



## Deliverable 3.1

### Report on the design of next-generation common garden trials for future tree adaptation

#### Dissemination Level

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<b>Sen</b>	<i>Sensitive — limited under the conditions of the Grant Agreement</i>	<input type="checkbox"/>
<b>CI</b>	<i>RESTREINT-UE/EU-RESTRICTED, CONFIDENTIEL-UE/EU-CONFIDENTIAL, SECRET-UE/EU-SECRET under Decision <a href="#">2015/444</a></i>	<input type="checkbox"/>

#### Type

<b>R</b>	Document, Report	<input checked="" type="checkbox"/>
<b>DEM</b>	Demonstrator, Pilot, Prototype	<input type="checkbox"/>
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## Executive summary

As a result of climate change, targeted efforts are needed to improve the resilience of European forests. Common gardens are one of the most effective ways to assess survival, growth, resilience and interactions between different tree species and provenances. As part of OptFORESTS, we have developed a new network of common gardens with an innovative design aimed at investigating the following five questions:

1. Performance of marginal vs central populations.
2. Performance of individuals neighbouring to individuals of other provenances of the same species.
3. Hidden reaction norms of provenances under contrasting environments.
4. Performance of individuals neighbouring to individuals of other species.
5. Assisted migration.

The common gardens are divided into five types depending on their location – the bioclimatic regions. Each region is a separate network, but together, the common gardens from all five regions form a large European network in which we will evaluate the survival, phenotypic traits and interactions of eight provenances by species, of 12 economically and ecologically important, and underused tree species. Two species (*Quercus petraea* and *Pinus sylvestris*) will be represented in all common gardens regardless of the bioclimatic region. Each trial will be approximately 1 ha large, where 1,600 seedlings belonging to five tree species will be planted. Each tree species will be represented by eight provenances, four central and four marginal.

Taken together, these trials represent a novel approach to assess the resilience and performance of species and provenances under different climatic conditions that are often unusual for the tree species. We anticipate that the network of OptFORESTS common gardens will be of great importance to European forestry in the years to come.

## Introduction

As a result of climate change, targeted efforts are needed to improve the resilience of European forests while maintaining the ecological, social and economic functions of forests in a sustainable manner. This has been taken up in EU policy, e.g., in the EU Biodiversity Strategy and the New EU Forest Strategy for 2030. The associated target of planting 3 billion (additional) trees in Europe by 2030 requires a diversity of suitable forest reproductive material (FRM) from a wide range of species to meet biodiversity and forest restoration requirements while considering carbon sequestration and economic viability needs in the face of climate change.

OptFORESTS aims to generate knowledge on the adaptive capacity to climate change of underused or minor tree species alongside important commercial forest tree species by drawing on diverse FRM from characterised unique genetic lineages across Europe.

While traditional common gardens compare the performance of different populations of a single species in the same environment, in OptFORESTS we will also evaluate the resilience and performance of different provenances in mixed plots (i.e., how individuals of different provenances behave when surrounded by individuals of other species and/or provenances). We have therefore designed two sets of experimental trials/common garden experiments: the **generic trials** to investigate the potential for resilience, assisted migration and performance of selected tree species and provenances in different environments across Europe (considering also interactions between provenances), and the **luxury trials** to investigate the interactions between a subset of these species/provenances to identify relevant species/provenance combinations as part of a mixed forest management system. The generic trials and the luxury trials thus complement each other. Moreover, a luxury trial is always accompanied of a generic trial which will be established next to each other. Taken together, these trials and the geographical location of tested provenances represent a novel approach to species/provenance diversity and climate gradient coverage that will be of great importance for European forestry in the coming years.

## Objectives

This report presents the trial designs and their location, and the species and provenances to be included in the trials across the climatic regions targeted by this project - both for the generic trials and for the luxury trials.

## Methods

The results presented in this report were co-created by researchers and stakeholders from public forestry agencies, forestry companies and tree nurseries. In short, the design of the common gardens and the selection of lineages were elaborated by the researchers, while the selection of the tree species and the locations of the common garden were elaborated by the stakeholders and the researchers in close interaction.

Two workshops were organised as part of the design of this new generation of common gardens. The first workshop, held in Bordeaux and funded by a grant from the ANR and INRAE, was organised before the start of the project in order to take advantage of the first autumn of the project to start collecting seeds in line with the common garden design. Ten researchers and nursery representatives from seven countries participated and 1) defined the questions that the common garden design should answer and 2) draft a design (tentative number of species and provenances) to run simulations to obtain the optimal design to answer the questions posed with statistical certainty.

Following the workshop, INIA-CSIC conducted a simulation analysis in CycDesigN (Whitaker et al. 2002). The constraints for the simulation analysis were the maximum number of seedlings allowed (set to 1,600) to control for the size of the common gardens relative to the available budget and the fact that five tree species should be included in each common garden to cover the diversification component (underused tree species). The following combinations of parameters were simulated: split-plot, incomplete-block and row-column designs in combination with 3-, 4-, 7- and 9-tree plots and four or five provenance pairs (i.e., eight or 10 provenances) per tree species. From these simulations, we estimated the proportions of different neighbouring trees (of the same or different species/provenance) to check for the efficiency of the different designs in providing mixed plots for future comparisons of species/provenances interactions. The results were discussed in an online session to select four best options that were subsequently presented and discussed at the second workshop immediately after the OptFORESTS kick-off meeting.

During the second workshop, all project partners contributing to WP3 ranked the questions, discussed and agreed on the final design of the generic common gardens, defined the term “unique lineages” in the context of the project and finally selected the tree species for the common gardens, working in five groups, one per biogeographical region. The selection of tree species took into account information from country-specific meetings between OptFORESTS researchers and forest services, national agencies, companies and nurseries, as appropriate for each country and submitted to OptFORESTS via a survey.

