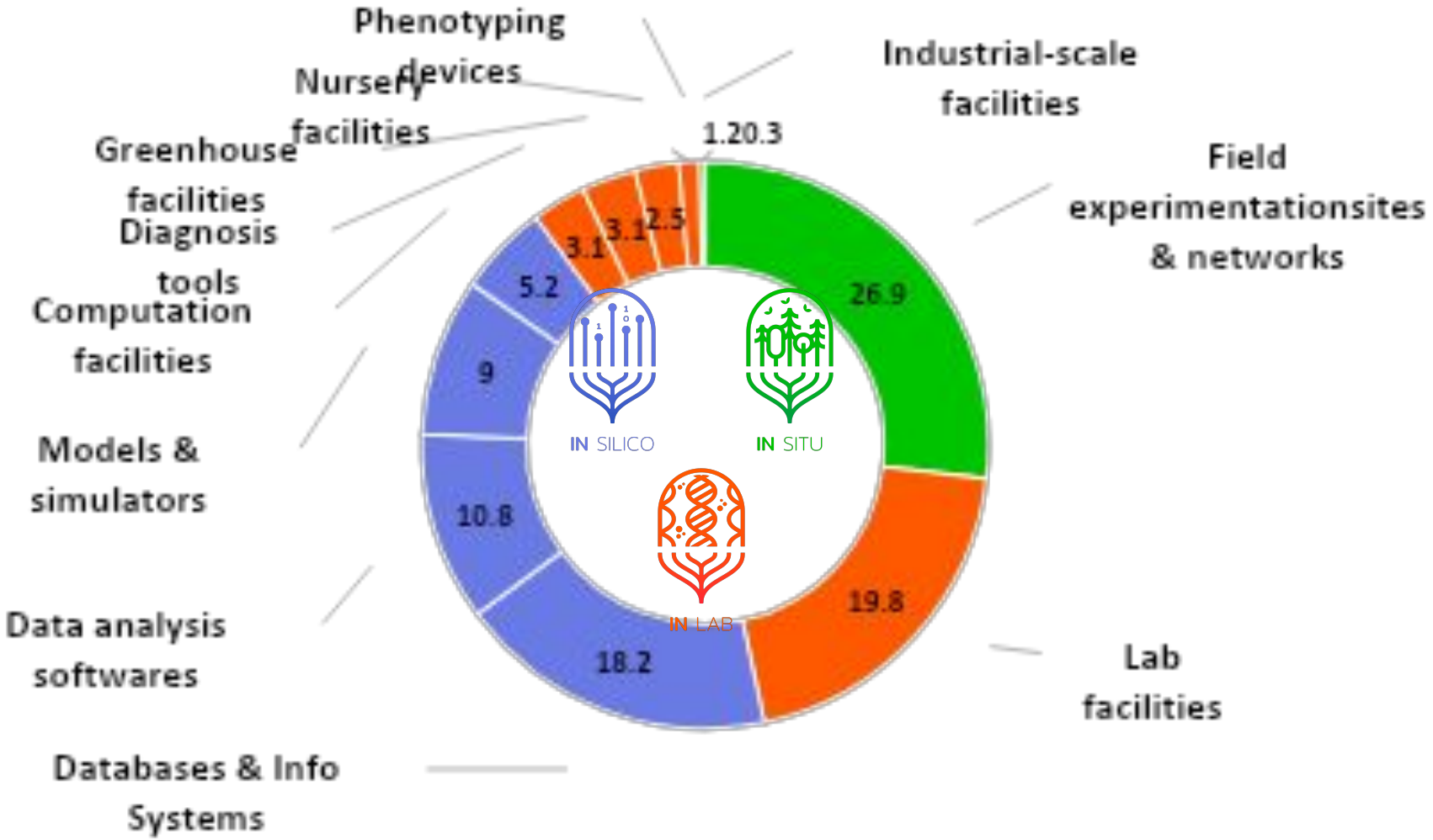
- Software (modelling, simulation, virtual reality)
- Hardware / high-performance computing, virtual headsets
- Hardware / data infrastructures
- Buildings (for low-equipped countries)

