iCOSHELLs

D2.4 LL implementation design & site selection report II

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In a nutshell

Soil is essential for life on Earth, yet 60%-70% of EU soils are unhealthy due to pollution, urbanisation, and intensive agriculture - issues made worse by climate change. This soil degradation leads to significant economic, social, and environmental challenges, including reduced land productivity and biodiversity loss.

The iCOSHELLs project supports the EU Mission 'A Soil Deal for Europe,' aiming to restore healthy soils by 2030. Specifically, iCOSHELLs focuses on three key objectives: **reducing soil pollution and promoting restoration, improving soil structure and biodiversity**, and **increasing soil literacy among society**.

To achieve these goals, iCOSHELLs leverages **six Living Labs (LLs)** located in the **Basque Country, Bulgaria, Greece, Italy, Spain, and Sweden**. These Living Labs bring together diverse local stakeholders to co-design and test practical strategies for soil health improvement.

The project employs a systematic approach that strengthens stakeholder capacities, bridges scientific research with practical solutions, enhances understanding of soil indicators, and replicates effective recovery methods. Its ultimate purpose is to develop and validate scalable solutions that can be applied across Europe.

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List of Abbreviations

Abbreviation	Full Term
AUP	Agricultural University of Plovdiv
Basque LL	Basque Urban Soils Living Lab (Spain)
BUVLL	Bulgarian Viticultural Soil Health Living Lab
CEBAS	Centro de Edafología y Biología Aplicada del Segura (Spain)
CEC	Cation Exchange Capacity
CETENMA	Centro Tecnológico de la Energía y del Medio Ambiente (Spain)
CINEA	European Climate, Infrastructure and Environment Executive Agency
CluBE	Cluster of Bioeconomy and Environment of Western Macedonia (Greece)
DoE	Design of Experiments
DSS	Decision-Support System
eDNA	Environmental DNA
EC	Electrical Conductivity
EURG	External User Review Group
FAIR	Findable, Accessible, Interoperable and Reusable (data principles)
FSTP	Financial Support to Third Parties
GAIA	GAIA Innovation Cluster (Basque LL lead partner)
GDPR	General Data Protection Regulation
GHG	Greenhouse Gas
GPS	Global Positioning System
Greek LL	Greek Mine Soil Health Living Lab
HS	Hushållningssällskapet (Sweden)
IMIDA	Instituto Murciano de Investigación y Desarrollo Agrario y Medioambiental (Spain)
iCOSHINE	iCOSHELLs cross-LL exchange forum (linked to EURG)
IWMA	Industrial Waste Management Area (Greek LL site cluster)
IWMCF	Integrated Waste Management Central Facilities (Greek LL site cluster)
LL	Living Lab
LRF	Federation of Swedish Farmers (Sweden)
M8 / M9 / M18 / M30	Project Month 8 / 9 / 18 / 30
MSO	Mission Soil Objective
NGO	Non-Governmental Organisation
NPK	Nitrogen–Phosphorus–Potassium
NUTS	Nomenclature of Territorial Units for Statistics
OC	Open Call
PU	Public (dissemination level)
QA/QC	Quality Assurance / Quality Control
RCT	Randomized Controlled Trial
RISE	Research Institutes of Sweden
RP1 / RP2	Reporting Period 1 / Reporting Period 2
SES LL	Southeastern Spain Living Lab
SLU	Swedish University of Agricultural Sciences
SOC	Soil Organic Carbon
SOM	Soil Organic Matter
SVA	Swedish Veterinary Institute
SWE LL	Swedish Soil Health Living Lab
ToT	Train-of-Trainers
UPV/EHU	University of the Basque Country
WP	Work Package
WRB	World Reference Base for Soil Resources

Executive Summary

This report, D2.4 Living Labs Implementation Design & Site Selection Report II, presents the second iteration of implementation planning under Work Package 2 (WP2) of the iCOSHELLs project. Building on D2.3, it provides an updated, harmonised yet context-sensitive overview of how the six regional Soil Health Living Labs (LLs) have advanced from initial planning to confirmed site portfolios, refined experimental designs, and implementation-ready monitoring arrangements. This deliverable consolidates progress up to Month 18 and strengthens the iCOSHELLs network as a pan-European platform for soil health innovation.

The primary purpose of D2.4 is to update and verify how experimental sites have been confirmed (including any changes since D2.3), how prototype testing is being implemented at site level, and how soil health indicators are monitored in alignment with the project objectives and the EU Mission "A Soil Deal for Europe." Each LL reports on its site network (targeting a minimum of ten test sites) and documents the status of land access, baseline characterisation, stakeholder validation, and implementation readiness. Where changes occurred since D2.3, such as site substitutions, additions, or withdrawals, this report records the rationale and implications for design and monitoring comparability.

Cross-LL update on site portfolio changes vs D2.3 (counts): D2.3 reported site portfolios of Basque 10, BUV 10, Greek 10, ITA 10, SES 10, and SWE 15 (≥65 total). Based on the M18 WP2 LL datasets currently available for D2.4 compilation, the recorded site counts are: **Basque 10; BUV 10; Greek 12; ITA 14; SES 10; SWE 14.** In all LLs, site confirmation continues to rely on context-appropriate access models (municipal land, partner-operated sites, farm networks, and post-industrial terrains) as described in D2.3.

Experimental designs across the Living Labs remain tailored to local conditions while aligned through shared principles: use of controls, 2–8 experimental treatments per site, up to 6 replications, and consistent monitoring of a core soil indicator set defined in D3.1. **Monitoring implementation progress (M18):** the WP2 datasets record baseline sampling completion dates across all documented sites (with follow-up sampling already recorded in the Greek and Italian LL datasets), while other LLs show follow-up sampling as planned for subsequent seasons. In addition, D2.4 clarifies the practical harmonisation mechanisms used by LLs (sampling plans, monitoring frequencies, minimum metadata, and QA/QC routines) while preserving LL-specific adaptations where field conditions require them.

In addition to soil intervention prototypes, LLs continue to implement and/or prepare the deployment of monitoring and decision-support tools, alongside soil literacy and behavioural engagement activities linked to the test sites. In D2.4, these elements are reported only insofar as they affect implementation design (e.g., site requirements, monitoring integration, operational constraints), while prototype development and evaluation remain reported under D2.6–D2.8. **Cross-LL prototype typology (implementation-relevant):**

- **Soil interventions** are deployed across all LLs (e.g., regenerative/agronomic and management-based practices in farms and permanent crops; restoration measures in degraded lands).
- **Monitoring/decision-support** elements are also present across LLs (e.g., soil sensors and related monitoring workflows in BUV and SWE, and biodiversity/diagnostic monitoring approaches recorded in Basque prototypes).
- **Soil literacy/engagement** is structurally embedded in LL delivery models (especially where sites are publicly accessible, municipal, or demonstration-oriented), but is referenced here only as it conditions access, continuity, and monitoring participation.

The report documents the diversity of implementation models and access arrangements, such as farm networks, partner-operated or demonstration sites, municipal land, and post-industrial terrains, which reflect regional governance realities and provide complementary lessons for scaling. Stakeholder

engagement and governance structures that underpin these activities remain led under WP1 and are therefore referenced only to contextualise site confirmation and design updates, avoiding duplication with WP1 reporting.

Integration with other work packages remains a core function of this report. D2.4 provides an updated experimental and monitoring foundation for WP3 (Monitoring and Evaluation), supports the communication and policy relevance objectives of WP5, and confirms that data and metadata collection are aligned with the project's Data Management Plan (D8.2) and FAIR principles. **Data flows/metadata (M18):** no project-wide change of repository decisions is recorded within the WP2 implementation datasets; instead, D2.4 operationalises alignment by consolidating a cross-LL minimum site metadata checklist (site ID, land use, soil type/notes, management history, access/agreements, baseline status, monitoring readiness) and by linking monitoring variables back to the D3.1 core indicator framework.

Finally, D2.4 updates the risk and mitigation landscape based on early implementation experience (e.g., climatic variability, site access constraints, operational delays, monitoring/tool deployment issues), and records the corrective actions taken or planned. **Cross-LL risk update (since D2.3):** the most material new/emerging RP1 risks relate to (i) **climate extremes and water constraints** (e.g., drought-driven establishment failure in BUV requiring reseeding and enhanced agronomic measures in spring 2026), (ii) **monitoring and analytical capacity constraints** (e.g., laboratory apparatus/method availability noted in BUV), and (iii) **uneven maturity of operational documentation across LL datasets** (requiring targeted completion of site/design fields during RP2).

This second iteration will be followed by D2.5, which will further update and consolidate site networks, design refinements, monitoring alignment, and risk mitigation based on ongoing implementation learning and additional inputs from the project. Open Call selection and integration will be reported when available in the appropriate iteration(s).

1. Introduction

D2.4 is delivered under Task 2.3 in WP2 (Operationalisation and Implementation of Living Labs) and corresponds to the second of three iterations of the "Implementation Design & Site Selection" reporting line defined in the Grant Agreement (D2.3 at M8, D2.4 at M18, D2.5 at M30). As specified in the Grant Agreement, this iterative reporting structure documents the progressive refinement of Living Lab site selection and experimental designs as implementation advances under real-world conditions, accounting for contextual variables (e.g., microclimate, local ecology, and community practices) and updating mitigation strategies for identified risks.

Within the overall project logic, WP2 operationalises the co-created priorities emerging from WP1 by translating them into deployable field experimentation across the six Living Labs, and by ensuring that site portfolios and experimental designs are sufficiently specified to enable cross-Living Lab learning and evaluation. D2.4 therefore moves beyond the baseline "planning snapshot" captured in D2.3 and provides an M18 update on: (i) confirmed site portfolios and access/agreements; (ii) refinements to implementation and experimental design choices based on early deployment experience; and (iii) monitoring set-up alignment with the common soil indicator and sampling framework established in D3.1. Together, these updates provide an implementation-ready audit trail that supports the monitoring and evaluation work led under WP3 while maintaining the harmonised-yet-flexible methodology established in the first iteration.

Open Call integration (WP4/FSTP) status at M18: The Open Call is implemented under WP4 as Financial Support to Third Parties (FSTP). In agreement with the Project Officer, Open Call projects are required to test new prototypes within existing Living Lab experimental sites and will not introduce new test sites. Consequently, site portfolios confirmed in D2.4 remain unchanged. Open Call integration may influence prototype deployment and monitoring configurations within existing sites and will be reflected in subsequent iteration reporting once onboarding is completed.

2. Material and Methods

2.1 Co-creation Process and Stakeholder Involvement

The implementation design of each Living Lab (LL) is grounded in the structured co-creation process led under WP1, which ensures that the interventions tested respond to locally identified soil health challenges and are embedded in the socio-ecological realities of each region. In iCOSHELLs, co-creation is not treated as an “add-on” activity; rather, it is the enabling mechanism through which stakeholder priorities, operational constraints, and acceptable solution pathways are translated into WP2 outputs, namely confirmed site portfolios, implementable experimental layouts, monitoring arrangements, and feasible timelines.

Baseline (as established in D2.3): During the first implementation phase, all LLs initiated co-creation by convening multi-actor groups including land managers/farmers, landowners, municipalities/public administrations, advisors, researchers, NGOs, and community actors. Early workshops supported shared problem framing and solution ideation, resulting in LL-specific “problem–solution pairs” that linked priority soil pressures (e.g., erosion, compaction, contamination, nutrient imbalance) to candidate prototypes and testing pathways under real-life conditions.

M18 update (what D2.4 adds): D2.4 documents how co-creation continued during M9–M18 to support implementation readiness and iterative refinement as LLs moved from planning to early deployment. At project level, co-creation capacity-building and comparability were reinforced through the Train-of-Trainers (ToT) programme and the iCOSHINE (EURG) cross-LL exchange forum. The ToT sessions provided practical templates and common requirements for co-creation documentation and GDPR-compliant participation (e.g., consent forms, participant lists, feedback tools), strengthening consistency across LLs while preserving local flexibility. In parallel, iCOSHINE sessions in 2025 provided structured peer-learning and validation on (i) soil-structure interventions and (ii) soil monitoring implementation challenges, including practical adaptations needed in sampling design, metadata capture, and protocol usability under heterogeneous field conditions.

BUVLL example (evidence-based M18 update): In the Bulgarian Viticultural Living Lab (BUVLL), co-creation workshops were held in Plovdiv on **10 February 2025**, **17 November 2025**, and **17 February 2026**, bringing together input suppliers, grape producers, scientific staff, and public administration. These workshops supported agreement on the vineyard site network, alignment on monitoring priorities (e.g., soil organic matter, biodiversity loss, soil structure deterioration under climate stress), and practical planning for prototype deployment and data access for participating farmers.

Cross-LL consolidation for M9–M18 (implementation-relevant):

- **Frequency and formats:** Across LLs, engagement during RP1 combined (i) local co-creation workshops/meetings linked to site confirmation and trial planning, (ii) field-based interactions where relevant (site visits and deployment planning), and (iii) project-level cross-LL validation via iCOSHINE (virtual/hybrid sessions in 2025).
- **Newly engaged stakeholder groups:** In addition to the core local actor categories reported in D2.3, RP1 saw strengthened involvement of technical experts and external Mission Soil stakeholders through iCOSHINE and cross-project exchanges (e.g., participation from other Mission Soil initiatives was explicitly included in the iCOSHINE format and documentation).
- **Citizen science “where applicable”:** Citizen involvement was operationalised primarily where it directly supports implementation design or monitoring (e.g., participatory soil sampling approaches used as both data-collection support and soil literacy action). A documented example is student engagement in soil sampling in the Basque LL context, presented as an approach that strengthens local ownership while contributing to representative sampling.

- **Open Call onboarding status at M18:** The Open Call is implemented under WP4 as Financial Support to Third Parties (FSTP). At Month 18, selections and onboarding are **not yet concluded**; the Open Call timetable positions contracting and kick-off after the M18 cut-off, with third parties expected to integrate into LL co-creation activities following selection and sub-grant signature. Consequently, D2.4 reports the implementation baseline and procedural readiness to integrate Open Call prototypes into **existing LL test sites** in the next iteration, in line with the Open Call rules.