The design of the luxury common gardens took place via online meetings in a group composed of partners who volunteered to establish these larger (and more resource consuming) common gardens. During these discussions, the group decided on the tree species and their provenances, the number of trees, their distribution, etc. in alignment with the research interests of OptFORESTS partners and their countries, as well as stakeholders expectations.

The process and outcome of selecting unique lineages and provenances was elaborated in MS2.

## Results and discussion

The trials will address the following questions (ranked in order of importance from most important to least important by the attendees of the two workshops):

1. Performance of marginal vs central populations.
2. Performance of individuals neighbouring to individuals of other provenances of the same species.
3. Hidden reaction norms of provenances under contrasting environments.
4. Performance of individuals neighbouring to individuals of other species.
5. Assisted migration.

### The generic common gardens

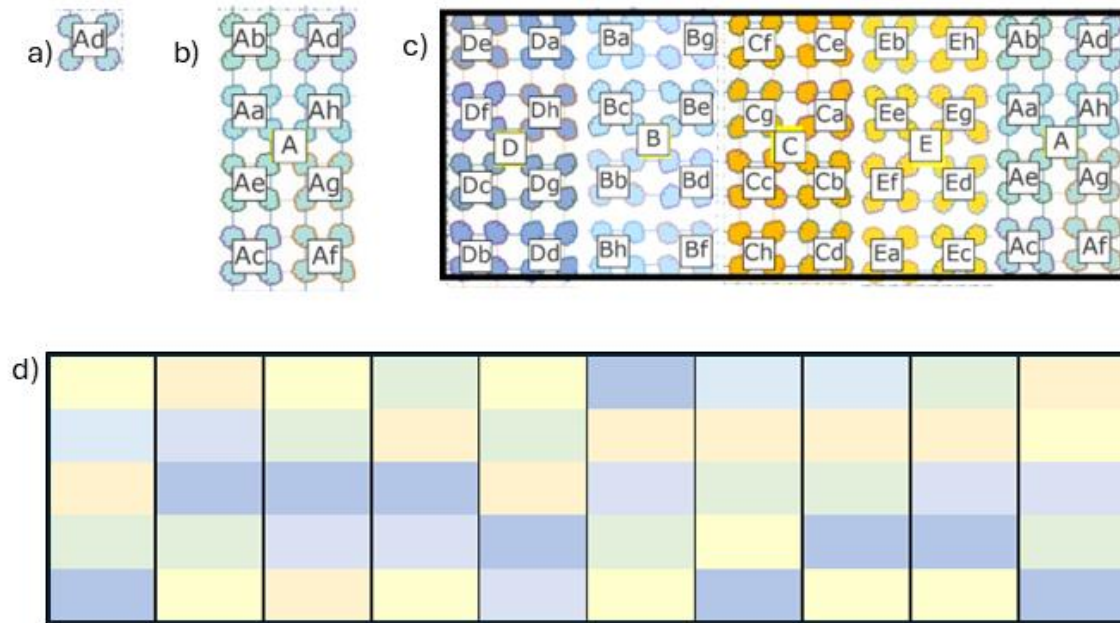
The design of the generic common gardens reflects our **aim to study species and provenance performance** – including differences between central and marginal populations of the same tree species as well as provenance interactions, and to keep the trials for 20-30 years (which calls for relatively small but well replicated trials and for multi-tree plots, to allow for cuttings when trees become older). Questions 1, 2, 3 and 5 will be addressed in these trials.

Each generic common garden:

- Contains **5 tree species**
- **Scots pine and sessile oak** are present in all trials
- The species within regions (common garden type) are the same
- Trials are of approximately 1 ha, preferred spacing is 2.5 m, 1600 seedlings per trial

### *The design*

A split-plot design proved to be better suited than the incomplete-block design to pursue our aim (Table 1). Trees of one provenance are grouped into 4-tree sub-plots (Fig. 1a), which are combined into 32-tree plots of one species (Fig. 1b). The plots of all five species are grouped into blocks (Fig. 1c). The blocks are repeated 10 times within a common garden (Fig. 1d and e). Distribution of blocks within the common garden will follow the land environmental gradients, whenever possible. Individual trees will be largely surrounded by trees of the same species but of different provenance (Table 1). Subplots of four trees will allow three thinning cycles, which is essential for the maintenance of the experiments in the long term.



**Figure 1.** Design of the generic trials. a) 4-tree **subplot** of provenance *d* and species A, b) **plot** of species A containing all 8 provenances distributed randomly within plot (*a-h*, total of 32 trees), c) **block** containing all 5 species (plots) distributed randomly within block and d) common gardens containing the **10 blocks** (1,600 trees).

**Table 1.** Comparison of neighbour proportions, i.e., how many neighbours are of the same species but different provenance, the same species and the same provenance, or different species between the incomplete-block design and the split-plot design. The comparisons are made for individual trees. The split-plot design promotes a larger proportion of neighbours of the same species but different provenance - in line with our objectives, while the alternative incomplete-block design has a comparably large proportion of neighbours of the different species.