IN EDU — **4.2 M€**

- Demonstration & educational sites
- Digital learning platforms and virtual labs
- Scientific equipment dedicated to professional training and participatory sciences initiatives

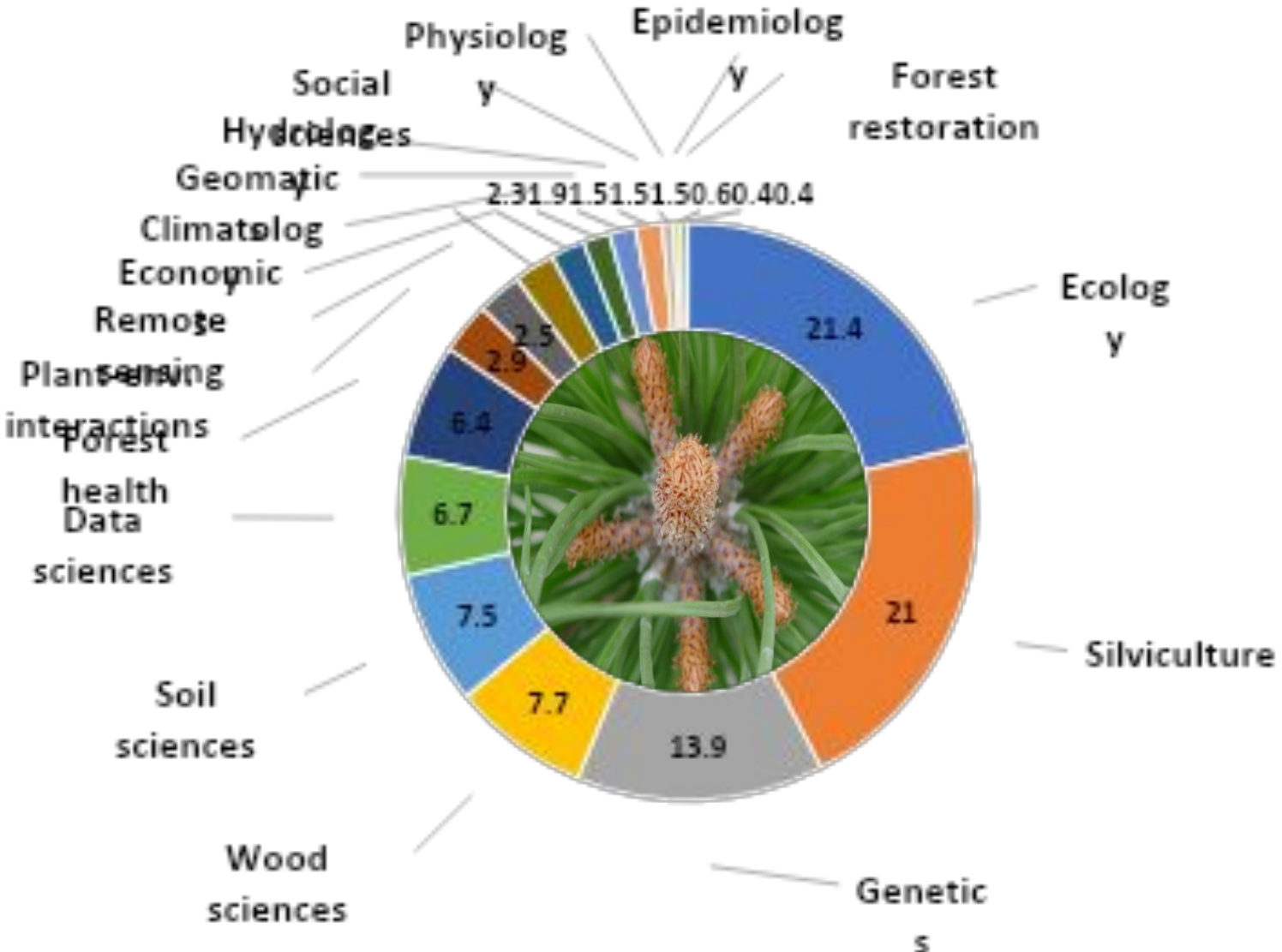
Service types

(% of 179 Service entries by Partners)