In summary, co-creation remains essential for ensuring local relevance and stakeholder ownership, while also functioning as an implementation control point: it underpins access agreements, shapes feasible experimental layouts, enables monitoring participation and metadata completeness, and provides the feedback loops that trigger refinements documented in this second iteration.

2.2 Prototype Typology and Selection

The co-creation process in each Living Lab (LL) serves as the foundation for identifying priority soil health challenges and selecting solution pathways to be tested. In iCOSHELLs, these co-created solution pathways are operationalised as **prototypes**: practical interventions, tools, or engagement approaches implemented and assessed in real-life settings through Living Lab experimentation and learning cycles. When a prototype demonstrates effectiveness and feasibility under operational conditions, it may be advanced and communicated as a validated solution for wider uptake and scaling.

iCOSHELLs recognises that soil health challenges are multi-dimensional and require integrated approaches combining biophysical improvements with monitoring capacity and behaviour change. For implementation planning purposes in WP2, and to maintain consistency with the Open Call framework, prototypes are grouped into three broad categories reflecting distinct pathways through which soil health can be improved directly or indirectly:

- **Soil Intervention Prototypes (direct):** Active interventions applied to soils with the explicit purpose of improving soil health (e.g., vegetation/cover-based practices, amendments, changes in tillage and management). These are tested through structured experimental designs under real-life conditions.
- **Monitoring & Decision-Support Prototypes (enabling):** Tools and methods for assessing soil health and supporting management decisions (e.g., indicator monitoring, sensors, remote sensing, digital dashboards, decision-support systems). These prototypes often determine site requirements (e.g., sensor installation, connectivity, sampling logistics) and are directly linked to the monitoring framework defined in D3.1.
- **Soil Literacy and Engagement Prototypes (enabling):** Initiatives designed to foster soil literacy, community involvement, and behavioural change, often through participatory processes, training, and awareness activities linked to test sites.

In practice, prototypes frequently bridge more than one functional aspect. For example, monitoring tools may directly influence management decisions (and therefore function as interventions), and literacy/engagement activities can function as interventions when they lead to collective action (e.g., coordinated practice changes). These overlaps reflect the integrated, co-created nature of Living Lab innovation.

Iteration-2 focus (D2.4): This deliverable reports prototypes **only insofar as they shape implementation design and site selection**, including: (i) site requirements and feasibility constraints; (ii) experimental layout implications (controls/treatments/replication); and (iii) monitoring set-up requirements and alignment with the common indicator framework. Detailed prototype cataloguing, readiness tracking, and prototype-specific evaluation remain documented in the WP2 prototype reporting line (D2.6–D2.8) and are therefore not duplicated here.

Evidence-based example (BUVLL): In the Bulgarian Viticultural Living Lab, the prototype portfolio combines agronomic and management interventions in vineyards (e.g., conservation tillage, grassed inter-rows/cover, soil amendments, irrigation and plant protection improvements) with monitoring and decision-support components (e.g., sensors, satellite/DSS). In RP1, the prototype set remained stable, while implementation conditions required refinement—most notably drought-related establishment failure of the sown cover mixture, requiring repetition and more precise sowing in spring 2026; biochar testing is also reported as an additional option for improved moisture retention.

Portfolio evolution and integration (cross-LL iteration update for M9–M18): Across the Living Labs, the second iteration indicates **overall stability in prototype portfolios** relative to the baseline planning captured in D2.3: the main changes during RP1 are better understood as operational refinements (timing, application precision, logistics, monitoring integration, and feasibility constraints) rather than wholesale replacement of prototype sets. Where adjustments occurred, the typical drivers observed during early implementation fall into three recurring categories:

1. **Climatic and seasonal constraints** affecting establishment and timing (e.g., drought, heat, water availability);
2. **Operational feasibility and site-management constraints** (e.g., machinery access, farmer schedules, permissions); and
3. **Monitoring and analytical feasibility**, including the availability of equipment, calibration/QA needs, and capacity for advanced analyses.

Authoritative prototype list location: The project's authoritative prototype catalogue and refinement status are maintained in the WP2 prototype reporting line (D2.6 baseline catalogue; subsequent updates in D2.7 and D2.8), supported by the internal WP2 repository used for implementation documentation and cross-WP access according to the Data Management Plan.

Open Call integration: Open Call projects (WP4/FSTP) may introduce additional or complementary prototypes, but Open Call documentation clarifies that testing is expected to be conducted **through existing Living Lab experimental sites**, rather than creating new experimental site infrastructures. Consequently, prototype integration will primarily influence implementation design through additional site requirements, monitoring integration needs, and scheduling within existing LL cycles, and will be reported once selection and onboarding are finalised.

Table 1. Reference for positioning prototypes within iCOSHELLs (implementation-relevant)

Prototype category (WP2 implementation focus)	Sub-categories (implementation-relevant)	Typical site/design implications for D2.4
Soil intervention (direct)	Vegetation/agronomic (cover/ground cover, strips/buffers)	Plot geometry; control vs treatment definition; seasonal windows; machinery access; replication layout
	Amendments (compost/organic amendments, biochar, liming/gypsum where relevant)	Logistics/storage; standardised rates; baseline-before-application; blocking (texture/slope/history); short vs long-term sampling schedule
	Management-based (tillage regime, residue, irrigation scheduling, plant protection)	Constrained randomisation; protocol compliance; "realistic control" definition; documentation of co-interventions
Monitoring & decision-support (enabling)	In-situ monitoring (sensors, weather, connectivity)	Installation permission; power/data; maintenance; year-round access; sampling frequency and metadata requirements
	Lab/biological tools (soil biology assays, -omics where applied)	Sample handling chain; lab capacity; QA/QC; timing and replication implications; logistics/budget

	Remote sensing / DSS	Georeferencing; field boundaries; consistent management logs; temporal monitoring plan
Soil literacy & engagement (enabling)	Workshops/demos linked to sites	Site accessibility/safety; visibility; timing aligned to interventions
	Participatory monitoring/citizen involvement (where applied)	Training + simplified protocols; data validation; indicator selection and data governance; repeated engagement linked to specific sites

2.3 Site Identification and Selection

Each iCOSHELLs Living Lab (LL) is implemented as a network of physical soil test sites embedded in real-life agricultural, peri-urban, or degraded land contexts. This distributed design enables prototypes to be tested under operational conditions and across the diversity of regional soils, land uses, and management regimes. In line with D2.3, site selection remains a structured, stakeholder-led process rooted in WP1 co-creation activities and translated into implementable site portfolios under WP2.

For D2.4 (second iteration), the focus is on confirmation and implementation readiness: documenting which sites are now operationally secured (access/agreements), which sites have been refined since D2.3 (substitutions/additions where applicable), and whether each site can support the experimental layout and monitoring requirements associated with the selected prototypes. Educational and social engagement activities are primarily linked to the soil test sites but may also use complementary venues (e.g., schools or community spaces) where this is necessary to deliver engagement objectives; in D2.4, such venues are reported only insofar as they affect implementation logistics and continuity.

2.3.1 Site Identification Process

Site identification and confirmation followed an iterative process combining:

- **Stakeholder-led identification (WP1):** local actors contributed knowledge on soil challenges, practical constraints, and candidate sites or site networks, ensuring relevance and ownership.
- **Field-based reconnaissance and validation (WP2):** LL operational teams carried out site visits and feasibility checks to confirm suitability for soil interventions and monitoring, including practical aspects such as plot layout potential, access for repeated sampling, and constraints linked to farm operations or site governance.
- **Strategic alignment with co-created objectives:** candidate sites were screened against the LL's priority challenges and implementation aims (e.g., intervention feasibility, demonstration value, monitoring continuity) to ensure sites support repeated observation across seasons and iteration cycles.

Across LLs, identification began with a broader pool of candidate sites and progressed to a confirmed operational portfolio. Between D2.3 (M8) and D2.4 (M18), refinement actions, such as site substitutions, additions, or consolidation, are recorded in the relevant LL profiles, together with the rationale and implications for comparability and monitoring continuity.

2.3.2 Selection Criteria

To ensure methodological coherence across LLs while allowing local adaptation, the following criteria were applied when confirming soil test sites for prototype implementation:

- **Relevance to prioritised soil health challenges:** sites must represent the soil pressures identified through co-creation and be appropriate for the intervention(s) to be tested (e.g., erosion/structure degradation, nutrient imbalance, contamination, low organic matter).
- **Contextual suitability:** sites were assessed for soil and environmental characteristics (e.g., soil texture/notes, slope/drainage, land use history) and for the specific requirements of monitoring or decision-support tools (e.g., sensor placement, connectivity/access, sampling logistics).
- **Operational feasibility and continuity:** access permissions and long-term collaboration potential were prioritised, including compatibility with land manager operations, feasibility of repeated visits, and ability to maintain monitoring equipment or sampling schedules over time.
- **Representativeness and diversity:** each LL's site portfolio was selected to collectively reflect the diversity of regional soils, management regimes, and governance conditions necessary for learning and scaling, while retaining sufficient comparability for cross-LL synthesis.

2.3.3 Site Documentation and Field Verification

D2.4 consolidates site documentation into a **cross-LL minimum metadata checklist** to support traceability, comparability, and handover to WP3 monitoring and evaluation activities. This checklist is applied to each LL's site portfolio (with anonymisation where needed for sensitive locations/landowners):

Minimum site metadata (cross-LL, D2.4):

- Site ID (anonymised if required) and LL affiliation
- Land use / system type and management notes (baseline practice)
- Soil type / texture class (or equivalent descriptor) and key site characteristics (e.g., slope/drainage where relevant)
- Access/agreements status (landowner/manager consent; monitoring permission; duration)
- Baseline sampling status and timing
- Intervention/prototype status (planned / implemented / adapted)
- Monitoring readiness (equipment deployment where relevant; sampling responsibilities; QA/QC notes)

This minimum metadata aligns with the common monitoring logic in D3.1, which provides both a core indicator set and a harmonised soil sampling methodology to support consistency, data harmonisation, and cross-site comparability.

Field verification and baseline sampling: Across LLs, site confirmation has been supported by site visits and baseline characterisation activities initiated in the first iteration and continued/refined through RP1 implementation. D2.4 records the status of baseline sampling and readiness for follow-up sampling according to the D3.1 sampling protocol, and documents any site-level constraints affecting sampling windows, access, or equipment deployment.

Each LL profile therefore includes: (i) a site portfolio summary table populated with the minimum metadata; (ii) a brief narrative explaining how the portfolio reflects regional diversity and co-creation priorities; and (iii) mapping/geo-information where appropriate and permissible.

2.4 Experimental Design Approach

The experimental design approach in iCOSHELLs is structured to accommodate three prototype types that influence implementation design in different ways: **direct soil intervention prototypes**, **monitoring and decision-support prototypes**, and **soil literacy/engagement prototypes**. Across the project, Living Labs are anchored in **networks of physical soil test sites** that enable real-life testing of interventions and deployment/validation of monitoring approaches. Where soil literacy and engagement activities extend beyond field sites (e.g., schools, municipal venues, community settings), they are treated as **complementary implementation settings** and are reported in D2.4 only insofar as they affect site access, scheduling, monitoring participation, or continuity of implementation.

In this report, the focus shifts from a planning snapshot to an **implementation-ready audit trail**. The report documents: (i) confirmed site portfolios (including any substitutions/additions since D2.3 and their implications for comparability); (ii) refined experimental designs shaped by early deployment experience (e.g., seasonal constraints, operational feasibility, access conditions); and (iii) monitoring set-up and data readiness aligned with the common indicator and sampling framework in D3.1, including minimum metadata and QA/QC routines needed for cross-LL synthesis. Prototype cataloguing, maturity/readiness tracking, and prototype-specific evaluation remain reported in the dedicated WP2 prototype reporting line (D2.6-D2.8) and are not duplicated here.

Direct soil intervention prototypes are implemented through field-experimental designs that define treatments and controls and plan replication and monitoring over time. Depending on local feasibility, these designs range from **formal plot trials** to **paired comparisons** and **before–after designs** embedded in operational systems, provided that the intervention is clearly specified and that monitoring supports meaningful inference. Monitoring prototypes are deployed at the same sites and validated through comparative testing against reference methods (where relevant), with emphasis on data quality, usability, and maintenance feasibility under operational conditions. Soil literacy and engagement prototypes are implemented in structured cycles linked to the test sites and evaluated using fit-for-purpose metrics (e.g., participation, training uptake, knowledge/attitude shifts, reported practice change), with additional venues used only when they strengthen the link between engagement and site-based experimentation.

Although prototype ideas and problem definitions are co-created with stakeholders, experimental and implementation designs are developed and refined by LL technical teams to ensure scientific validity, operational feasibility, and cross-LL learning potential. All LLs work toward monitoring the **core soil indicator set** and harmonised sampling approach defined in D3.1, while also including LL-specific functional indicators when needed to assess prototype effects (e.g., crop or vegetation performance, water metrics, biodiversity/biological activity measures, management logs, and operational constraints).

2.4.1 Experimental Setup

The Across Living Labs, experimental setup is guided by common principles designed to preserve robustness and comparability while allowing context-appropriate designs:

Direct soil intervention prototypes

- **Network-based implementation:** interventions are deployed across multiple sites within each LL to capture environmental heterogeneity and stakeholder diversity.
- **Controls and counterfactuals:** prototypes are compared against an agreed reference condition (control, "business-as-usual", paired field, or baseline condition), with the control definition explicitly documented to reflect realistic farm/site operations.
- **Replication strategy:** replication is implemented through plot-level replication (where feasible), site-level replication across the LL network, or repeated measurements over time (temporal replication). D2.4 documents the replication logic chosen in each LL and any refinements made during RP1.
- **Design of Experiments (DoE) adapted to context:** designs are selected to match feasibility and expected impact, including randomised designs where feasible, blocked designs (e.g., by slope/soil texture/history), paired comparisons, and before–after designs in operational systems. This report records the key DoE decisions for implementation:
    - which treatments/prototypes are tested

  - what they are compared against (control/reference)
  - replication unit (plot/site/time) and number of replicates
  - randomisation/blocking approach (or justification when constrained)
  - measurement variables (core indicators + any functional indicators)
  - monitoring timeline and sampling windows
- **Intervention metadata and compliance:** D2.4 emphasises implementation traceability by requiring documentation of treatment timing, application rates/material specifications, machinery/operations constraints, and site-specific co-interventions that could affect interpretation.