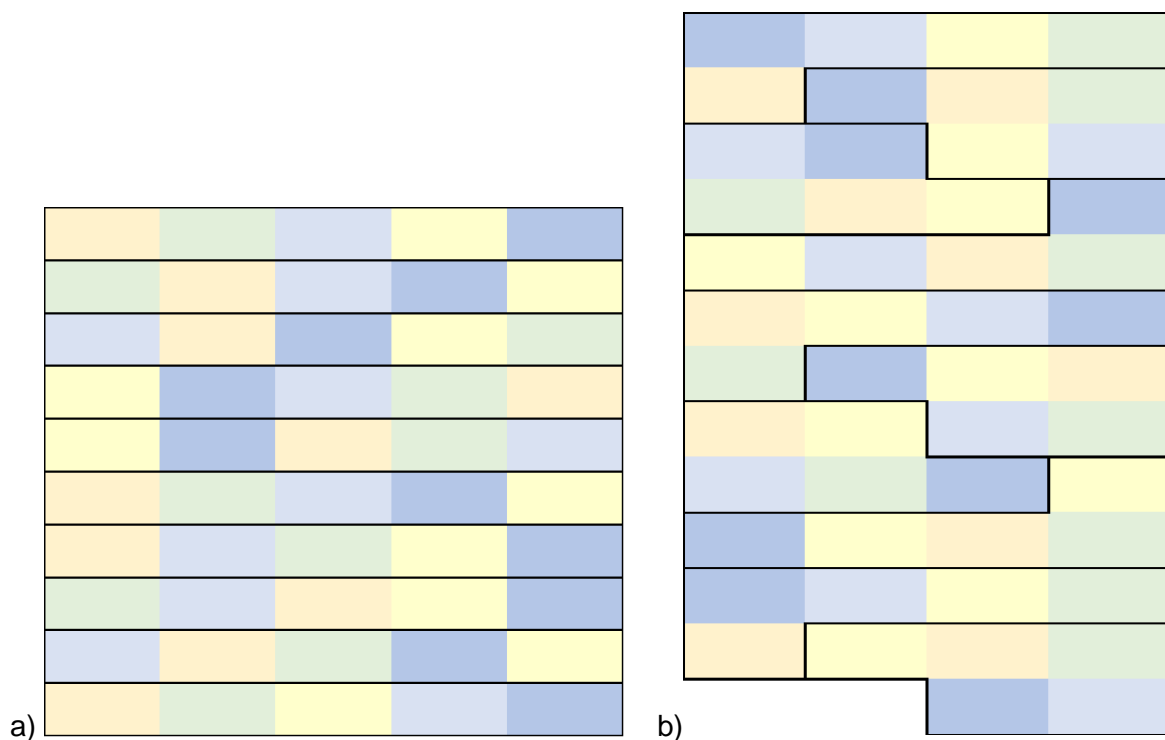
	Subplot size (number of trees)	Plot size (number of subplots)	Proportion of neighbours of same species but different provenance	Proportion of neighbours of the same provenance	Proportion of neighbours of different species
Incomplete block	4	10	<b>8.43%</b>	43.35%	<b>48.21%</b>
Split plot	4	8	<b>43.75%</b>	37.50%	<b>18.75%</b>

Summary of the generic common garden design in numbers is as follows:

- 4 trees of each provenance (subplot) x 8 provenances (plot) x 5 species (block) x 10 blocks = 1,600 trees per common garden
- 8 subplots (provenances) are randomly placed within the plot of a tree species and 5 plots are randomly placed within the block. Randomisation can be done either by rolling dice, taking numbers out of a bag or generating random numbers in a computer
- Each trial should be allocated 1 ha, which implies a spacing of 2.5 m. In addition, a buffer row surrounding the common garden is needed. However, in order to adapt the trial to local conditions, distances between 2 and 3 m can be accepted
- With a tree spacing of 2.5 m x 2.5 m, the plots in Fig. 1b would be 20 m x 10 m, the block in Fig. 1c 50 m x 20 m and the common garden in Fig. 1d 200 x 50 m (= 10,000 m<sup>2</sup> = 1 ha).

### ***Modifications of the design to fit the planting site***

Keeping the design as simple as possible is recommended both for ease of establishing and to facilitate subsequent monitoring. However, sites for common gardens rarely have an exact rectangular shape. Therefore, the arrangement of the blocks and even the shape of the blocks can be adapted to fit the space available at the respective common garden location and to follow the specific environment gradients in the site. Indeed, blocks should be arranged to minimize within-block variability in soil and terrain (Fig. 2). The shape of the plots (Fig. 1b) can also be changed into a shape different than rectangular, but the 4-tree subplots should always be a 'square' (Fig. 1a), not to interfere with later thinning.



**Figure 2.** Block distribution in the site. a) Design for a 100 m x 100 m site and b) design for an 80 m x 130 m site.

### **Species and provenances of the generic common garden trials**

The common gardens cover five European bioclimatic regions - the Alpine, Atlantic, Boreal, Continental and Mediterranean. The **widespread** and **economically important** *Pinus sylvestris* and *Quercus petraea* will be included in all common gardens. The remaining three species depend on the bioclimatic region (Table 2). The four provenance pairs of each tree species are the same regardless of the climatic region in which the species will be planted (to favour comparisons across climatic regions and to simplify seed collections).

In addition to the widespread and commonly used in forestry *Pinus sylvestris* and *Quercus petraea*, **regionally important but less used** species such as *Abies alba*, *Pinus pinaster*, *Fagus sylvatica*, *Q. pubescens*, *Larix decidua* and *Castanea sativa* are also represented in the trials. Finally, *Tilia cordata*, *Prunus avium* and *Pinus nigra* are representatives of a large group of **underused species** that are of great importance for biodiversity in general, but for which we have limited phenotypic data in common gardens. The combination of these species' groups will therefore provide valuable performance data for conventional forestry as well as for enrichment planting and restoration efforts in the most important bioregions of Europe.

For each climatic region we have also selected a reserve species in case some of the primary species fail, e.g., because of lack of seeds or during cultivation in the nurseries.

**Table 2.** The 12 tree species included in the OptFORESTS common garden network, their distribution across the common garden types (bioclimatic regions) and list of common gardens in each region (nurseries responsible for producing the plants in parenthesis). *Pinus sylvestris* and *Quercus petraea* will be used in all trials.