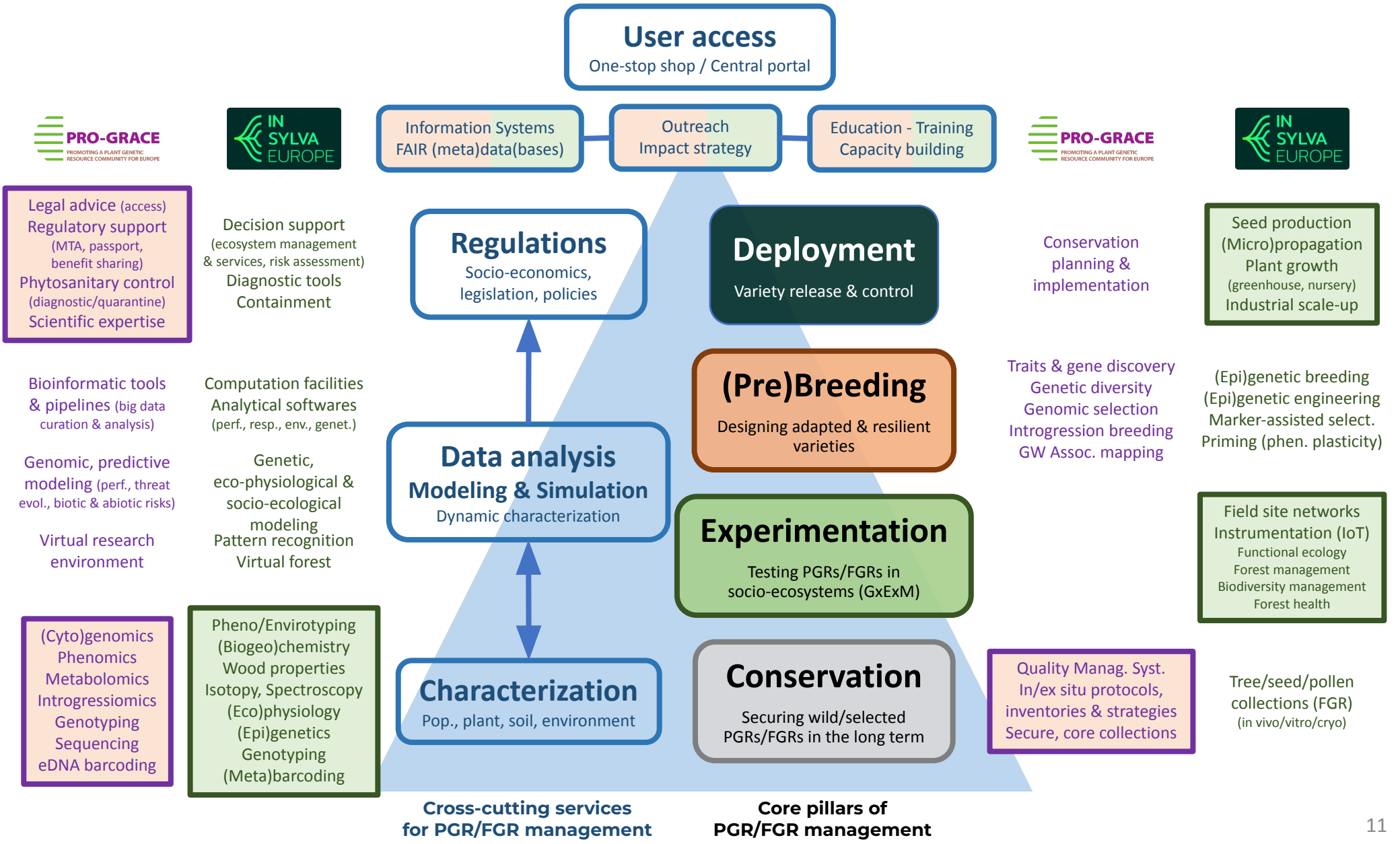
Scientific fields

(% of 179 Service entries by Partners)