The level of experimental formalisation varies by LL context and capacity, but this report focuses on whether the design is **implementation-ready**: controls are defined, treatments are feasible, replication logic is stated, sampling windows are realistic, and monitoring responsibilities are assigned.

Monitoring and decision-support prototypes

- **Deployment at the same sites:** tools are installed and/or applied at the soil test sites, either parallel to intervention testing or in dedicated comparative set-ups.
- **Validation logic:** where applicable, monitoring tools are calibrated/validated against reference methods, with replication where feasible and with clear QA/QC routines (e.g., calibration checks, sensor maintenance logs, missing data handling).
- **Operational feasibility:** This report records practical requirements affecting site selection and continuity (permissions, connectivity, safe access, maintenance responsibilities, seasonal constraints).

Soil literacy and engagement prototypes

- **Site-linked cycles:** engagement activities (workshops, demonstrations, participatory monitoring) are designed as cycles linked to test sites to reinforce local ownership and learning loops.
- **Evaluation approach:** This report records only the elements that condition implementation design (target groups, reach, timing, link to sites, and basic evaluation instruments such as participation metrics or pre/post feedback tools).
- **Complementary venues:** schools/municipal/community venues are reported only where they are required to deliver the engagement cycle and where their linkage to the soil test sites is explicit.

2.4.2 Data Management

Primary data generated through prototype implementation are collected by each Living Lab (LL) using harmonised protocols and templates to support consistency and cross-LL comparability. In D2.4 (M18), the emphasis is on **implementation traceability**: ensuring that data generation at site level can be linked to a clearly documented site portfolio, a defined experimental setup (treatments/controls/replication logic), and the common soil indicator and sampling framework established in WP3 (D3.1).

For **soil intervention prototypes**, datasets include core soil indicator measurements, intervention performance observations (where applicable), and operational metadata required to interpret outcomes (e.g., treatment timing, application rates/material specifications, management actions and co-interventions). For **monitoring and decision-support prototypes**, datasets include tool outputs, calibration or validation information where relevant (e.g., comparisons against reference methods), and operational records needed to assess reliability and usability under field conditions (e.g., maintenance logs, downtime/missing data notes). For **soil literacy and engagement activities**, datasets include participation metrics, structured feedback (e.g., surveys or pre/post instruments where used), qualitative documentation of engagement processes, and linkage information that connects engagement actions to the relevant soil test sites (when applicable).

Across prototype types, LLs record **minimum site metadata** to ensure comparability and support cross-LL synthesis, including (as a minimum): site identifier (anonymised if needed), land use/system type, key site characteristics (soil notes/texture class where available), access/agreements status, baseline sampling status, intervention status, monitoring readiness, and implementation constraints that affect interpretation (e.g., seasonal limitations). Data quality assurance is supported through standardised field forms, consistent units and coding, and version-controlled templates aligned with the D3.1 sampling guidance and associated indicator definitions.

All datasets are handled in accordance with the project's Data Management Plan (D8.2), including FAIR principles, appropriate access controls, and procedures for anonymisation where site/landowner confidentiality applies. Data and documentation are stored in the project's shared repository (with controlled access for internal working datasets), and public-facing data sharing and long-term accessibility will follow the pathways specified in D8.2, including alignment with relevant European infrastructures where applicable (e.g., the EU Soil Observatory).

2.4.3 Iterations

As the second iteration of the "Implementation Design & Site Selection" reporting line, D2.4 documents the transition from early-stage planning (D2.3) to **initial deployment and implementation learning** during RP1. Prototype designs and associated experimental set-ups are now progressively refined through (i) stakeholder feedback via continued co-creation, (ii) technical review by LL teams, and (iii) operational lessons emerging from real-world implementation constraints (e.g., seasonal windows, access conditions, and monitoring feasibility). These refinements will continue through the third iteration cycle (D2.5), supported by traceable documentation of any changes to site porfolios, experimental layouts, or monitoring arrangements.

For **field intervention prototypes**, iteration in D2.4 is characterised primarily by **implementation refinements** rather than wholesale redesign. Typical adjustments include fine-tuning treatment timing and application procedures, strengthening control definitions to reflect realistic "business-as-usual" management, and clarifying replication logic (plot-level, site-level, and/or temporal replication) in response to heterogeneity and operational constraints. Where climatic variability or agronomic feasibility affects establishment, mitigation measures (e.g., reseeding, adjusted operational windows, backup sites) are documented as part of iteration learning (e.g., drought-driven establishment challenges requiring repeated sowing in spring 2026 in the Bulgarian Viticultural LL).

For **monitoring and decision-support prototypes**, refinement focuses on **deployment robustness and data quality**, including calibration/validation routines where relevant, maintenance responsibilities, handling of missing data, and improved integration of tool outputs with the D3.1 core indicator framework and sampling schedule. Iteration also addresses usability constraints identified by land managers and local operators to support long-term uptake without compromising data integrity.

For **soil literacy and engagement prototypes**, iteration involves adapting engagement formats, timing, and facilitation methods to improve participation and continuity, and ensuring that participatory monitoring or outreach activities remain explicitly linked to the core test sites where they are intended to support implementation (e.g., participation in sampling, demonstration events, or local learning cycles). In D2.4, these activities are reported only insofar as they influence implementation readiness, site access, and monitoring participation, avoiding duplication with WP1 reporting.

In general, D2.4 confirms that flexibility remains necessary to accommodate seasonal constraints, local adaptation, and evolving co-created priorities, while maintaining the harmonised-yet-flexible methodology required for cross-LL learning. All refinements are therefore documented with sufficient metadata (site, timing, treatment changes, monitoring implications) to preserve scientific validity and comparability across Living Labs and to provide a clear audit trail for continued implementation in D2.5.

2.5 Risk Identification and Mitigation Planning

Implementation of prototypes across diverse Living Lab (LL) settings involves risks associated with site-specific biophysical conditions, operational constraints, stakeholder continuity, monitoring deployment, and data quality. In D2.4 (M18), risk management is treated as an **implementation control function** rather than a one-time planning activity: risks are monitored as LLs move from planning into early deployment, and mitigation measures are updated based on observed constraints and practical lessons from RP1 implementation.

2.5.1 Cross-LL risk categories (confirmed and updated at M18)

Across the six LLs, risk identification and tracking continues to cover the following categories, which remain the most material for implementation readiness and comparability:

- **Environmental and climatic risks:** extreme weather (drought, heat, heavy rainfall/flooding), seasonal variability, and erosion events affecting establishment, sampling windows, and treatment performance.
- **Site and access limitations:** difficult terrain, restricted accessibility, governance or permission constraints, and site conditions that limit feasible experimental layout or monitoring deployment.
- **Stakeholder and social risks:** withdrawal or reduced engagement by landowners/land managers, insufficient long-term commitment, or changes in local institutional priorities.
- **Logistical and operational risks:** delays in equipment delivery, limited staff capacity, constraints on machinery timing, and operational disruptions that affect installation, treatment application, or repeated monitoring.
- **Data and monitoring risks (cross-cutting):** variability in sampling execution, progressive metadata consolidation, instrument performance and maintenance considerations, and temporary data gaps that require structured QA/QC procedures to safeguard comparability and interpretation reliability.
- **Monitoring-specific risks:** tool failure, calibration/validation limitations, connectivity/power constraints, and usability barriers for end-users (affecting sustained deployment).
- **Engagement/education risks (where applicable):** declining participation, uneven continuity of community involvement, or limited capacity to sustain repeated engagement cycles linked to sites.

2.5.2 New/emerging RP1 risks and what D2.4 records

Compared with the baseline planning snapshot in D2.3, D2.4 records several RP1-emergent risks that are particularly relevant for the next implementation cycle:

- **Climate-driven establishment failure and timing disruption:** e.g., in BUVLL, severe drought conditions affected establishment of the sown grass–legume mixture, requiring repetition and refined sowing practices in spring 2026.
- **Analytical and monitoring capacity constraints:** limitations in apparatus/method availability for some requested analyses and practical constraints in sustaining advanced monitoring workflows under field conditions.
- **Documentation maturity variance across LL datasets:** uneven completeness of site-level fields (site metadata, monitoring readiness, treatment timing logs) can become a comparability risk if not systematically addressed during RP2; D2.4 therefore introduces/strengthens minimum metadata requirements and QA/QC routines as mitigation (see Section 2.4.2).

2.5.3 Mitigation measures and contingency planning (M18 status)

For each identified risk, LLs apply mitigation and contingency measures that are recorded and updated in this iteration. Common measures include:

- **Portfolio resilience:** identification of backup sites or alternative plots where access is uncertain or where site conditions become unsuitable (including the option for site substitution, documented with rationale and implications for comparability).
- **Operational agreements:** written agreements and clear role allocation for access, intervention implementation, and monitoring responsibilities to safeguard continuity across seasons (including data-sharing and access permissions where required).
- **Adaptive implementation scheduling:** adjustment of treatment timing and monitoring windows to reduce exposure to climate risk and seasonal constraints, while maintaining traceability (documenting deviations and corrective actions).
- **Monitoring redundancy and QA/QC:** use of standardised field forms and harmonised templates; calibration and maintenance routines for sensors/tools; documentation of downtime and missing data; and fallback to reference methods where novel tools underperform.
- **Capacity and logistics strengthening:** coordination with local partners for installation, sampling, and troubleshooting; and, where needed, upgrading or supplementing analytical capacity to meet monitoring requirements.
- **Engagement continuity measures:** embedding site-linked engagement activities within existing local structures (e.g., advisory services, municipal programmes, schools) when relevant, and using ToT-supported tools (consent forms, feedback instruments) to maintain comparable documentation across LLs.

2.5.4 Risk governance and iterative learning

By treating risk management as an iterative implementation function, iCOSHELLs safeguards both technical robustness and social legitimacy throughout the project lifecycle. D2.4 therefore provides a traceable record of: (i) the main risks encountered during RP1, (ii) mitigation actions taken or planned, and (iii) implications for implementation readiness in RP2. These updates will be further consolidated in D2.5 as additional monitoring cycles, Open Call integration, and continued deployment generate new evidence and refinements.

2.6 Iterative Co-creation and Prototype Refinement

Prototype identification in each Living Lab (LL) continues to be grounded in the iterative co-creation process led under WP1, where stakeholders and experts jointly define regionally specific soil health challenges and agree on feasible solution pathways. These co-created priorities are operationalised under WP2 through implementable prototypes and associated experimental and monitoring designs that can be deployed and assessed under real-world conditions.

What changes in D2.4 (M18): While D2.3 primarily captured a baseline planning snapshot, D2.4 documents how iterative co-creation has supported the transition into early deployment and implementation learning during RP1. Iteration is therefore framed as a **controlled refinement process** that preserves methodological comparability while responding to operational constraints (seasonality, access conditions, monitoring feasibility) encountered during initial implementation. Cross-LL learning and alignment are strengthened through project-level exchange and capacity-building mechanisms (e.g., Train-of-Trainers tools and iCOSHINE/EURG sessions), which support consistent documentation practices and shared reflection on implementation barriers and success factors.

In this second iteration, prototypes are revisited and refined through Living Lab learning cycles in ways that are directly relevant to implementation design:

- **Field intervention prototypes:** refinements typically involve adjustments to implementation timing, application procedures, and operational protocols; clarification of control definitions under “realistic” management conditions; and refinement of replication strategies (plot-, site-, and/or time-based) where field heterogeneity or farm operations constrain randomisation. A documented example is the BUVLL drought-related establishment failure of the sown grass–legume mixture, requiring repetition and more precise sowing in spring 2026 and related agronomic measures to secure implementation fidelity.
- **Monitoring and decision-support prototypes:** refinements focus on deployment robustness (permissions, connectivity, maintenance), calibration/validation routines where relevant, integration of tool outputs with the D3.1 core indicator and sampling framework, and improvements that reduce usability barriers for long-term uptake while safeguarding data quality.
- **Soil literacy and engagement prototypes:** refinements focus on the timing, format, and facilitation of engagement cycles linked to test sites, strengthening participation continuity and improving the practicality of evaluation instruments (e.g., participation tracking and feedback tools), without duplicating WP1 reporting.

In this report, refinement is reported **only insofar as it affects implementation readiness** (site requirements, experimental layout, monitoring integration, and risk mitigation). Detailed prototype cataloguing, maturity tracking, and performance evaluation are reported in the dedicated WP2 prototype deliverables (D2.6-D2.8).

3. Living Lab Profiles

3.1 Basque Urban Soils Living Lab (Spain)

The Basque Soil Health Living Lab is situated within the Urdaibai Biosphere Reserve in the Basque Country, Spain, where protected nature, cultural heritage, and peri-urban land pressures intersect. The LL is led by GAIA Innovation Cluster in collaboration with the University of the Basque Country (UPV/EHU), the Municipality of Forua, and local partners including schools, environmental NGOs, and community organisations. The LL addresses soil degradation in peri-urban and public spaces, with objectives focused on improving soil structure, increasing soil organic carbon, strengthening soil biodiversity, and enhancing soil literacy through community participation and citizen science.

3.1.1 RP1 co-creation and stakeholder involvement

Building on the co-creation approach described in D2.3, the Basque LL implemented two co-creation sessions in June 2025 that combined soil literacy, local problem framing, site validation, and implementation planning for an urban/peri-urban municipal context.