Type:	Alpine	Atlantic	Boreal	Continental	Mediterranean
<b>Species 1</b>	<i>Quercus petraea</i>	<i>Quercus petraea</i>	<i>Quercus petraea</i>	<i>Quercus petraea</i>	<i>Quercus petraea</i>
<b>Species 2</b>	<i>Pinus sylvestris</i>	<i>Pinus sylvestris</i>	<i>Pinus sylvestris</i>	<i>Pinus sylvestris</i>	<i>Pinus sylvestris</i>
<b>Species 3</b>	<i>Abies alba</i>	<i>Pinus pinaster</i>	<i>Fagus sylvatica</i>	<i>Prunus avium</i>	<i>Pinus nigra</i>
<b>Species 4</b>	<i>A. pseudoplatanus</i>	<i>Castanea sativa</i>	<i>Tilia cordata</i>	<i>Tilia cordata</i>	<i>Quercus pubescens</i>
<b>Species 5</b>	<i>Tilia cordata</i>	<i>Prunus avium</i>	<i>Larix decidua</i>	<i>Quercus pubescens</i>	<i>Castanea sativa</i>
<b>Reserve</b>	<i>Larix decidua</i>	<i>Fagus sylvatica</i>	<i>Prunus avium</i>	<i>Abies alba</i> & <i>A. pseudoplatanus</i>	<i>Pinus pinaster</i>
<b>Common gardens</b>	Austria 1 (BFW)	Denmark 1 (ONF)	Finland 1 (Luke)	Austria 2 (BFW)	France 3 (ONF)
	Czechia 1 (CZU)	France 2 (ONF)	Finland 2 (Luke)	Bulgaria (FSCS)	Italy (BFW)
	France 1 (ONF)	Spain 1 (TRAGSA)	Norway (Luke)	Czechia 2 (CZU)	Slovenia 2 (BFW)
	Switzerland (BFW)	*Scotland 1 (FR)	*Sweden 2 (Luke)	Denmark 2 (ONF)	Spain 2 (TRAGSA)
		*Scotland 2 (FR)		France 3 (ONF)	*Serbia (IFO-BE)
		*Sweden 1 (ONF)		Germany (ONF)	
				Romania 1 (FSCS)	
				Romania 2 (FSCS)	
				Slovenia 1 (BFW)	
			*Luxemburg (ONF)		

\*Common gardens established by external organisation to the OptFORESTS consortium (FR: Forest Research, UK; IFO-BE: Institute of Forestry - Belgrade, Serbia).

Within species, each provenance pair represents a unique genetic lineage (distinct (phylo)genetic group) in which one provenance is ecologically or geographically part of the core distribution and the other marginal.

In the context of the OptFORESTS project, **marginal populations** are primarily tree populations that are at the edge of the ecological or geographical niche/distribution of the species. This marginality could be altitudinal (e.g., approaching the tree line), drought-related (e.g., in a more southern climate) or defined by other ecological or geographical boundaries. Thus, for different tree species, the drivers of marginality may be different (temperature, precipitation, unusual soils, etc.). For example, we would consider a population of European beech, a tree species that normally thrives in cool and humid climates, as marginal if it grows in a dry and warm climate or in a Mediterranean bioclimate (with dry summers) or if it constitutes an isolated population separated from the core distribution by relevant geographical barriers (e.g., high mountains).

The provenance pairs selected for each species can be found in the Annex at the end of this document. In whatever common garden a given species is planted, the same set of provenances are used (except in a few cases where lack of plants/seeds will force us to use the reserve populations/species).

## The luxury common gardens

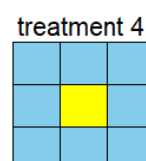
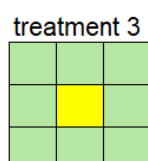
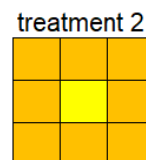
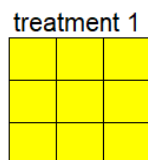
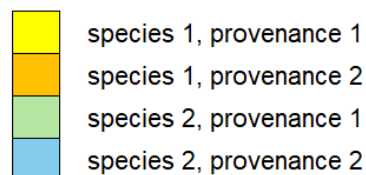
The aim of the luxury trials is to **investigate the interactions between species** (question 4) followed by investigating in more detail the interactions between provenances of the same species (question 2), which are considered relevant for the future forests in the areas where these trials are to be established. In order to ensure sufficient statistical power for the analysis, the number of species and provenances is kept low. The species combinations were determined at local level by the OptFORESTS partners establishing the luxury trials, after consultation with stakeholders. In this way, the species combinations are anchored in the local relevance for forestry in future climate conditions.

### *The design*

The luxury common gardens consist of only two species, one provenance of each of them. To facilitate between-species comparisons, the interface between species in the trials is maximized (Fig. 4). By choosing the incomplete-block design, individual plants have approximately 10 times the proportion of neighbours of different species (31.60%) compared to the split-plot design (3.65%, Table 3).