Complementarity between IN-SYLVA Europe RI and GRACE-RI

→ Forest ecosystem adaptation vs. PGR conservation & use: positioning within the framework of PGR/FGR management



Integration potential: synergies and collaboration opportunities

Conceptual integration in forestry/agroforestry:

PRO-GRACE
PROMOTING A PLANT GENETIC RESOURCE COMMUNITY FOR EUROPE

Genebanks & secure conservation
Genome-wide genetic characterization & phenotyping
Genomic, predictive modeling
Bioinformatic frameworks for big data analysis
Legal and phytosanitary frameworks for PGR management

IN SYLVA EUROPE

Experimental site networks & flexible (IoT) instrumentation
Ecosystem-level (field) characterization, phenotyping & envirotyping
Ecophysiological & socio-ecological modeling
Biological & environmental data management
Decision support & deployment pathways for selected FGR

🔗 **Together:** **Enable predictive, multiscale FGR management from genes to ecosystems, from conservation to deployment of adapted forest varieties in a legal EU framework**

Key joint opportunities (tentative):

- Shared **data standards and interoperability** (FAIR principles, joint metadata structures).
- **Interoperable meta-portal for PGR/FGR (data) management.**
- Joint **modelling frameworks combining molecular-to-ecosystem scales** (link genomic → ecophysiological → socio-ecological models).
- **Build multi-scale digital twins for adaptation & resilience forecasting** (from genome to ecosystem).
- Common **training and outreach programmes** (PGR/FGR management, bridging agroforestry and forestry).
- Collaborative **policy and service interface** for access, biosecurity, benefit sharing, co-design and deployment of FGR (jointly cover entire policy chain for FGR management).

IN-SYLVA EUROPE

Forest ecosystem adaptation to global change

Small seed embryos to become well-adapted trees in a changing environment!
IN-SYLVA Europe RI development towards sustainable forest ecosystem management!
© J.-F. Trontin

Thanks for your attention!

A long-term forest RI initiative led by France based on seed multinational European projects!

A multinational effort involving already over 260 people!

Two-way collaboration strategy with 13 ESFRI Research Infrastructures

Towards enhanced inter- and trans-disciplinary collaborative EU projects on forest adaptation

Increasing knowledge on forest adaptation
Contribution (OUTPUTS to RIs): deepen ecosystem knowledge
Benefits (INPUTS from RIs): formalised forest research

IN SYLVA EUROPE

Fostering technological innovation
Contribution (OUTPUTS to RIs): enhanced technologies
Benefits (INPUTS from RIs): formalised technological deployment

GHG AND OTHER ATMOSPHERE ISSUES

ICOS-ERIC (L)

- Carbon cycle
- GHG monitoring
- Intensive instrumentation

ACTRIS-ERIC (L)

- Short-lived constituents
- Air quality monitoring

ECOSYSTEM STRUCTURE/FUNCTION

ANAEE-ERIC (L)

IN	Ecosystem functioning; Biotic and abiotic interactions; Intensive instrumentation
OUT	Testing/modelling (large gradients) Thesaurus/ontology (forest ecosystems)

eLTER RI (P)

- Ecosystem dynamics
- Socio-ecological approach
- Integrated standard observation
- Intensive instrumentation

COLLECTIONS

DISSCO (P)

- Biorepositories
- Natural collections
- Digitisation services

MIRRI-ERIC (L)