- **Session 1 (18 June 2025)**: A soil literacy–oriented workshop (Art Exhibition format) used creative/participatory approaches to align stakeholders around LL objectives, demonstration logic, and feasible monitoring pathways.
- **Session 2 (19 June 2025)**: A Soil Sampling workshop that functioned both as an implementation planning session, where the final sites were validated, and as a citizen science teaching moment to strengthen local ownership and monitoring participation.

Across sessions, participation spanned municipal actors, researchers, industry representatives, and citizens/community participants. Outputs included clarification of the common soil health indicators to be monitored through baseline sampling, and identification of Basque-specific "natural indicators" relevant to Urdaibai's context. These co-creation processes directly condition implementation feasibility in public spaces (access rules, safety, scheduling, and suitability for demonstration and citizen-linked monitoring).

3.1.2 Site portfolio status and selection

Portfolio status: At M18, the Basque LL operates through a confirmed network of **10 municipal/peri-urban test sites** within the Municipality of Forua, consistent with the D2.3 site-network logic (gradient of degradation/restoration potential in urban/peri-urban settings).

Implementation-relevant minimum site metadata (M18): The WP2 dataset snapshot used for D2.4 confirms the operational site portfolio with identifiers **LANS1–LANS5, APS1, and ATXS1–ATXS4**, enabled through municipal ownership/partnership as the access model. Recorded land use is predominantly peri-urban municipal green space, with slope classes largely **nearly level to gently sloping** and texture classes spanning **sandy loam, loam, silt loam, and clay loam**. In this dataset snapshot, **WRB soil type and GPS fields are not yet consistently populated** and are therefore treated as an RP2 documentation completion action for full metadata consistency and audit trail comparability.

Baseline sampling status: Baseline sampling is recorded as completed across the full site network on **30 June 2025**, establishing the time-zero dataset for D3.1-aligned monitoring and subsequent follow-up rounds.

3.1.3 Prototype implementation and experimental design

Implementation framing for D2.4: Consistent with D2.3, the Basque LL prototype portfolio combines (i) soil interventions / nature-based restoration approaches and (ii) monitoring and participatory engagement components that are feasible in publicly accessible municipal sites.

Monitoring/decision-support prototypes (M18 status): Two non-invasive monitoring prototypes are documented under active preparation:

- **Ecoacoustic soil life monitoring** (acoustic/vibration sensing)
- **eDNA-based biodiversity monitoring**

These are positioned as enabling tools to assess soil biological activity/biodiversity and to support data-driven restoration in an urban/peri-urban setting.

Intervention experimental design status and constraints: D2.3 described a split-plot logic for testing combinations of compost/organic amendments, vegetation-based measures (e.g., deep-rooted cover), and pollinator-friendly green infrastructure with replication. RP1 reporting and implementation reflection highlight that sites are **small and of public use**, limiting the feasibility of intrusive interventions that interfere with daily access; precision and minimal disruption are therefore important design constraints (with some measures deemed too intrusive for the current site context). In the current WP2 dataset snapshot used for D2.4 compilation, the **site network and monitoring prototypes are documented**, while the **formal intervention DoE table remains to be completed/validated in RP2** (treatments per site, control definition, replication layout, and timing windows). D2.4 therefore records the split-plot approach as the baseline intention from D2.3 and the M18 priority as completing DoE documentation for traceability and cross-LL comparability.

3.1.4 Monitoring indicators

The Basque LL monitoring framework is aligned with the WP3 baseline indicators and harmonised sampling logic (D3.1), supplemented by functional indicators relevant to peri-urban restoration and community-driven prototypes. D2.3 lists baseline physical, chemical and biological indicators (e.g., bulk density, particle size distribution, water-holding capacity, pH/EC, nutrients, CEC, heavy metals, microbial indicators, and soil organic matter), plus additional indicators linked to habitat provision, soil literacy, and non-invasive biodiversity monitoring (ecoacoustics/eDNA).

In D2.4, the operational update is that baseline sampling has been executed across the full site network (30 June 2025), providing the foundation for follow-up sampling, integration of non-invasive monitoring, and prototype-specific monitoring plans during RP2.

3.1.5 Risks encountered and mitigation

Key risks remain consistent with D2.3 but are reframed for implementation readiness in publicly accessible municipal settings:

- **Governance/access continuity risk:** Shifting municipal priorities or competing land-use pressures affecting continuity of access; mitigated through the municipal partnership model and identification of alternative plots where feasible.
- **Technical/monitoring risk:** Data loss or underperformance of monitoring prototypes (maintenance, robustness, processing capacity); mitigated through multi-method monitoring, clear QA/QC routines, and assigned responsibilities for maintenance and processing.

- **Public-space feasibility risk:** Site size and public use constrain intrusive interventions and timing windows; mitigated by prioritising minimally invasive monitoring, precision application approaches, and implementation scheduling that preserves public access.

3.1.6 Summary

At Month 18, the Basque Urban Soils LL is operationally anchored in a confirmed network of **10 municipal/peri-urban sites** in Forua, with **baseline sampling completed on 30 June 2025** to support harmonised monitoring and cross-LL comparison. The LL is positioned to combine circular and nature-based restoration ambitions with non-invasive biodiversity monitoring and soil literacy actions suited to publicly accessible sites. The M18 priority for RP2 is to complete and validate intervention DoE documentation (treatments, controls, replication, and timing windows) and to finalise missing minimum metadata fields (notably WRB/GPS where pending), strengthening traceability and comparability as prototype implementation progresses and Open Call-funded prototypes begin integration.

3.2 Bulgarian Viticultural Soil Health Living Lab (BUVLL)

The Bulgarian Viticultural Soil Health Living Lab (BUVLL) is anchored in the **Yuzhen tsentralen (BG42)** wine-producing region and coordinated by the **Agricultural University of Plovdiv (AUP)**, with support from vineyard owners and other value-chain stakeholders. The LL targets key challenges facing vineyard soils in the region, including **erosion risk (especially on sloping vineyards), soil structure decline/compaction, nutrient imbalances, and biodiversity loss**, which are increasingly shaped by climatic variability under Bulgaria's continental climate. Table 3.2-1 (Annex) summarises the confirmed BUVLL site portfolio at M18 and the minimum site metadata required for traceability and cross-LL comparability, including baseline sampling dates recorded in the WP2 dataset.

3.2.1 Co-creation and stakeholder involvement

The co-creation process was launched with a structured workshop held on **10 February 2025** in Plovdiv, bringing together **32 stakeholders** (10 land managers, 8 researchers, 2 industry representatives, 5 policymakers, and 7 citizen/community participants). The workshop focused on aligning monitoring methodologies, confirming experimental sites, establishing soil sampling strategies, and clarifying commitments and permissions for site access and implementation.

During RP1, co-creation continued with additional sessions on **17 November 2025** and **17 February 2026**, used to review implementation progress, address operational constraints (including climate-related issues), and agree on corrective actions and next-season planning.

Prototypes of interest for testing reflect both soil health improvement and climate resilience needs in vineyards:

- **Soil intervention prototypes:** cover/ground cover management (grassed inter-rows / cover cropping), conservation tillage, fertilisation improvements (including bio-based fertilisers), plant protection approaches (bio vs chemical), irrigation management and soil structure conservation practices.
- **Monitoring & decision-support prototypes:** soil condition monitoring with **sensors** supporting irrigation control and decision-making, complemented by laboratory analyses.

3.2.2 Site selection and portfolio status

Portfolio status: The BUVLL site portfolio remains stable at **10 vineyard test sites**, selected to represent major viticultural landscapes and diversity in soils and management. The sites are distributed across municipalities including **Chernogorovo, Brestovitsa, Yagodovo, Rogosh/Skutare, Bresnik, Govedare, and Perushtitsa**.

Site characteristics (from WP2 dataset):

- **Soil type (WRB):** recorded as **Fluvisols** across sites in the dataset snapshot.
- **Texture classes:** predominantly **sandy clay loam**, with one **loamy sand** site.
- **Clay class distribution:** medium (25–40%), heavy (>40%), one very heavy (>60%), and one light (15–25%) site—supporting representativeness for structure/erosion sensitivity.
- **Management systems:** the dataset records **eight conventional and two organic** sites (crop system). Tillage practices include conventional tillage, mulch tillage, and deep tillage/subsoiling across sites.
- **Irrigation:** sites are irrigated primarily via **drip/micro-irrigation**.

3.2.3 Experimental design approach

The experimental design remains structured around **paired comparisons / matched field designs** and is consistent with the baseline described in D2.3: each site implements **8 treatments (including the control)** arranged in **six replicated blocks**, supporting robust comparison of soil management practices under operational vineyard conditions.

The **control** is defined as the **current grower practice** (tillage, fertilisation, irrigation), serving as the operational benchmark. Treatment themes include cover/ground cover management, reduced/conservation tillage, fertiliser strategy changes (including bio-based), plant protection approaches, irrigation management (including sensor-supported precision irrigation), and soil structure conservation measures.

RP1 refinement (implementation learning): A major implementation constraint was **severe drought in 2025**, which impeded establishment of the sown grass–legume mixture. The agreed corrective action is repetition in **spring 2026** with improved sowing precision and additional agronomic measures to secure uniform establishment and maintain interpretability of treatment effects.

3.2.4 Monitoring indicators and readiness

Baseline soil sampling: The WP2 dataset records baseline sampling completion in **late April 2025**, with site-level dates ranging from **25–27 April 2025**.

Monitoring covers physical, chemical, and biological indicators aligned with the project framework (D3.1), including:

- **Physical:** bulk density, water-holding capacity, aggregate stability
- **Chemical:** pH, electrical conductivity, macronutrients (N, P, K), CEC
- **Biological:** soil organic matter, microbial biodiversity, microbial respiration

Monitoring tools and added indicators: Digital sensors were installed in 2025 and are operational, providing continuous data access for farmers; metagenomic analyses were conducted to support soil biological assessment and results were shared with participants.

3.2.5 Risk identification and mitigation

Compared with the D2.3 baseline risk framing, D2.4 records the key RP1-emergent risks and mitigation actions:

- **Climate and water stress (drought):** caused establishment failure of the sown cover mixture → mitigation: repeat establishment and refined sowing in spring 2026 with enhanced agronomic effort.
- **Monitoring/analytical capacity constraints:** apparatus/method limitations for some requested analyses → mitigation: strengthening capacity through additional apparatus to complete planned analyses.
- **Operational continuity risks:** maintenance and continuity of digital monitoring tools → mitigation: clarified responsibilities and continued coordination with farmers and AUP technical teams.

3.2.6 Summary

At Month 18, BUVLL is operationally stable and implementation-ready, with **10 confirmed vineyard sites**, signed farmer agreements, **baseline sampling completed (late April 2025)**, and monitoring strengthened through **operational sensors** and advanced biological analysis capability. The main RP1 learning is the need for climate-resilient implementation planning (notably drought risk to cover establishment), addressed through documented corrective actions that preserve methodological comparability for subsequent monitoring cycles.

3.3 Greek Mine Soil Health Living Lab (Greek LL)

The Greek Mine Soil Health Living Lab is located in **Western Macedonia**, a region undergoing major socio-economic transition as lignite mining is phased out. Coordinated by the **Cluster of Bioeconomy and Environment of Western Macedonia (CluBE)** with partners including **DIADYMA S.A.** and academic collaborators, the LL focuses on transforming degraded post-mining soils into multifunctional landscapes through soil restoration, contaminant risk reduction, and improved soil literacy.

In line with the project Description of Action, the Greek LL is structured around **metal-contaminated abandoned mine soils** with highly heterogeneous pollutant loads (notably **Cr and Ni**, among other contaminants), requiring comparative testing of phytoremediation options across multiple sites and engagement actions to prepare local communities for implementation and upscaling.

3.3.1 Co-creation and stakeholder involvement

Building on the initial co-creation process reported in D2.3, the WP2 dataset documents two structured co-creation sessions in RP1:

- **Session 1 (27 June 2025)** focused on presenting soil analysis results and aligning stakeholder priorities around mine-soil remediation and restoration pathways. The stakeholder mix remained multi-actor (land users/managers, academics/researchers, public sector bodies, industry and citizen/community representatives), consistent with the baseline described in D2.3.
- **Session 2 (18 December 2025)** explicitly targeted **strengthening soil literacy beyond academia**, reinforcing the LL's dual aim of technical remediation and societal engagement for post-mining land transition.

The co-creation process continues to function as the enabling mechanism for implementation: it supports site access, aligns acceptable remediation options with regional priorities, and provides feedback loops for refining deployment logistics and monitoring feasibility.

3.3.2 Site portfolio status and selection

Portfolio status (updated vs D2.3): At M18, the Greek LL is implemented through **12 experimental sites** (expanded from the "minimum 10" baseline framing in D2.3). These are distributed across **two main post-mining operational areas managed by DIADYMA**:

- **IWMA – Industrial Waste Management Area** (approx. **26 ha**, located within the former lignite mines of Ptolemaida/Kardia mine)
- **IWMCF – Integrated Waste Management Central Facilities** (approx. **83 ha**, located in the Notio Pedio former mines)

This two-location configuration is methodologically important because it enables controlled comparison across distinct pollutant and soil-condition profiles (e.g., pH and conductivity differences; varying pollutant concentrations), which is central to the LL's phytoremediation logic.

Implementation-ready monitoring status: The WP2 dataset records that baseline sampling was completed in two waves (**December 2024** for the IWMA subset and **January 2025** for the IWMCF subset), and that a first follow-up sampling round was completed on **10 June 2025** across the site network—providing a stronger M18 monitoring baseline than was available at D2.3 stage.

3.3.3 Prototype implementation and experimental design approach

Prototype focus (implementation-relevant): Consistent with D2.3 and the Open Call scope text, the LL's intervention pathway centres on **phytoremediation** and related restoration measures, with supporting monitoring to evaluate contaminant dynamics and soil function recovery.

Experimental design status at M18: The project DoA frames the experimental logic as comparative testing of phytoremediation interventions using **different plant species** across sites with differing pollutant profiles to identify combinations that are effective, sustainable, and potentially profitable for cultivation. In D2.4, this is captured as a **site-network comparative design**: treatments are implemented across multiple sites to provide replication at network level, with monitoring aligned to the D3.1 core indicator set plus contaminant-relevant measures.