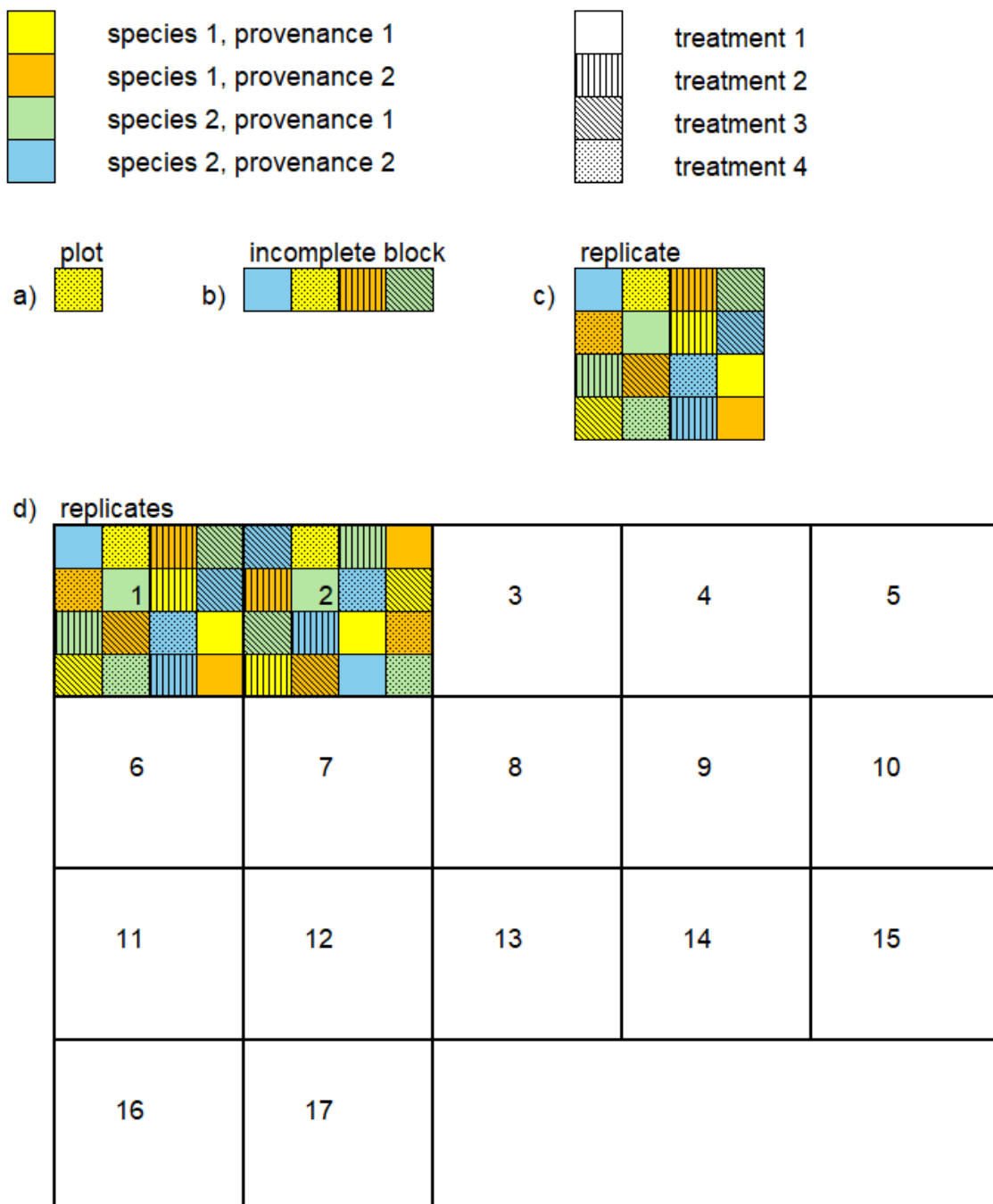
The design is a 9-tree subplot (Fig. 3) in which each treatment has a central tree surrounded by trees of:

- The same provenance
- A different provenance of the same species
- Provenance 1 of the second species
- Provenance 2 of the second species



**Figure 3.** Design of the luxury trials - treatments. Each cell represents one tree. All four treatments for an individual provenance as the central tree are shown.

This is repeated for all species and provenances ( $n=4$ ), adding up to a total of 144 trees ( $9 \times 4 \times 4$ ), making a replicate that combines 4 incomplete blocks, which in turn is repeated 17 times (Fig. 4). Thus, each trial consists of 2,448 trees, i.e., 612 trees per provenance. At a spacing of 2 m (a bit shorter than for the generic common gardens as to promote higher competition), this would make the size of the trial approximately 1 ha (in addition to the 1 ha of the associated generic common garden). While the 9-tree subplots cannot be changed, the incomplete blocks can have different shapes (not necessarily square) to adapt to the site.



**Figure 4.** Design of the luxury trials. a) **subplot** with species 1, provenance 1 and treatment 4, b) **incomplete block** involving the 4 species-provenance combinations and one of the 4 treatments (see Fig. 3), c) 4 incomplete blocks make a **replicate** containing all species/provenances and treatments, and d) common garden including the **17 replicates**.

Summary of the luxury common garden design in numbers is as follows:

2 species and 2 provenances of each species distributed into

- 9-tree subplots
- 4 treatments, which are assigned randomly within incomplete blocks
- 4 provenances (of two tree species), which are assigned randomly within incomplete blocks
- 17 replicates, their arrangement and shape can be adapted to fit the space available at the respective location. Further, (incomplete) blocks should be arranged to minimize within-block variability in soil and terrain
- 9 x 4 x 4 x 17=2,448 plants
- Size: 1 ha, 2 m spacing, 612 plants/ provenance

**Table 3.** Comparison of neighbourhood proportions (same species (different provenance), same provenance, different species) of individual trees in the selected design.

	Sublot size (number of trees)	Block size	Proportion of neighbours of same species but different provenance	Proportion of neighbours of the same provenance	Proportion of neighbours of different species
Incomplete block	9	4 subplots/*IB x 4 *IB	7.00 %	61.40 %	31.60%
Split plot	9	4 subplots (1 per treatment) x 4 provenances	32.90%	63.45%	3.65%

\*IB: Incomplete block

### **Species and provenances of the luxury common garden trials**

The luxury trials will be set up adjacent to the generic trials, with luxury trials tentatively in the Atlantic, continental and Mediterranean bioclimatic zones (Table 4). Each luxury trial will contain two of the five species of the neighbouring generic trial and two of the eight provenances of each species. It is not necessary that the provenances of a species belong to the same lineage, but one of the provenances should be of local origin (suitable for the current climate) and the other from the south of the trial (suitable for the future climate). In this way, in addition to studying interactions between species and provenances, we will be able to draw conclusions about potential assisted migration.