- Microbial resources
- Ecosystem biomonitoring (e.g., soil health, zoonoses)

SAMPLING - PHENOTYPING - DATA

ELIXIR (L)

- High-throughput data management & analysis
- Chemistry, genetics/ genomics

LIFEWATCH-ERIC (L)

- Biodiversity & ecosystem research
- Massive data computing
- Advanced modelling

EMPHASIS (P)

IN	Lean, efficient phenotyping - IoT sensors - High-resolution wireless networks - Remotely operated autonomous system
OUT	Field plots across large gradients Experimental datasets for modelling

GRACE (C)

IN	PGR conservation Breeding technologies
OUT	PGR experimentation

EU-IBISBA (P)

IN	Envirotyping tools
OUT	Forest biotechs

Euro-BioImaging-ERIC (L)

IN	Time-lapse imaging for phenotyping & envirotyping in vivo (e.g. PET)
OUT	Field plots for Proof-of-Concept of new imaging technology in the field

OPERAS (P)

IN	Methodologies for open and collaborative citizen science Transnational access of resources and integration in EOSC Analytics of open access content
OUT	Participatory forest research in citizen science with a focus on social sciences and humanities

Users needs at European level, besides national initiatives

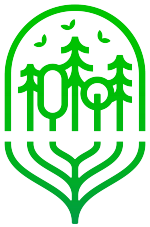
Bottlenecks

Fragmentation, lack of harmonized procedures and pheno- & enviro-typing tools

Insufficient capacities for characterisation of genetic resources and their environment

Low integration of data and long term sharing in Europe
Insufficient science-based tools for stakeholders

Needs



IN SITU

Forest experimentation (ca. 200 k sites)

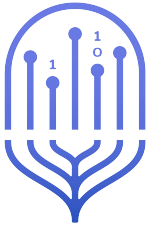
Genotype x Environment x Silviculture interactions

Remote access using modular, lightweight and low cost devices

IN LAB

High throughput and diversified analytical platforms

Forest ecosystem compartments and components, tree/wood and soil traits, pipelines for samples analysis



IN SILICO

Information systems

Long term access to FAIR metadata & data

Modelling & simulation (+ mobile Apps)

Integration of interdisciplinary data into diagnosis and modelling tools integrating climate change scenarios

IN SYLVA EUROPE

Main aim | **To set up an European RI with a multilateral, distributed design gathering in situ, in lab and in silico resources & services for the continuous adaptation of forest ecosystems to global change**

Forestry information, education and training services

Internal/external training services and mobility (capacity-building programme)
High-quality Open Educational Resources (OERs) to meet education needs (knowledge, skills, technologies)

IN EDU | IN SYLVA EUROPE

1- Increase excellence of Partner's research facilities staff
(e.g., new professions with evolving technologies)

2-Development of new curricula for the future of forests
e.g., multicriteria analysis and illustrative learning environments (practical and/or virtual forest showcase)

3-Increase science-based forest knowledge in the Society

24 universities & high schools from 14 countries

Target users of IN-SYLVA EUROPE services

↓ Scientific communities ↓

G1- Scientists directly involved in forest ecosystem adaptation

G2- Scientists who can benefit from and further contribute to improving RI services

Forest publication corpus in EU	2002 2011	2009 2019
Tatry & Leiser 2012 Païvinen et al. 2023	**141,326**	**>182,000**

20 countries (50-80% international collaboration)