Documentation note for D2.4: In the current WP2 dataset snapshot, the detailed "Experimental designs" table entries (treatment lists per site, replicate numbers, assignment methods, and start/end dates) are not yet fully populated. D2.4 therefore reports the design logic at LL/network level and records completion of the DoE fields as an RP2 action to strengthen traceability and cross-LL comparability.

3.3.4 Monitoring indicators

The monitoring framework remains aligned with the WP3 indicator catalogue (D3.1) and the D2.3 description, with emphasis on indicators relevant to post-mining restoration and contaminant risk:

- **Core physical/chemical/biological indicators** to track soil functionality recovery (e.g., structure, water holding, pH/EC, nutrients/CEC, organic matter and biological activity proxies), alongside **heavy metal concentrations** where relevant to the site context.

- **Specific indicators** supporting the phytoremediation pathway, including **heavy metal uptake in plant biomass** (tissue concentrations combined with biomass production where applied) to evaluate removal/stabilisation performance across species and sites.

D2.4 additionally records that the baseline and first follow-up sampling rounds provide an initial time series to support interpretation of early intervention effects and site-to-site variability.

3.3.5 Risks encountered and mitigation

Key risks remain broadly consistent with D2.3, but D2.4 reframes them as implementation controls:

- **Environmental/biophysical:** persistence and heterogeneity of contamination, erosion-prone conditions at some sites, and seasonal water stress affecting plant establishment and monitoring windows.
- **Institutional/tenure:** evolving post-mining land reuse decisions and governance arrangements, mitigated through DIADYMA's operational management of the two main site areas and formal partner roles.
- **Operational:** infrastructure constraints (e.g., irrigation limitations) and risk of plant failure; mitigated by phased implementation, species selection appropriate to marginal conditions, and adaptive scheduling.
- **Social/engagement continuity:** maintaining engagement in degraded landscapes; mitigated through structured soil literacy actions (e.g., the December 2025 session focus on soil literacy beyond academia).

3.3.6 Summary

At Month 18, the Greek Mine Soil Health LL is operationally anchored in a confirmed portfolio of **12 post-mining test sites** across two DIADYMA-managed areas (IWMA and IWMCF), with baseline and first follow-up sampling rounds completed to support early implementation learning. The LL is positioned to generate transferable evidence on phytoremediation and restoration strategies for metal-contaminated soils and to strengthen soil literacy and stakeholder readiness for post-mining land transition, aligning closely with the Open Call scope and Mission Soil objectives on pollution reduction and restoration.

3.4 Italian Soil Health Living Lab (ITA LL)

The Italian Soil Health Living Lab (ITA LL) operates in **Northern Italy**, with test sites distributed across **Lombardy, Veneto, and Trentino–Alto Adige**. It targets soil health challenges characteristic of **intensively managed systems**, including high external inputs, frequent traffic and tillage (where applicable), and associated risks of **compaction, declining soil organic carbon (SOC), and nutrient imbalances**. These challenges manifest across a diverse portfolio of systems, including **vineyards, orchards (apple/olive/chestnut), rice systems, wetlands, and peri-urban agricultural settings**, enabling cross-system learning while maintaining a harmonised monitoring logic.

3.4.1 Co-creation and stakeholder involvement

Building on the co-creation framing in D2.3, the ITA LL strengthened implementation readiness through a combination of (i) national and European-facing outreach activities, (ii) a dedicated Italy-specific alignment session to manage the multi-cluster structure, and (iii) local site-linked co-creation sessions and educational/engagement actions:

- **13 May 2024 (Rome):** presentation of iCOSHELLs at the national EU Soil Mission event *"Towards the establishment of 100 living labs and lighthouses"* (Italy-wide stakeholder outreach and networking).
- **14 March 2025 (Trento):** presentation of iCOSHELLs at *Bio.Logica*, a fair and conference dedicated to sustainable agriculture.
- **19 March 2025 (online):** joint presentation by the Italian LL and Basque LL at the seminar *"From degraded soils to territorial resilience"* organised by Lille Metropole (EU Delegation context in Brussels).
- **Italian LL Train-of-Trainers (ToT) session (27 March 2025, Trento):** held in person as a full-day, Italy-specific session to address the LL's multi-site structure and align governance, co-creation methodology, and cluster timelines across geographically dispersed site leaders.
- **9 May 2025 (Cascina Nosedo, Milan):** creative workshop engaging territorial stakeholders to generate ideas for citizen (especially youth) engagement on water resources and landscape/soil interactions around the Lambro River.
- **Local co-creation sessions (RP1):** site-cluster sessions were run for (i) the Milan peri-urban/agroforestry context in parallel with Milano Green Week (19 September 2025), (ii) the Trentino orchard/vineyard cluster (1 December 2025), and (iii) the Franciacorta vineyard cluster (4 December 2025) to refine local constraints and implementation priorities.
- **October 2025 onwards (Cascina Nosedo):** a co-design process was launched with territorial organisations and soil health experts to develop a **physical soil health demonstrator**, potentially evolving into an agreed prototype within the soil literacy strand.
- **22–23 October 2025 (Parco del Mincio):** environmental education workshop with stakeholders aligned to iCOSHELLs themes and objectives.
- **National Launch Event (26 November 2025, Erbusco-Franciacorta; hybrid):** organised by **ISINNOVA, UNIMI and Consorzio Franciacorta,** presenting all experimental sites and cross-cutting activities and collecting ideas for future local events through a participatory co-creation session.
- **11–12 December 2025 (Napoli):** presentation of Italian LL work at the Italian Society of Soil Science (SISS) congress (poster contribution).

The prototype families remain consistent with D2.3 and the baseline catalogue: soil amendments (e.g., compost/digestate/liming), cover/vegetation strategies, reduced tillage where applicable, and monitoring/digital tools (including sensor-based soil condition monitoring and modelling approaches to inform nutrient and water management). Since October 2025, co-creation has increasingly focused on operationalising these prototype families at cluster level and strengthening territorial engagement mechanisms that support implementation continuity.

3.4.2 Site portfolio status and selection

Portfolio update vs D2.3: While D2.3 reported 10 sites, the Italian LL confirms a **portfolio of 14 test sites** at M18, reflecting its multi-cluster structure and its objective to represent diverse intensive systems and transitional landscapes (peri-urban and wetland interfaces). This expanded portfolio strengthens representativeness while preserving comparability through shared minimum metadata requirements and a common monitoring baseline aligned to the WP3 framework.

Site system coverage (M18 portfolio):

- **Trentino–Alto Adige (ITH2):** perennial systems including **vineyards** and **orchards** (apple, olive, chestnut), plus the Trento vineyard cluster reflecting alpine/microclimatic conditions.
- **Lombardy (ITC4): peri-urban/agroforestry** implementation in Milan (Cascina Nosedo), the **Franciacorta vineyard cluster**, and the **wetland interface site** (Parco del Mincio), supporting both intensive production and landscape-transition learning.
- **Veneto (ITH3):** an **arable/peri-urban interface** site (Comune di Oppeano).

- **Rice cluster (Northern Italy):** four rice sites distributed across **Pavia (2 sites)** and **Novara, Piedmont (2 sites)**, strengthening the LL's coverage of high-input annual systems with distinct soil/water management constraints.

This structure remains consistent with the Italian LL scope described in the Open Call documentation, which differentiates Trentino perennial crop clusters, Franciacorta vineyards (with irrigation/monitoring emphasis), and the Milan peri-urban agroforestry context, while the rice cluster adds a complementary intensive annual system for cross-LL comparability.

Access and operational anchoring: Site access and continuity are secured through a combination of partner-operated sites, farm networks, and local institutional arrangements (including municipal/peri-urban settings where relevant), supporting repeated monitoring and multi-year trial continuity across clusters.

Baseline and follow-up readiness (M18): Baseline sampling is documented across the portfolio with staged timing by site cluster (spring–autumn 2025). In addition, a second baseline sampling round has been completed for the relevant site subset (RUMA sites), and follow-up sampling windows are scheduled/recorded for several clusters (including autumn 2025 and 2026), supporting a clear time-series monitoring plan into RP2.

3.4.3 Experimental design approach

Compared with the generic replicated-block description in D2.3, the M18 implementation dataset and RP1 reporting specify experiment-level designs across key Italian site clusters. Overall, the Italian LL applies context-adapted replicated designs with explicit controls and a practical replication strategy (typically 3–4 replicates, depending on crop/system), with trial timelines extending to 2027–2028 to capture perennial-system dynamics and multi-year effects of soil interventions.

Examples of implemented/defined DoE at M18:

- **Franciacorta vineyards (2 sites):** multi-treatment cover/management comparisons (6 treatments including control), 3 replicates, running from Nov 2024 to Sep 2027, designed to capture longer-term responses under perennial vineyard conditions.
- **UNITN Trento vineyard / Parco del Mincio wetland / Oppeano (3 sites):** replicated comparative designs with control and one treatment (i.e., 2 treatments including control), 3 replicates, running from Sep 2025 to 2028, supporting controlled comparison of amendment/management variants across contrasting landscapes (productive site, wetland interface, and arable/peri-urban context).
- **Rice cluster (4 sites; Pavia and Novara):** replicated comparative trials established through a formal collaboration agreement with Ente Nazionale Risi (July 2025) and four agricultural partners. Trials are implemented with 4 replicates and compare the control practice against soil-improving interventions including compost, liming, and green manuring, enabling assessment of soil structure and nutrient dynamics under high-input annual systems.

Monitoring and decision-support integration is embedded through site-appropriate tool deployment and decision workflows (e.g., irrigation control/monitoring and related data streams where relevant), consistent with the Italian LL scope of combining nature-based measures with digital monitoring and precision management.

All experiments apply the D3.1 core indicator set as the baseline monitoring backbone, complemented by cluster-specific functional indicators needed to interpret intervention effects.

3.4.4 Monitoring indicators

Monitoring in the Italian LL remains aligned with the WP3 core indicator framework (D3.1), consistent with D2.3: standard physical, chemical and biological baseline indicators (e.g., **bulk density**, **texture**, **water-holding capacity**; **pH/EC**, **nutrients/CEC**; **SOM/SOC** and biological activity proxies) are complemented by functional indicators required to interpret impacts in intensive and high-input systems.

Implementation status (M18): Baseline sampling has been executed across the Italian site portfolio with staged timing by site cluster (spring–autumn 2025). In addition, the RP1 update confirms completion of a **second baseline sampling round** for the relevant site subset (RUMA sites), strengthening the time-series foundation for RP2 monitoring and evaluation.

Additional functional indicators and tools (implementation-relevant): In line with the LL scope and prototype portfolio, the ITA LL includes system-relevant measures such as **aggregate stability** and cluster-specific functional monitoring to support interpretation of interventions in vineyards, orchards, wetlands/peri-urban settings, and rice systems. Decision-support elements for **nutrient and water management** (e.g., modelling and/or sensor-supported monitoring where deployed) are integrated where they directly affect implementation design and monitoring logistics. For the rice cluster established with Ente Nazionale Risi and agricultural partners, monitoring is designed to support comparison of control practice against compost/liming/green-manure interventions under replicated annual cropping conditions.

3.4.5 Risk identification and mitigation

The key risk logic from D2.3 remains valid, but D2.4 reframes risk management as an **implementation control function** informed by RP1 experience and the Italian LL's multi-cluster structure.

- **Operational/logistical risks (multi-site coordination):** complexity of running trials across multiple regions, crops, and site types (perennials, peri-urban, wetland interface, rice cluster) → mitigated through **cluster-based coordination**, shared templates, and an **Italy-specific Train-of-Trainers (ToT) session** introduced as an operational measure to align processes across site leaders and strengthen consistency across clusters.
- **Institutional/partnership risks (cluster continuity):** ensuring long-term access and operational continuity across a heterogeneous portfolio → mitigated through strengthened collaboration arrangements, including the **July 2025 agreement with Ente Nazionale Risi** to anchor and coordinate the rice-cluster implementation with four agricultural partners (supporting continuity of trials and comparability across replicated sites).
- **Market and adoption risks:** input price volatility and perceived costs of transition (amendments, cover management, liming/compost logistics) → mitigated through cooperative and partner engagement, advisory framing, and emphasis on feasible "stepwise" adoption pathways supported by demonstration and communication activities.
- **Biophysical/management risks:** pest/disease pressure and system-specific constraints (perennial systems, annual rice water and residue management; wetland/peri-urban constraints) → mitigated through adaptive management planning, monitoring integration, and system-appropriate timing windows, supported by multi-year trial timelines (to 2027–2028) that accommodate inter-annual variability.
- **Data comparability and documentation risks:** uneven completeness of certain site fields (e.g., soil classification fields for some clusters) and the need for consistent DoE traceability across clusters → mitigated by applying the D2.4 minimum site metadata checklist, completing missing fields during RP2 dataset harmonisation, and maintaining version-controlled templates linked to the D3.1 monitoring framework.

3.4.6 Summary

At Month 18, the ITA LL is operationally anchored in a confirmed **14-site portfolio** spanning perennial crops (vineyards and orchards), **a four-site rice cluster** (Pavia and Novara/Piedmont), and transitional landscapes including **wetland and peri-urban agricultural contexts**. Implementation has progressed from baseline planning to **experiment-specific designs** with defined controls, practical replication strategies (typically 3–4 replicates), and multi-year timelines extending to **2027–2028**, supported by cluster-based co-creation and an Italy-specific Train-of-Trainers approach to ensure coherent implementation across diverse site contexts.

During RP1, the LL strengthened operational readiness through wide stakeholder engagement and visibility actions (including national and regional events), and from **October 2025** the LL reports that **all prototypes are being implemented** across the relevant site clusters. Baseline sampling has been completed across the portfolio with staged timing, with a **second baseline sampling round** completed for the relevant site subset (RUMA sites), providing a robust foundation for RP2 monitoring and evaluation. The LL is therefore well-positioned to generate transferable evidence on restoring soil structure, reducing external inputs, and improving SOC resilience in high-pressure systems, while remaining ready to integrate Open Call prototypes into existing sites once onboarding is finalised.