**Table 4.** Species and provenances for the luxury trials.

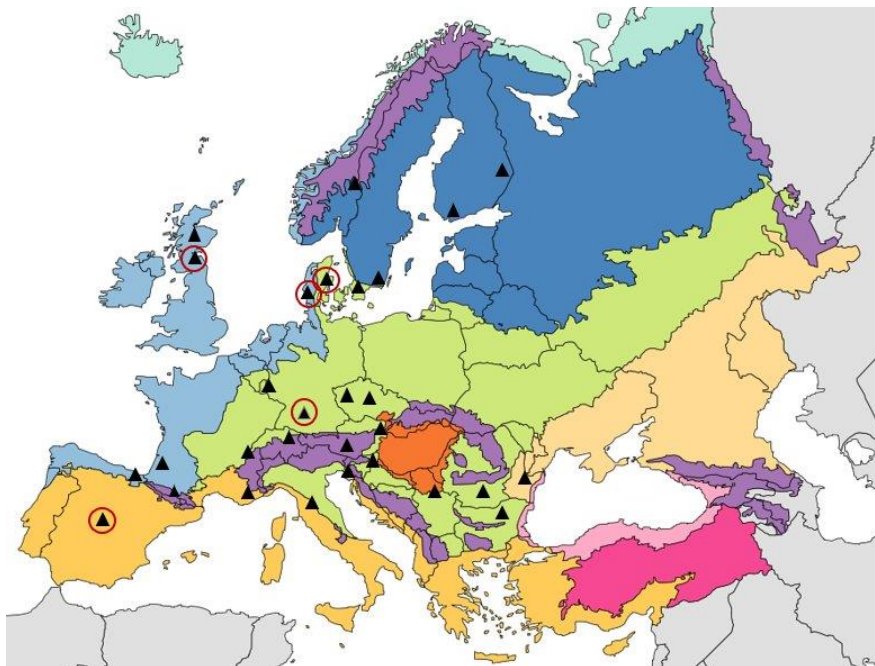
	Hosting country	Cimatic zone	species	Provenance 1	Provenance 2	Nursery raising seedlings
1	Denmark	Atlantic	<i>Q. petraea</i>	Spain (core)	Sweden	UCPH
			<i>C. sativa</i>	Spain (core)	Romania (marginal)	UCPH

2	Denmark	Continental	<i>Q. pubescens</i>	France (Western lineage)	Switzerland (marginal)	CZU
			<i>Q. petraea</i>	Spain (core)	Sweden	CZU
3	Germany	Continental	<i>Q. pubescens</i>	France (core)	Spain (marginal)	TUM
			<i>P. avium</i>	Germany (reserve)	Italy (marginal)	TUM
4	Scotland	Atlantic	<i>Q. petraea</i>	Scotland	Spain (core)	*FR
			<i>P. sylvestris</i>	Norway (marginal)	Switzerland (core)	*FR
5	Spain	Mediterranean	<i>Pinus nigra</i>	Spain (core)	France (marginal)	TRAGSA
			<i>Q. pubescens</i>	S France (central European lineage, core)	Spain (marginal)	TRAGSA

\*Common garden established by external organisation to the OptFORESTS consortium (FR: Forest Research, UK).

### Locations of generic and luxury common gardens

In many cases the specific sites for the trials have already been determined and are being prepared for planting, while in other cases this process is still ongoing. Standardised information about each site (e.g., coordinates, altitude, annual precipitation, bedrock/soil, etc) is given in an Excel document on the project's SharePoint as soon as the site is determined. The approximate location of the generic and luxury common garden trials is shown on Fig. 5.



**Figure 5.** Map with the location of 29 generic common gardens (c. 1 ha) in 16 countries, of which 6 common gardens are established by organisations outside the consortium (from UK, Sweden, Luxembourg and Serbia). In addition, 5 luxury common gardens (red circles) will tentatively be established adjacent to a generic common garden. Colours denote climatic regions: lilac - Alpine, dark blue - boreal, light blue - Atlantic, green - continental, orange - Mediterranean.

## Practicalities of trial establishment

The trials will be established on forest soil or previously arable land. The soil of the trials will be prepared with a plough or similar, if possible. The corners of each experimental block will be marked with poles and each planting site with bamboo sticks (or other durable sticks) to make them easy to find and to keep track of the vitality and other plant phenotypic traits, after the trials have been carried out. After planting, the trials will be mapped to position to allow keeping their identity (species, provenance, individual) based on the labelling made in the nurseries. All common gardens will be fenced to prevent browsing by wild animals. In addition, plastic tubes may be used to protect individual plants from rodents if local conditions require it. The planting distance of 2–3 m will allow manual or mechanical weeding, depending on local practice, which is crucial for the survival and vitality of the plants in the first years.

## Conclusion

The innovative next-generation common garden design presented here offers many opportunities for future collaborative research. The experiments should provide statistically sound answers to questions such as the genetic effects of marginality on tree performance, the impact of interactions between provenances in growth and survival, the existence of hidden reaction norms and the feasibility of local assisted migration schemes.

## Project outputs achieved

The design of the new generation of multi-species common gardens developed by OptFORESTS WP3 makes establishment of the experiments feasible even when only a limited area is available for trials. The relatively small size makes also easier to maintain and monitor the common gardens. Nevertheless, the simulations provide the certainty that the results will be statistically sound and allow the five questions posed to be answered with confidence. The design has also attracted interest outside the OptFORESTS consortium. In addition to a higher number of common gardens (23 compared to 20 initially foreseen) within the project consortium, six common gardens are currently planned to be established by colleagues outside the consortium (number of common gardens in brackets): Luxembourg (1), Scotland (2), Serbia (1) and Sweden (2).