↓ Other stakeholders ↓

G3- Stakeholders controlling and/or benefiting from forest ecosystem services

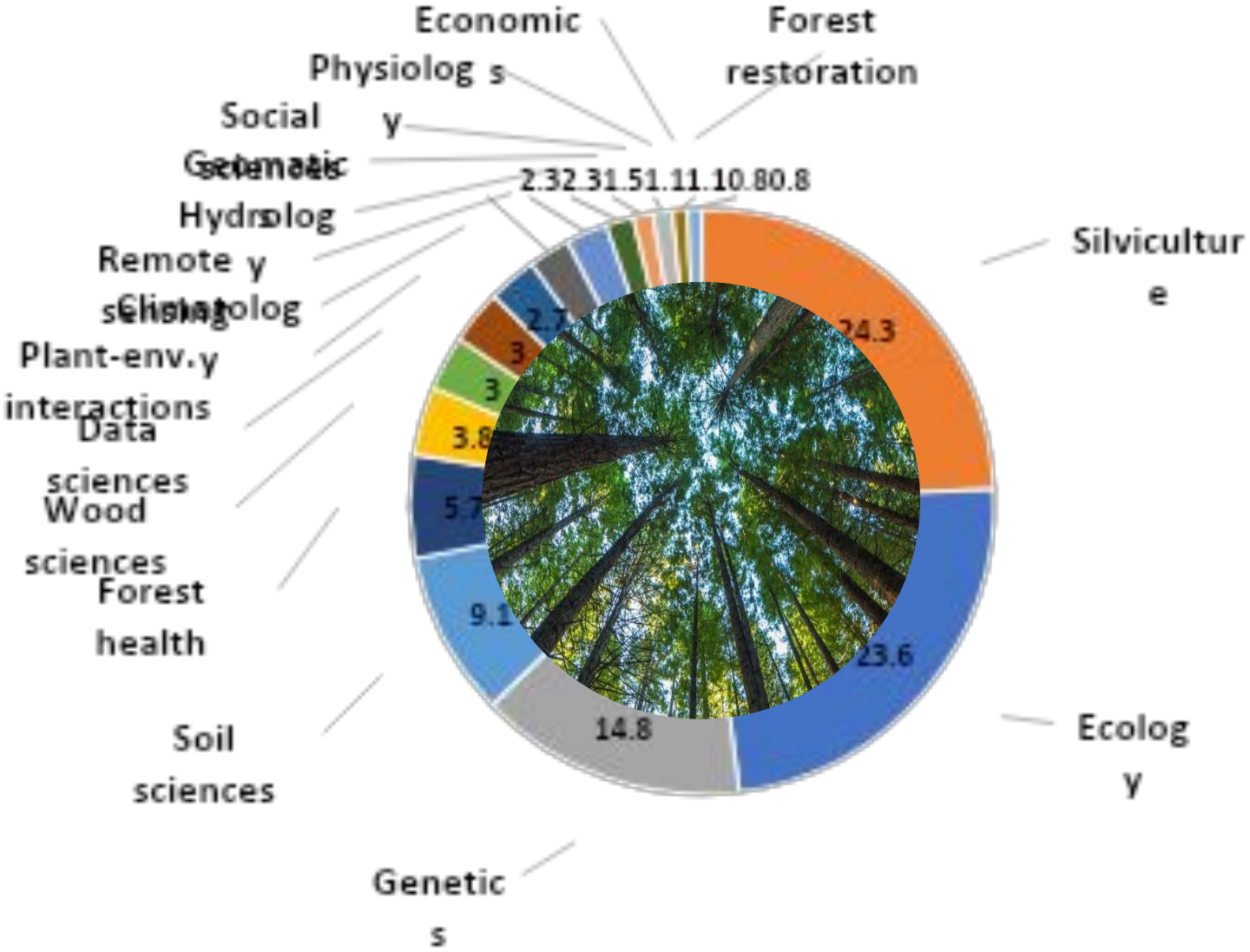
G4- Stakeholders with needs in forest/forestry education & training

87 letters of interest from 16 EU countries

(including 8 ministries, 17 agencies, industries, universities, forest organisations, NGOs, etc.)