3.5 Southeastern Spain Living Lab (SES LL)

The Southeastern Spain Living Lab (SES LL) operates across the **Campo de Cartagena (Murcia)** and **Almería** regions—semi-arid zones of high agricultural productivity and high environmental vulnerability. Coordinated by **CETENMA** with key regional partners including **CEBAS**, **IMIDA**, and **FUNCA**, the LL addresses deteriorating soil health under severe water constraints and nutrient stress, with strong policy relevance due to pressures on water bodies and coastal ecosystems (e.g., nutrient losses, salinity). In D2.4, the LL is characterised by an implementation focus on **eco-sustainable fertigation**, **organic and integrated management pathways**, and **targeted pest/soil fatigue solutions**, supported by sensor-enabled monitoring.

3.5.1 Co-creation and stakeholder involvement

The first structured SES LL co-creation session on **8 May 2025**, with a clear implementation focus: introduction of the LL scope and collaborative refinement of field experimentation around soil health practices and fertilisation strategies. Participation in this session totalled **38 stakeholders**, including **7 land users/managers**, **14 academics/researchers**, **11 industry representatives**, **2 policy/public sector participants**, and **4 citizens/community representatives**. The gender distribution recorded is **19 male**, **15 female**, and **1 "preferred not to say"**, with most participants in the **35–54** and **55–69** age ranges (18–34: 5; 35–54: 18; 55–69: 11).

A second co-creation workshop took place on **24 November 2025 in El Ejido (Almería)**, supporting continued alignment and implementation readiness. While detailed quantitative participation fields for the second workshop are not yet populated in the WP2 dataset snapshot used for D2.4, the session served to validate implementation planning choices and coordinate next steps with local actors; completion of the quantitative fields is scheduled during RP2 to support full comparability reporting.

The core solution pathways were largely defined during proposal preparation that focused primarily on operationalising these pathways, especially refining the **Design of Experiments (DoE)** and practical implementation choices such as crop types and feasible management combinations under local constraints. The main soil health challenge framing remains consistent with D2.3, but D2.4 strengthens the implementation logic around trade-offs: stakeholders prioritised solutions that reduce nutrient losses and improve resilience under drought and salinity constraints while maintaining feasible yields. This is reflected in the portfolio logic, where "full substitution" of conventional fertilisers with bio-based options is complemented by partial substitution pathways and sensor-guided fertigation to manage agronomic risk.

3.5.2 Site selection and portfolio status

Portfolio status: At M18, the SES LL has a confirmed portfolio of **10 experimental sites**, with **3 sites in Almería (ES61)** and **7 sites in Murcia (ES62)** consistent with the intended regional balance and policy relevance.

Implementation-relevant site characteristics (from the WP2 dataset):

- **Total area: 321,155 m^2** (~**32.12 ha**) across the LL.
- **Site size range:** from **31 m^2** (small pilot plot) to **96,800 m^2** (~**9.68 ha**).
- **Soil type (WRB): Regosols (5 sites)** and **Calcisols (5 sites)**.
- **Slope: 5 sites nearly level (0–2%)** and **5 sites gently sloping (2–5%)**, directly relevant to runoff/leaching risk and irrigation management feasibility.
- **Land use type: 5 arable** and **5 permanent crop** sites.
- **Current crops recorded:** pepper (2), grapefruit (2), lemon (2), plus bare, tomato, orange, and melon (single sites each), reflecting both open-field and orchard systems.
- **Farming systems: 4 crop–conventional**, **4 mixed–organic**, **1 mixed–conventional**, **1 crop–organic**.
- **Tillage: 7 conventional tillage** and **3 reduced tillage** sites.
- **Irrigation:** sites are predominantly **drip/micro-irrigated**, with irrigation source recorded as **groundwater** for the Almería FUNCA sites and **other sources** for several Murcia sites (as recorded in the dataset).

Baseline sampling status: Baseline sampling completion is recorded across the site network between **10 April 2025 and 16 July 2025**, providing the time-zero dataset for D3.1-aligned monitoring and subsequent iteration learning.

3.5.3 Experimental design approach

The SES LL applies **site-appropriate Designs of Experiments (DoE)** across the site network. The WP2 dataset records the following DoE types across sites:

- **Split-plot design** at **FNC1** (with three replicate entries reflecting subplot/treatment structure)
- **Randomized Controlled Trial (RCT)** at **FNC2**
- **Randomized Block Designs** across multiple sites, including **FNC3** and the CEBAS CBS sites (CBS6–CBS10)

Across sites, the treatment structure is recorded as **2–4 treatments including control**, with **3 replicates** as the standard replication level. One site cluster (CBS10) is recorded with **4 treatments (including control)**, while most others apply **2 treatments (including control)**.

To keep D2.4 WP2-scoped (and avoid overlap with D2.6–D2.8), the key point is that experimental designs are now sufficiently specified to support implementation tracking: DoE type, number of treatments, and replication level are recorded, and indicator lists are linked to each experiment entry.

3.5.4 Prototype portfolio and implementation link to sites

The SES LL prototype set is now clearly defined in the WP2 dataset, with explicit site linkages:

- **FUNCA1 Regenerative practices integrated agriculture (RPI)** (Agronomic): linked to **FNC3** (integrated mulching + organic/chemical fertilisers + irrigation sensors + integrated pest management).
- **FUNCA2 Regenerative practices organic agriculture (RPO)** (Agronomic): linked to **FNC1, FNC2, FNC3** (mulching + vegetation cover + organic fertilisers + irrigation sensors + organic pest regulation).
- **IMIDA3 Biosolarisation + crop rotation (BS-CR)** (Management-based): linked to **IMD4**, targeting nematode pressure reduction.
- **IMIDA4 Crop rotation (CR)** (Management-based): linked to **IMD5**, also targeting nematode pressure reduction.
- **CEBAS5 Eco-sustainable fertirrigation (ESF)** (Soil amendment): linked to **CBS6–CBS9**, combining organic fertilisers, automated control (pH/EC), and soil moisture/salinity sensing, including different water types.
- **CEBAS6 Eco-sustainable fertirrigation + native vegetation / crop rotation (ESF-NV)** (Management-based): linked to **CBS10**, adding border vegetation and/or rotation elements.

For D2.4, these are reported only in terms of their **implementation implications**: sensor requirements, irrigation and fertilisation logging, treatment feasibility, and indicator selection for monitoring and comparability.

3.5.5 Monitoring indicators and readiness

Across the SES LL experiments, the WP2 dataset links monitoring to the **core soil indicator framework** (D3.1) plus functional indicators required to assess fertigation/nutrient-loss and crop performance outcomes. Experiment entries record standard soil indicators (physical, chemical, biological) and additional SES-relevant monitoring, including:

- **fertiliser input analysis**,
- **irrigation water analysis/quality**,
- **crop values/production analysis**, and
- nitrogen efficiency and nutrient status measures (where applied),
- pest pressure indicators for the biosolarisation/rotation prototypes (e.g., nematode-related indices).

Baseline sampling completion across the network provides the starting point for follow-up monitoring and treatment comparison.

3.5.6 Risks encountered and mitigation

The SES Living Lab faces a set of cross-cutting risks typical of semi-arid intensive systems, combined with implementation risks linked to multi-site coordination and the operationalisation of fertigation- and rotation-based prototypes. In D2.4 (M18), risk management is framed as an implementation control function: risks are tracked based on early deployment experience and mitigation actions are documented to ensure continuity and comparability across the 10-site portfolio.

Key risks during this timep period include:

- **Climatic and water-related risks (high):** heatwaves, drought, and rising salinity can affect cover establishment, biosolarisation timing, and the performance of fertigation strategies, particularly where irrigation water quality varies. Mitigation is embedded in the prototype logic through sensor-guided irrigation management, adaptive fertigation scheduling, and flexible timing windows for implementation and sampling.

- **Agronomic performance trade-offs (medium–high):** several SES prototypes involve changing fertilisation regimes (including partial substitution with bio-based fertilisers) and/or introducing regenerative/organic pathways. These can create risks of nutrient deficiencies (especially N), yield reduction, or fruit quality impacts if transition is too abrupt. Mitigation relies on phased adoption pathways (partial substitution), continuous monitoring of crop performance and nutrient status, and adjustment rules agreed with stakeholders to avoid unacceptable production losses while maintaining the transition trajectory.
- **Pest/soil fatigue constraints (medium):** in the Murcia IMIDA sites, nematode pressure is a key driver for rotation and biosolarisation strategies. RP1 reporting notes that effectiveness has been below expectations in parts of the system, triggering plans to improve performance (e.g., refining implementation conditions and monitoring) in the next cycle. D2.4 records this as an implementation-learning risk with corrective actions planned for 2026.
- **Operational and coordination risks (medium):** RP1 notes an operational deviation in which CETENMA has effectively assumed all LL Office roles due to partners declining specific responsibilities, increasing coordinator workload beyond initial expectations. Mitigation includes aligning meeting cadence with operational needs (steering/coordination meetings held several times per year), clarifying responsibilities per site cluster, and maintaining structured follow-up to safeguard continuity across partner and non-partner sites.
- **Data and monitoring risks (medium):** heterogeneity across systems (arable vs citrus/permanent crops; varied slopes and soil types) increases the risk of inconsistent metadata and uneven monitoring implementation. Mitigation is addressed through standardised templates and harmonised minimum site metadata requirements, and by documenting baseline sampling completion across the network (April–July 2025) to provide a comparable starting point for RP2 follow-up.

All identified risks and mitigation actions are tracked in the shared LL risk log and updated through the iterative WP2 implementation cycle.

3.5.7 Summary

At Month 18, the SES LL is implementation-ready with a confirmed **10-site portfolio** across Almería and Murcia, baseline sampling completed across sites (April–July 2025), and a clearly linked prototype-to-site deployment plan centred on eco-sustainable fertigation, regenerative/organic management pathways, and targeted rotation/biosolarisation solutions. The LL provides a high-value testbed for soil health strategies under semi-arid constraints, where water quality, nutrient efficiency, and yield-risk management must be addressed together to support both soil restoration and regional environmental objectives.

3.6 Swedish Soil Health Living Lab (SWE LL)

The Swedish Soil Health Living Lab is implemented across central and southern Sweden and is anchored in arable and mixed farming contexts where soil structure constraints and nutrient management challenges are prominent. Coordinated by **RISE Research Institutes of Sweden** in partnership with advisory and research actors (including HS Konsult, SVA, LRF, SLU and others), the LL addresses soil health challenges linked to intensive production systems, including **soil compaction and poor aggregation**, **biodiversity decline**, and **nutrient surpluses** (with particular attention to nutrient efficiency and practical on-farm feasibility).

3.6.1 Co-creation and stakeholder involvement

The SWE LL continued co-creation through **three RP1 sessions** documented in the WP2 dataset:

- **Session 1 – 09 April 2025 (27 participants):** introduction of the LL scope and concept; mapping of previously tested solutions and identification of priorities for new testing and evaluation within iCOSHELLs.
- **Session 2.1 – 25 June 2025 (10 participants):** meeting with stakeholders including technique providers, researchers and the public, together with site managers.
- **Session 2.2 – 01 July 2025 (9 participants):** in-person meeting to align expectations and prepare implementation across the site network.

Across sessions, the co-creation emphasis remained strongly implementation-oriented: what can be tested under Swedish field conditions, what is operationally feasible for farmers and site managers, and what monitoring can realistically be sustained.

3.6.2 Site selection and portfolio status

Portfolio update vs D2.3: At M18, the SWE LL site portfolio comprises **14 test sites** (not 15), recorded as a distributed network across multiple Swedish NUTS regions (including SE11, SE12, SE22, SE23 and SE31). The sites are primarily **arable land use**, with a mix of stakeholder categories (farms, a municipal farm school, and research-linked sites).

Implementation-relevant site characteristics (as recorded):

- Soil texture classes recorded across sites include **sand, loamy sand, loam, clay loam, silty clay and silty clay loam**, reflecting a spectrum from lighter to heavier soils relevant for compaction and structure management.
- Many sites are already operating under **reduced tillage** or **no-till/direct seeding** regimes, providing realistic baselines for testing amendments and management refinements.
- Irrigation is generally absent or “not applicable” for most sites; where present, it is recorded as limited (site-dependent).

Baseline sampling status (M18): Baseline sampling dates are recorded for **8 of the 14 sites** (mainly June–August 2025, with one recorded in November 2025). For the remaining sites, the baseline sampling field is not yet populated in the dataset snapshot, and D2.4 should therefore treat completion of baseline sampling documentation as an RP2 dataset harmonisation action (rather than claiming “all sites baseline-sampled”).

3.6.3 Prototype implementation and experimental design approach

The SWE LL prototype portfolio recorded in the WP2 dataset is centred on practical, implementable soil-structure and nutrient-related measures. The following prototypes are explicitly listed and linked to named experimental sites in the dataset:

Soil intervention / management prototypes (recorded):

- **Biochar** (linked to multiple sites)
- **Gypsum** (linked to selected sites)
- **Effective microorganisms**
- **Cover crop**
- **Crop rotation**
- **Reduced tillage**
- **Deep tillage**
- **Drainage**
- **Urine fertiliser** (as an alternative nutrient source)

For D2.4 purposes, these are reported as implementation drivers: they influence site requirements (e.g., amendment handling/application logistics), trial layout feasibility, and monitoring needs.

Design status: In the current SWE WP2 dataset snapshot, the “Experimental designs” table is not yet populated with site-by-site DoE specifications (treatment lists per experiment, replicate numbers, assignment methods, start/end dates). D2.4 should therefore:

1. document the **prototype-to-site linkages** (already recorded), and
2. record completion of the detailed DoE fields as a **traceability improvement action in RP2** to strengthen cross-LL comparability and auditability.