## References

Whitaker D, Williams ER, John JA. CycDesigN: A package for the computer generation of experimental designs. Version 2.0. 2002. CSIRO Forestry and Forest Products, Canberra, Australia.

## Annex 1. List of provenances to include in common gardens

The list of species and provenances, including reserve population pairs, to be used in the common gardens is given in Annex 1. These are subject to change based on the masting patterns in the autumn of 2024.

Annex 1: ID of provenances planned to be sampled. The ID consists of serial number of provenances, acronym for species, country code and letter to denote core (C) or marginal (M) provenance.

Population ID	Species	Core population	Marginal population
1-AA-IT-C	<i>Abies alba</i>	Italy, Terranova di Pollino (CNR)	
2-AA-IT-M	<i>Abies alba</i>		Italy, Passo del cerreto - Monte la Nuda (CNR)
3-AA-ES-C	<i>Abies alba</i>	Spain, Monte Zuriza (TRAGSA)	
4-AA-FR-M	<i>Abies alba</i>		France, Canigou (INRAE/ONF)
5-AA-RO-C	<i>Abies alba</i>	Romania, E Carpathians (INCDS)	
6-AA-BG-M	<i>Abies alba</i>		Bulgaria (FSCS)
7-AA-AT-C	<i>Abies alba</i>	Austria (BFW)	
8-AA-FR-M	<i>Abies alba</i>		France, Issole (INRAE/ONF)
9-AP-IT-C	<i>Acer pseudoplatanus</i>	N Italy (CNR)	
10-AP-IT-M	<i>Acer pseudoplatanus</i>		S distribution margin in Italy (CNR)
11-AP-BA-C	<i>Acer pseudoplatanus</i>	Bosnia (if not possible Slovenia, GIS)	
12-AP-GR-M	<i>Acer pseudoplatanus</i>		S Greece (CNR)
13-AP-GE-C	<i>Acer pseudoplatanus</i>	Georgia (ONF)	
14-AP-GE-M	<i>Acer pseudoplatanus</i>		Georgia (ONF)
15-AP-CH-C	<i>Acer pseudoplatanus</i>	Switzerland, Guggisberg (WSL)	
16-AP-DE-M	<i>Acer pseudoplatanus</i>		N Germany (TUM)
17-AP-BG-C	<i>Acer pseudoplatanus</i>	Bulgaria (FSCS)	
18-AP-BG-M	<i>Acer pseudoplatanus</i>		Bulgaria (FSCS)
19-CS-IT-C	<i>Castanea sativa</i>	Italy (CNR)	
20-CS-IT-M	<i>Castanea sativa</i>		Italy (CNR)
21-CS-ES-C	<i>Castanea sativa</i>	Spain, Atlantic climate (TRAGSA)	
22-CS-ES-M	<i>Castanea sativa</i>		Spain (TRAGSA, INIA)
23-CS-FR-C	<i>Castanea sativa</i>	French Pyrenees (ONF)	
24-CS-FR-M	<i>Castanea sativa</i>		French Pyrenees (ONF)
25-CS-GR-C	<i>Castanea sativa</i>	Greece (ONF)	

26-CS-GR-M	<i>Castanea sativa</i>		Greece (ONF)
27-CS-SI-C	<i>Castanea sativa</i>	Slovenia (GIS)	
28-CS-RO-M	<i>Castanea sativa</i>		Romania (INCDS), alternative Serbia (GIS)
29-FS-IT-C	<i>Fagus sylvatica</i>	Central Italy (CNR)	
30-FS-IT-M	<i>Fagus sylvatica</i>		Sicily, Italy (CNR)
31-FS-SI-C	<i>Fagus sylvatica</i>	Slovenia (GIS)	
32-FS-SI-M	<i>Fagus sylvatica</i>		Slovenia (GIS)
33-FS-FR-C	<i>Fagus sylvatica</i>	France (ONF)	
34-FS-ES-M	<i>Fagus sylvatica</i>		Spain (TRAGSA)*
35-FS-SE-C	<i>Fagus sylvatica</i>	Sweden (NIBIO)	
36-FS-NO-M	<i>Fagus sylvatica</i>		Norway NIBIO)
37-FS-DE-C	<i>Fagus sylvatica</i>	Germany (TUM)	
38-FS-CZ-M	<i>Fagus sylvatica</i>		Czech Republic (CZU)
39-LD-CH-C	<i>Larix decidua</i>	Switzerland (WSL)	
40-LD-FR-M	<i>Larix decidua</i>		France (ONF)
41-LD-RO-C	<del><i>Larix decidua</i></del>	<del>Romania (INCDS)</del>	
42-LD-RO-M	<del><i>Larix decidua</i></del>		<del>Romania (INCDS)</del>
43-LD-CZ-C	<i>Larix decidua</i>	Czech Republic (CZU)	
44-LD-PL-M	<i>Larix decidua</i>		Poland (CZU)
45-LD-IT-C	<i>Larix decidua</i>	Italy (CNR)	
46-LD-CH-M	<i>Larix decidua</i>		Switzerland (WSL)
47-LD-AT-C	<i>Larix decidua</i>	Austria (BFW)	
48-LD-SI-M	<i>Larix decidua</i>		Slovenia (GIS)
49-PN-ES-C	<i>Pinus nigra</i>	Spain (TRAGSA)	
50-PN-FR-M	<i>Pinus nigra</i>		France (ONF)
51-PN-FR-C	<i>Pinus nigra</i>	France (ONF)	
52-PN-IT-M	<i>Pinus nigra</i>		Calabria, Italy (CNR)
53-PN-BA-C	<i>Pinus nigra</i>	Bosnia (BFW)	
54-PN-BA-M	<i>Pinus nigra</i>		Bosnia (GIS)
55-PN-TR-C	<i>Pinus nigra</i>	Turkey (ONF)	
56-PN-CY-M	<i>Pinus nigra</i>		Cyprus (BFW)
57-PN-HR-C	<del><i>Pinus nigra</i></del>	<del>Croatia (GIS)</del>	
58-PP-IT-C	<i>Pinus pinaster</i>	Tocci (CNR)	
59-PP-IT-M	<i>Pinus pinaster</i>		Pantellaria (CNR)
60-PP-ES-C	<i>Pinus pinaster</i>	Cortes de la Frontera (Málaga) (TRAGSA/INIA)	
61-PP-MO-M	<i>Pinus pinaster</i>		Adeldal (TRAGSA/INIA)