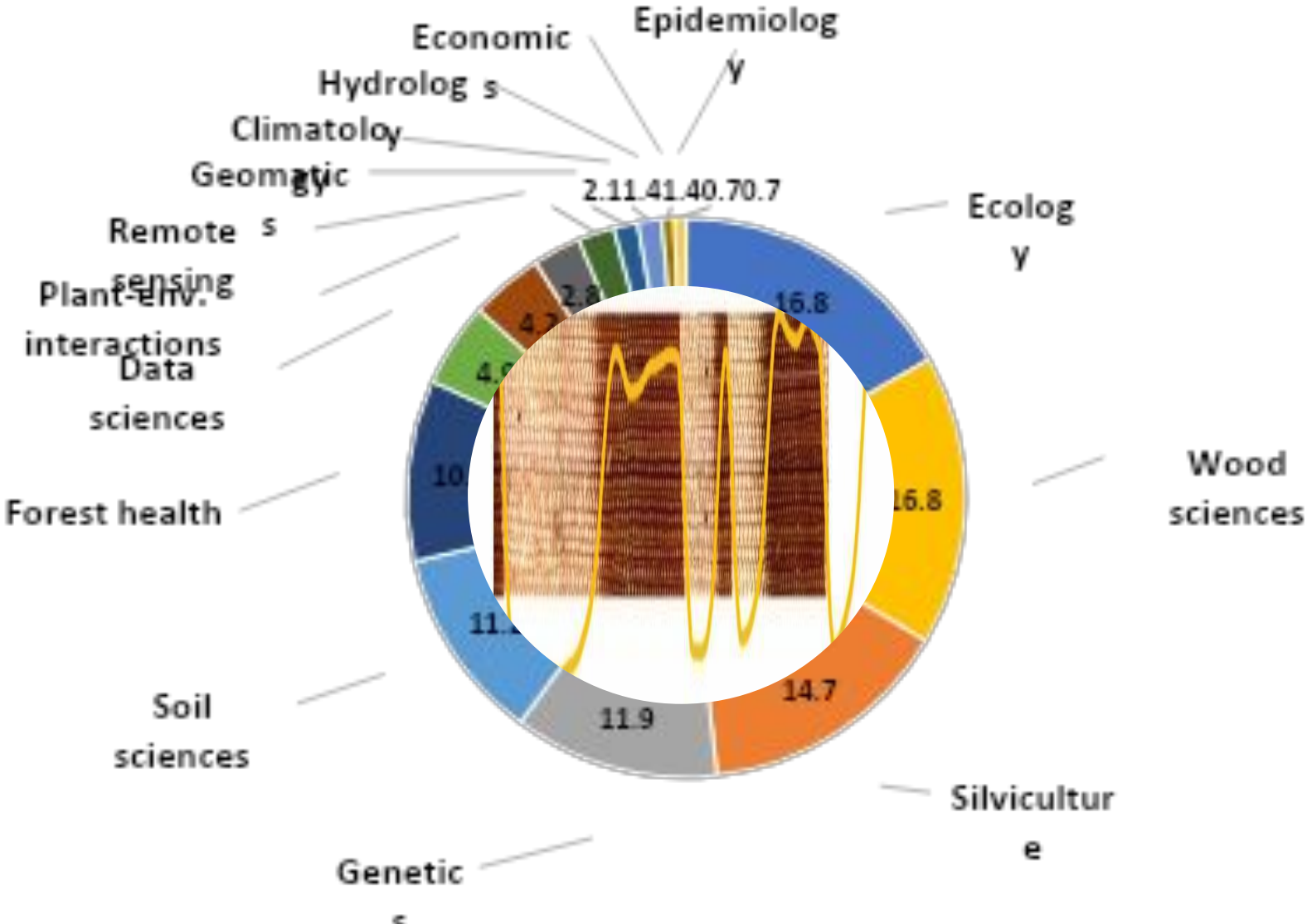
Scientific fields

(% of 89 in situ Services by Partners)



Scientific fields

(% of 63 in lab Services by Partners)



Scientific fields

(% of 67 in situ Services by Partners)