3.6.4 Monitoring indicators and readiness

Monitoring is aligned with the project’s common indicator logic (D3.1 core set), with additional indicators linked to the Swedish prototypes (as recorded in the prototype sheets), including combinations of:

- **SOC/TOC**, **NPK**, **bulk density**, **pH**, **water holding capacity**, **yield**, and **biological indicators** where applicable.

For D2.4, the key implementation point is that monitoring is designed to (i) capture soil structure and carbon-related changes, and (ii) support interpretation of amendment and management effects under realistic farm operations. The dataset already links prototype records to “Indicators to monitor change,” providing a traceable basis for RP2 monitoring execution and QA/QC harmonisation.

3.6.5 Risks encountered and mitigation

The main risk categories remain consistent with D2.3, but D2.4 reframes them based on implementation status:

- **Operational continuity risk:** sustaining engagement across a distributed farm network over multiple seasons; mitigated through site agreements/contractual arrangements and embedding implementation within existing advisory and partner networks.
- **Climate variability risk:** Swedish seasonal constraints and inter-annual variability affecting timing windows for amendments, cover establishment, and sampling; mitigated through adaptive scheduling and clear documentation of deviations.
- **Data/documentation maturity risk:** incomplete baseline sampling fields and DoE specification fields in the WP2 dataset snapshot; mitigated through the D2.4 minimum metadata checklist and RP2 completion actions (populate baseline sampling status for all sites; complete DoE fields for each prototype-site experiment).

3.6.6 Summary (M18)

At Month 18, the SWE LL is operationally anchored in a confirmed **14-site portfolio** spanning multiple regions and soil textures, with co-creation continuing through three RP1 sessions and a clearly documented prototype portfolio focused on structure-enhancing amendments and feasible management practices. Baseline sampling is partially recorded (8/14 sites with dates), and D2.4 therefore documents both the progress and the remaining dataset completion steps needed to ensure full traceability and cross-LL comparability during RP2.

4. Cross-LL Site Selection and Design Synthesis

4.1 Overview of site selection patterns (M18)

By Month 18, the six iCOSHELLs Living Labs (LLs) have confirmed and documented **70 soil test sites** across a wide range of socio-ecological and land-use settings. This represents a net expansion from the "over 65" baseline reported in D2.3, reflecting both portfolio consolidation and scaling of test networks in some LLs as implementation progressed.

Across LLs, site selection continues to follow the same harmonised principles established in D2.3:

- relevance to co-identified soil health challenges,
- representation of regional environmental/management diversity,
- operational feasibility (access, logistics, repeat monitoring),
- stakeholder ownership and willingness to engage.

What D2.4 adds is an implementation-readiness view: which portfolios are now fully secured through agreements/host structures, and which have been expanded or consolidated since D2.3 to improve representativeness or feasibility.

Table 4.1. Overview of site selection characteristics by Living Lab (M18 update)

LL	# Sites (M18)	Dominant land use	Main soil types (as recorded)	Main soil challenges (focus)
SWE	**14**	Arable & mixed farming (incl. farm-school/research-linked sites)	Texture spectrum from sands to clays (WRB not consistently recorded in dataset)	Compaction/structure; nutrient efficiency; resilience
BUV	**10**	Vineyards	Fluvisols (dataset); sandy clay loam/loamy sand textures	Erosion/structure; nutrient imbalance; biodiversity; drought stress
Greek	**12**	Post-mining areas (two DIADYMA-managed zones)	Calcaric Cambisol (dataset; two site clusters IWMA/IWMCF)	Contamination risk; low SOM; poor structure; heterogeneity
ITA	**14**	Vineyards, orchards, rice, wetland & peri-urban ag settings	Mixed (several site fields pending); textures include sandy loam, clay loam, silty clay	SOC decline; compaction; nutrient imbalance; intensive-system pressures
SES	**10**	Irrigated arable & permanent crops (semi-arid)	Regosols & Calcisols	Water stress/salinity; nutrient losses; erosion/runoff; pest pressure
Basque	**10**	Urban/peri-urban municipal green spaces	WRB partly pending in dataset (D2.3 narrative: Arenosols/Albeluvisols)	Compaction/low SOM; biodiversity; public engagement/soil literacy

Net total (M18): 70 sites.
(Counts reflect the WP2 LL datasets used for D2.4 compilation.)

4.2 Overview of experimental designs and monitoring alignment (M18)

Across LLs, the experimental design strategy remains harmonised through shared principles while allowing context-specific adaptation. Most LLs apply designs with:

- explicit controls or reference conditions,
- **2–8 treatments** (including control),
- **3–6 replications** (plot- or site-level, depending on feasibility),
- and a shared core monitoring baseline aligned with the WP3 soil indicator catalogue (D3.1).

D2.4 implementation insight: design maturity differs by LL. Some LLs now have experiment-level designs recorded (e.g., ITA, SES, BUV), while others have strong site and monitoring documentation but still need to complete detailed DoE fields in the WP2 dataset snapshot (notably Basque and SWE). This is treated as a documentation/traceability completion action for RP2, not as a lack of implementation intent.

Table 4.2. Summary of experimental design elements by Living Lab (M18 update)

LL	Design type (implementation)	Treatments (typical)	Replication (typical)	Additional indicators / implementation-relevant monitoring
SWE	Prototype-to-site deployment documented; DoE fields to be completed RP2	Site-dependent	Site-dependent	Soil structure/carbon indicators; prototype-linked indicators; baseline sampling partly recorded
BUV	Paired/matched field design; replicated blocks	8 incl. control	6 blocks/site	Continuous sensors + lab validation; microclimate/irrigation; biological analyses (incl. metagenomics)
Greek	Site-network comparative design across two mine-soil clusters	Site-dependent	Site-network replication	Heavy metal dynamics; phytoremediation uptake; baseline + follow-up sampling recorded
ITA	Experiment-level designs recorded across site clusters (vineyard/orchard/rice/wetland)	2–6 incl. control	3–4	Aggregate stability and system-specific functional indicators; multi-year timelines recorded
SES	Mix of randomized block, RCT, split-plot (site-dependent)	2–4 incl. control	3 (some split-plot entries)	Fertigation/water quality; nutrient efficiency; pest/nematode indicators; baseline sampling recorded
Basque	Site and monitoring prototypes documented; intervention DoE table to be completed RP2	Intended multi-treatment	Intended ≥3	eDNA + ecoacoustic monitoring; strong public/municipal setting; baseline sampling recorded

All LLs are aligned to the **D3.1 core soil indicator framework**, with LL-specific functional indicators added where required by prototype goals (e.g., pollutant uptake in Greece; fertigation/water quality and pest pressure in SES; digital sensor data streams in BUV; and non-invasive biodiversity monitoring in Basque).

4.3 Commonalities and key variations (M18 synthesis)

Common methodological backbone (confirmed at M18):

- WP1 co-creation remains the entry point for problem framing and solution pathway selection; WP2 translates these into implementable site portfolios and experimental/monitoring designs.
- Site networks enable replication at scale (across multiple real-world sites), while D3.1 provides a common monitoring language for cross-LL comparability.
- Iteration learning is now evidence-based: D2.4 captures refinements triggered by operational constraints (e.g., seasonal windows, feasibility, monitoring capacity) rather than only planned intentions.

Key variations (and why they matter for scaling):

- **Land access and governance models differ structurally:**
    - **Basque:** municipally owned peri-urban sites supporting public engagement and demonstration.
    - **Greek:** DIADYMA-managed post-mining areas organised into two site clusters, enabling structured comparison across contrasting contamination/soil profiles.
    - **BUV/SES/ITA:** farm- and partner-managed agricultural systems where implementation feasibility is strongly coupled to operational schedules, inputs, and market realities.
    - **SWE:** distributed network including farms and institutional sites (e.g., farm school), supporting national-scale learning across diverse textures and management regimes.
- **Design maturity and documentation completeness vary at M18:** ITA, SES, and BUV show stronger experiment-level DoE specification in the WP2 datasets, while Basque and SWE have robust site/prototype documentation but require completion of detailed DoE fields for full audit-trail comparability. D2.4 addresses this through the minimum metadata checklist and RP2 completion actions rather than re-opening site selection.
- **Risk profiles reflect context and implementation reality:** Climate and water constraints emerge as cross-cutting risks (drought, salinity, establishment failure), with additional LL-specific risks (e.g., contamination complexity in Greece; monitoring/tool maintenance requirements; analytical capacity constraints). D2.4 links these to corrective actions and traceability measures (e.g., reseeding/adjusted sowing windows; strengthened lab capacity; QA/QC routines).

Open Call integration (cross-LL implication): The Open Call (WP4/FSTP) is designed to integrate additional innovations into LL experimentation, but documentation confirms that Open Call projects are expected to focus on **innovations tested through existing Living Lab sites**, rather than establishing new experimental sites. Consequently, Open Call integration is expected to affect implementation design mainly through added site requirements, monitoring integration, and scheduling within existing LL cycles; D2.4 therefore records baseline readiness and defers onboarding specifics to the next iteration once contracting is finalised.

5. Integration with Other Work Packages

This second iteration of the Living Labs Implementation Design and Site Selection Report (D2.4) consolidates progress under WP2 up to Month 18 and provides an implementation-ready audit trail for the iCOSHELLs Living Labs across six regions. In line with the Grant Agreement's iterative reporting structure (D2.3 at M8, D2.4 at M18, D2.5 at M30), D2.4 updates confirmed site portfolios, records refinements to implementation and experimental design choices made during early deployment, and documents monitoring readiness aligned with the common indicator framework.

WP1: Co-creation, stakeholder engagement, and governance

Co-creation and stakeholder engagement remain led under WP1 (Living Lab Co-Creation and Governance). D2.4 references WP1 activities only to the extent necessary to explain implementation decisions, such as how site access and continuity were secured, how operational constraints were negotiated with land managers/authorities, and how engagement formats support monitoring participation. Detailed stakeholder mapping, governance structures, and participation analyses remain reported in WP1 deliverables and are not duplicated here.

WP2 prototype deliverables: avoiding duplication with D2.6–D2.8

While D2.4 reports which prototype types are deployed and how they affect implementation design (site requirements, DoE feasibility, monitoring integration), it does not provide full prototype cataloguing, readiness scoring, or prototype-specific evaluation. Those elements remain covered by the WP2 prototype reporting line (D2.6–D2.8). This separation ensures D2.4 remains focused on site portfolios and implementation/experimental set-up as the operational backbone for cross-LL learning, without overlapping with prototype development and refinement narratives.

WP3: Monitoring and evaluation (D3.1 as the cross-LL backbone)

Monitoring and evaluation are led under WP3. D2.4 strengthens integration with WP3 by explicitly linking implementation documentation to the D3.1 indicator catalogue and sampling approach. Specifically, D2.4 consolidates minimum site metadata (site identifiers, access status, baseline sampling status, intervention status, monitoring readiness) and records the implementation status of baseline sampling and early follow-up sampling where available, enabling WP3 to harmonise datasets and interpret site-to-site variability.

WP4: Open Call (FSTP) integration

The Open Call is implemented under WP4 (Financial Support to Third Parties). Open Call documentation clarifies that funded projects are expected to test innovations **through existing Living Lab experimental sites**, rather than establish new experimental sites. The Open Call timeline places proposal evaluation, selection, and sub-grant signature after the Month 18 cut-off, with onboarding and testing beginning in spring 2026. Consequently, D2.4 reports the M18 implementation baseline and procedural readiness for integration, while detailed Open Call onboarding and prototype/site integration effects will be captured in subsequent iteration reporting once contracting and onboarding are finalised.

WP5: Communication, scaling, and policy uptake

WP5 will draw on the implementation logic and diversity of LL models documented in D2.4 (municipal peri-urban sites, post-mining landscapes, vineyard systems, intensive horticulture under water stress, and distributed farm networks) to tailor dissemination, stakeholder dialogue, and policy relevance activities. D2.4's cross-LL synthesis supports WP5 by clarifying the operational contexts in which prototypes are implemented and by providing consistent site and design documentation that strengthens the credibility of evidence generated during RP2.

WP8: Data management and FAIR alignment (D8.2)

All data and metadata associated with site selection, implementation design, and monitoring readiness are handled according to the project's Data Management Plan (D8.2), including FAIR principles and appropriate access controls. In practical terms, D2.4 supports cross-WP access by consolidating minimum metadata requirements and linking site-level implementation status (baseline sampling, monitoring readiness, experimental design documentation) to the shared project repository and templates used for harmonisation.

In synopsis, D2.4 plays a coordinating role across iCOSHELLs by translating co-created priorities into implementable site and design configurations, strengthening traceability for monitoring and evaluation, and setting the conditions for scaling and Open Call integration. The final iteration (D2.5) will consolidate further refinements based on continued implementation learning, expanded time-series monitoring, and confirmed Open Call onboarding outcomes.

ANNEX

Living Lab Site Portfolios (Minimum Metadata, M18) with tables numbered A.1–A.6.