62-PP-ES-C	<i>Pinus pinaster</i>	Coca (TRAGSA/INIA)	
63-PP-ES-M	<i>Pinus pinaster</i>		Tabuyo del Monte (TRAGSA/INIA)
64-PP-FR-C	<i>Pinus pinaster</i>	Mimizan (INRAE)	
65-PP-FR-M	<i>Pinus pinaster</i>		Les Corbières (INRAE)
66-PP-PT-C	<i>Pinus pinaster</i>	Ovar (TRAGSA/INIA)	
67-PP-ES-M	<i>Pinus pinaster</i>		Asturias (TRAGSA/INIA)
68-PS-ES-C	<i>Pinus sylvestris</i>	Spanish Pyrenees (TRAGSA)	
69-PS-ES-M	<i>Pinus sylvestris</i>		Sierra Nevada (TRAGSA)
70-PS-IT-C	<i>Pinus sylvestris</i>	Apennines (CNR)	
71-PS-IT-M	<i>Pinus sylvestris</i>		Apennines (CNR)
72-PS-CH-C	<i>Pinus sylvestris</i>	Switzerland (WSL)	
73-PS-NO-M	<i>Pinus sylvestris</i>		Norway (NIBIO)
74-PS-FI-C	<i>Pinus sylvestris</i>	Finland (Luke)	
75-PS-CZ-M	<i>Pinus sylvestris</i>		Czech Republic (CZU)
76-PS-RO-C	<i>Pinus sylvestris</i>	Romania (INCDS)	
77-PS-RO-M	<i>Pinus sylvestris</i>		Romania (INCDS)
78-PA-DK-C	<i>Prunus avium</i>	Denmark (UCPH)	
79-PA-NO-M	<i>Prunus avium</i>		Norway (NIBIO)
80-PA-IT-C	<i>Prunus avium</i>	Italy (CNR)	
81-PA-IT-M	<i>Prunus avium</i>		Italy (CNR)
82-PA-RO-C	<i>Prunus avium</i>	Romania (INCDS)	
83-PA-BG-M	<i>Prunus avium</i>		Bulgaria (FSCS)
84-PA-FR-C	<i>Prunus avium</i>	France (ONF)	
85-PA-AT-M	<i>Prunus avium</i>		Austria (BFW)
86-PA-DE-C	<i>Prunus avium</i>	Germany (TUM)	
87-PA-DE-M	<i>Prunus avium</i>		Germany (TUM)
88-QP-ES-C	<i>Qercus petraea</i>	Spain (TRAGSA)	
89-QP-SC-M	<i>Qercus petraea</i>		Scotland (Scotland)
90-QP-RO-C	<i>Qercus petraea</i>	Romania (INCDS)	
91-QP-BG-M	<i>Qercus petraea</i>		Bulgaria (FSCS)
92-QP-FR-C	<i>Qercus petraea</i>	France (ONF)	
93-QP-SE-M	<i>Qercus petraea</i>		Sweden (Sweden)
94-QP-AT-C	<i>Qercus petraea</i>	Austria (BFW)	
95-QP-SI-M	<i>Qercus petraea</i>		Slovenia (GIS)
96-QP-DK-C	<i>Qercus petraea</i>	Denmark (UCPH)	
97-QP-DE-M	<i>Qercus petraea</i>		S Germany (TUM)

98-QU-SI-C	<i>Quercus pubescens</i>	Slovenia (GIS)	
99-QU-IT-M	<i>Quercus pubescens</i>		Italy (CNR)
100-QU-FR-C	<i>Quercus pubescens</i>	S France (ONF)	
101-QU-CH-M	<i>Quercus pubescens</i>		N Switzerland (WSL)
102-QU-FR-C	<i>Quercus pubescens</i>	France (ONF)	
103-QU-ES-M	<i>Quercus pubescens</i>		Spain (INIA/TRAGSA)
104-QU-RO-C	<i>Quercus pubescens</i>	Romania (INCDS)	
105-QU-TR-M	<i>Quercus pubescens</i>		Turkey (ONF)
106-QU-ES-C	<i>Quercus pubescens</i>	Spain (INIA/TRAGSA)	
107-QU-ES-M	<i>Quercus pubescens</i>		Spain (INIA/TRAGSA)
108-TC-RO-C	<i>Tilia cordata</i>	Romania (INCDS)	
109-TC-RO-M	<i>Tilia cordata</i>		Romania (INCDS)
110-TC-IT-C	<i>Tilia cordata</i>	Italy (CNR)	
111-TC-IT-M	<i>Tilia cordata</i>		Italy (CNR)
112-TC-CH-C	<i>Tilia cordata</i>	Switzerland, Murg (WSL)	
113-TC-SI-M	<i>Tilia cordata</i>		Slovenia (GIS)
114-TC-BG-C	<i>Tilia cordata</i>	Bulgaria (FSCS)	
115-TC-BG-M	<i>Tilia cordata</i>		Bulgaria (FSCS)
116-TC-FR-C	<i>Tilia cordata</i>	France (ONF)	
117-TC-FR-M	<i>Tilia cordata</i>		France (ONF)