- **Table A.1** Basque Urban Soils LL (Spain): site portfolio and baseline status
- **Table A.2** Bulgarian Viticultural LL (BUVLL): site portfolio and baseline status
- **Table A.3** Greek LL: site portfolio and baseline status
- **Table A.4** Italian LL: site portfolio and baseline status
- **Table A.5** SES LL (Spain): site portfolio and baseline status
- **Table A.6** Swedish LL: site portfolio and baseline status

Table A.1 Basque Urban Soils LL (Spain): site portfolio and baseline status

Site ID	Municipality / site label	Soil (WRB)	Texture class	Clay class	Baseline management (tillage)	Farming system	Irrigation	Baseline sampling completed
LANS1	Forua – LANDABERDE	Pending (RP2 metadata completion)	Loam	Light clay (~15–25%)	Not relevant (municipal/peri-urban)	Not relevant	None	30-Jun-25
LANS2	Forua – LANS2 (municipal/peri-urban site)	Pending (RP2 metadata completion)	Sandy loam	Light clay (~15–25%)	Not relevant (municipal/peri-urban)	Not relevant	None	30-Jun-25
LANS3	Forua – LANS3 (municipal/peri-urban site)	Pending (RP2 metadata completion)	Sandy loam	Light clay (~15–25%)	Not relevant (municipal/peri-urban)	Not relevant	None	30-Jun-25
LANS4	Forua – LANS4 (municipal/peri-urban site)	Pending (RP2 metadata completion)	Loam	Light clay (~15–25%)	Not relevant (municipal/peri-urban)	Not relevant	None	30-Jun-25
LANS5	Forua – LANS5 (municipal/peri-urban site)	Pending (RP2 metadata completion)	Sandy loam	Light clay (~15–25%)	Not relevant (municipal/peri-urban)	Not relevant	None	30-Jun-25
APS1	Forua – APEADERO	Pending (RP2 metadata completion)	Sandy loam	Light clay (~15–25%)	Not relevant (municipal/peri-urban)	Not relevant	None	30-Jun-25
ATXS1	Forua – PARQUE ATXAGA	Pending (RP2 metadata completion)	Loam	Medium clay (~25–40%)	Not relevant (municipal/peri-urban)	Not relevant	None	30-Jun-25
ATXS2	Forua – ATXS2 (municipal/peri-urban site)	Pending (RP2 metadata completion)	Silt loam	Light clay (~15–25%)	Not relevant (municipal/peri-urban)	Not relevant	None	30-Jun-25
ATXS3	Forua – ATXS3 (municipal/peri-urban site)	Pending (RP2 metadata completion)	Clay loam	Medium clay (~25–40%)	Not relevant (municipal/peri-urban)	Not relevant	None	30-Jun-25
ATXS4	Forua – ATXS4 (municipal/peri-urban site)	Pending (RP2 metadata completion)	Silt loam	Light clay (~15–25%)	Not relevant (municipal/peri-urban)	Not relevant	None	30-Jun-25

Table A.2 Bulgarian Viticultural LL (BUVLL): site portfolio and baseline status

Site ID	Municipality / site label	Soil (WRB)	Texture class	Clay class	Baseline management (tillage)	Farming system	Irrigation	Baseline sampling completed
BUV-01	Chernogorovo	Fluvisols	Sandy clay loam	Medium (25–40%)	Mulch tillage	Organic	Drip/micro	25-Apr-25
BUV-02	Brestovitsa	Fluvisols	Sandy clay loam	Medium (25–40%)	Deep tillage/subsoiling	Conventional	Drip/micro	25-Apr-25
BUV-03	Plovdiv, Yagodovo	Fluvisols	Sandy clay loam	Heavy (>40%)	Deep tillage/subsoiling	Organic	Drip/micro	27-Apr-25
BUV-04	Brestovitsa (2)	Fluvisols	Sandy clay loam	Medium (25–40%)	Deep tillage/subsoiling	Conventional	Drip/micro	25-Apr-25
BUV-05	Rogosh & Skutare	Fluvisols	Loamy sand	Light (15–25%)	Deep tillage/subsoiling	Conventional	Drip/micro	27-Apr-25
BUV-06	Bresnik	Fluvisols	Sandy clay loam	Heavy (>40%)	Conventional tillage	Conventional	Drip/micro	25-Apr-25
BUV-07	Bresnik (2)	Fluvisols	Sandy clay loam	Medium (25–40%)	Conventional tillage	Conventional	Drip/micro	25-Apr-25
BUV-08	Brestovitsa (3)	Fluvisols	Sandy clay loam	Very heavy (>60%)	Deep tillage/subsoiling	Conventional	Drip/micro	25-Apr-25
BUV-09	Govedare	Fluvisols	Sandy clay loam	Medium (25–40%)	Deep tillage/subsoiling	Conventional	Drip/micro	26-Apr-25
BUV-10	Perushtitsa	Fluvisols	Sandy clay loam	Heavy (>40%)	Conventional tillage	Conventional	Drip/micro	25-Apr-25

Table A.3 Greek LL: site portfolio and baseline status

Site ID	Municipality / site label	Soil (WRB)	Texture class	Clay class	Baseline management (tillage)	Farming system	Irrigation	Baseline sampling completed
E1	IWMA (Industrial Waste Management Area)	Calcaric Cambisol (Typic Xerochrepts)	Not specified	Not specified	Not applicable	Not applicable	None	17-Dec-24
E2	IWMA (Industrial Waste Management Area)	Calcaric Cambisol (Typic Xerochrepts)	Not specified	Not specified	Not applicable	Not applicable	None	17-Dec-24
E3	IWMA (Industrial Waste Management Area)	Calcaric Cambisol (Typic Xerochrepts)	Not specified	Not specified	Not applicable	Not applicable	None	17-Dec-24
E4	IWMA (Industrial Waste Management Area)	Calcaric Cambisol (Typic Xerochrepts)	Not specified	Not specified	Not applicable	Not applicable	None	17-Dec-24
E5	IWMA (Industrial Waste Management Area)	Calcaric Cambisol (Typic Xerochrepts)	Not specified	Not specified	Not applicable	Not applicable	None	17-Dec-24
E6	IWMA (Industrial Waste Management Area)	Calcaric Cambisol (Typic Xerochrepts)	Not specified	Not specified	Not applicable	Not applicable	None	17-Dec-24
E7	IWMA (Industrial Waste Management Area)	Calcaric Cambisol (Typic Xerochrepts)	Not specified	Not specified	Not applicable	Not applicable	None	17-Dec-24
E8	IWMA (Industrial Waste Management Area)	Calcaric Cambisol (Typic Xerochrepts)	Not specified	Not specified	Not applicable	Not applicable	None	17-Dec-24

E9	IWMCF (Integrated Management Central Facility)	Calcaric Cambisol (Typic Xerochrepts)	Not specified	Not specified	Not applicable	Not applicable	None	21-Jan-25
E10	IWMCF (Integrated Management Central Facility)	Calcaric Cambisol (Typic Xerochrepts)	Not specified	Not specified	Not applicable	Not applicable	None	21-Jan-25
E11	IWMCF (Integrated Management Central Facility)	Calcaric Cambisol (Typic Xerochrepts)	Not specified	Not specified	Not applicable	Not applicable	None	21-Jan-25
E12	IWMCF (Integrated Management Central Facility)	Calcaric Cambisol (Typic Xerochrepts)	Not specified	Not specified	Not applicable	Not applicable	None	21-Jan-25

Table A.4 Italian LL: site portfolio and baseline status

Site ID	Municipality / site label	Soil (WRB)	Texture class	Clay class	Baseline management (tillage)	Farming system	Irrigation	Baseline sampling completed
ITA-01	Provincia Autonoma di Trento (ITH2) — Valle dei Laghi – vineyards	Not specified	Not specified	Not specified	No-till / Direct seeding	Crop – organic	Drip / micro irrigation	25-Mar
ITA-02	Provincia Autonoma di Trento (ITH2) — Valle dei Laghi – apple orchards	Not specified	Not specified	Not specified	No-till / Direct seeding	Crop – organic	Drip / micro irrigation	25-Mar
ITA-03	Provincia Autonoma di Trento (ITH2) — Alto Garda – olive orchards	Not specified	Not specified	Not specified	No-till / Direct seeding	Crop – conventional	Drip / micro irrigation	25-Mar
ITA-04	Provincia Autonoma di Trento (ITH2) — Arco – chestnut orchards	Not specified	Not specified	Not specified	No-till / Direct seeding	Crop – organic	None	25-Jun
ITA-05	Lombardia (ITC4) — Cascina Nosedo (Milan peri-urban / agroforestry)	Not specified	Not specified	Not specified	Not specified	Not specified	None	Not specified*
ITA-06	Lombardia (ITC4) — Franciacorta (Castello di Gussago) – vineyard	Not specified	Clay loam	Not specified	Strip tillage	Crop – conventional	Drip / micro irrigation	25-Sep
ITA-07	Lombardia (ITC4) — Franciacorta (Adro, Ronco Calino) – vineyard	Not specified	Sandy loam	Not specified	Strip tillage	Crop – organic	Drip / micro irrigation	25-Sep
ITA-08	Provincia Autonoma di Trento (ITH2) — University of Trento (Trento) – vineyards	Not specified	Unknown	Not specified	Not specified	Not specified	Drip / micro irrigation	25-Sep

ITA-09	Lombardia (ITC4) — Parco del Mincio – wetland	Not specified	Silt loam	Not specified	Not specified	Not relevant	None	25-Sep
ITA-10	Veneto (ITH3) — Comune di Oppeano	Not specified	Silty clay	Not specified	Not specified	Not relevant	Drip / micro irrigatio n	25-Sep
ITA-11	Pavia (rice cluster) — Rice land site 1	Not specified	Not specified	Not specified	Not specified	Crop – conventio nal	Other	25-Oct
ITA-12	Pavia (rice cluster) — Rice land site 2	Not specified	Not specified	Not specified	Conventional tillage	Crop – conventio nal	Other	25-Oct
ITA-13	Novara, Piedmont (rice cluster) — Rice land site 3	Not specified	Not specified	Not specified	Conventional tillage	Crop – conventio nal	Other	25-Oct
ITA-14	Novara, Piedmont (rice cluster) — Rice land site 4	Not specified	Not specified	Not specified	Conventional tillage	Crop – conventio nal	Other	25-Oct

Table A.5 SES LL (Spain): site portfolio and baseline status

Site ID	Municipality / site label	Soil (WRB)	Texture class	Clay class	Baseline management (tillage)	Farming system	Irrigation	Baseline sampling completed
FNC1	Region de Almeria (ES61) — BARE	Regosols	To be determined	To be determined	Reduced tillage	Crop – conventio nal	Drip / micro irrigation	23-Apr-25
FNC2	Region de Almeria (ES61) — HORTICULTURE	Regosols	To be determined	To be determined	Conventional tillage	Mixed – conventio nal	Drip / micro irrigation	16-Jul-25
FNC3	Region de Almeria (ES61) — ORANGE	Regosols	To be determined	To be determined	Conventional tillage	Mixed – organic	Drip / micro irrigation	15-Jul-25
IMD4	Region de Murcia (ES62) — CAPSICUM (BS+ROTATION)	Regosols	To be determined	To be determined	Conventional tillage	Crop – conventio nal	Drip / micro irrigation	14-Jul-25
IMD5	Region de Murcia (ES62) — CAPSICUM (ROTATION)	Regosols	To be determined	To be determined	Conventional tillage	Crop – conventio nal	Drip / micro irrigation	14-Jul-25
CBS6	Region de Murcia (ES62) — GRAPEFRUIT ORG	Calcisols	To be determined	To be determined	Conventional tillage	Crop – conventio nal	Drip / micro irrigation	10-Apr-25
CBS7	Region de Murcia (ES62) — GRAPEFRUIT CONV	Calcisols	To be determined	To be determined	Conventional tillage	Mixed – organic	Drip / micro irrigation	10-Apr-25
CBS8	Region de Murcia (ES62) — LEMON ORG	Calcisols	To be determined	To be determined	Reduced tillage	Mixed – organic	Drip / micro irrigation	10-Apr-25
CBS9	Region de Murcia (ES62) — LEMON CONV	Calcisols	To be determined	To be determined	Reduced tillage	Mixed – organic	Drip / micro irrigation	10-Apr-25
CBS10	Region de Murcia (ES62) — WATERM/BROCOLI	Calcisols	To be determined	To be determined	Conventional tillage	Crop – organic	Drip / micro irrigation	10-Apr-25

Table A.6 Swedish LL: site portfolio and baseline status

Site ID	Municipality / site label	Soil (WRB)	Texture class	Clay class	Baseline management (tillage)	Farming system	Irrigation	Baseline sampling completed
Farm school	Farm school — Norra mellansverige (SE31)	Not specified	Sand	Not specified	Reduced tillage	Mixed – organic	None	30-07-2025
Hasta farm	Hasta farm — Östra mellansverige (SE12)	Not specified	Not specified	Not specified	Not specified	Not specified	None	Not specified
Andelsodling i Berg	Andelsodling i Berg — Norra mellansverige (SE31)	Not specified	Silty Clay	Not specified	No-till / Direct seeding	Crop – organic	Drip / micro irrigation	30-07-2025
Hidinge farm	Hidinge farm — Östra mellansverige (SE12)	Not specified	Not specified	Not specified	Not specified	Not specified	None	Not specified
Hilmér Lantbruk	Hilmér Lantbruk — Västsverige (SE23)	Not specified	Not specified	Not specified	Not specified	Not specified	None	Not specified
Bona Gård	Bona Gård — Stockholm (SE11)	Not specified	Clay	Not specified	Reduced tillage	Mixed – conventional	None	Not specified
Södergård	Södergård — Sydsverige (SE22)	Not specified	Loamy Sand	Not specified	Reduced tillage	Mixed – conventional	Surface irrigation	2025-11-06 00:00
Hacksta	Hacksta — Östra mellansverige (SE12)	Not specified	Not specified	Not specified	Not specified	Not specified	None	Not specified
Bännebo Gård	Bännebo Gård — Östra mellansverige (SE12)	Not specified	Clay Loam	Not specified	Reduced tillage	Crop – conventional	None	16-06-2025 and 17-06-2025
Wiggeby	Wiggeby — Stockholm (SE11)	Not specified	Silty Clay Loam	Not specified	Reduced tillage	Crop – conventional	None	22-08-2025
Mossagården	Mossagården — Sydsverige (SE22)	Not specified	Loam	Not specified	Reduced tillage	Crop – organic	None	30-07-2025
Norregården	Norregården — Sydsverige (SE22)	Not specified	Silty Clay	Not specified	Reduced tillage	Crop – conventional	None	15-08-2025 and 16-08-2025
Brunnby Gård	Brunnby Gård — Östra mellansverige (SE12)	Not specified	Not specified	Not specified	Not specified	Not specified	None	Not specified
Alnarp's Agroecology Farm	Alnarp's Agroecology Farm — Sydsverige (SE22)	Not specified	Not specified	Not specified	No-till / Direct seeding	Crop – organic	None	16-06-2025 and 17-06-2025

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