A shared digital space for soil innovation and the Nemesis virtual Living Lab platform

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Soil health Living Labs (LLs) generate some of their most valuable output not as a single breakthrough but as a continuous stream of dispersed, heterogeneous information – sensor readings, field-trial results, farmer observations, policy feedback – produced across multiple sites, institutions and countries. Left unconnected, this information stays locked inside individual LLs, each re-learning lessons the others have already learned. A shared digital space, through which LLs capture, structure and exchange data, methods and experience, is increasingly seen as the element that turns a set of independent Living Labs into a genuine network capable of learning collectively, provided each participant keeps ownership of what it contributes[1].

In practice, this is less a matter of building one central database than of connecting many smaller ones. Because every LL, partner organisation and country keeps its own systems, sensors and legal constraints, recent soil-data initiatives favour a distributed architecture: each site keeps its raw records locally and publishes only a structured, standards-based layer – common fields, common units, a shared schema – that a central service can query and combine on demand[2]. The payoff is concrete: a soil organic carbon trend measured at one Living Lab becomes directly comparable with another's, an erosion indicator computed in one country can be reproduced in another, and the resulting indicators stay usable long after the project that first computed them has ended[3].

Interoperability only pays off if stakeholders trust the platform enough to feed it in the first place. Evidence from agricultural data-sharing initiatives shows that farmers, researchers, public bodies and citizens attach different priorities to a shared digital space – privacy and control for those contributing data, scientific rigour for researchers, fairness and transparency for the wider public – and that these priorities need to be designed into the platform's governance from the outset rather than patched in afterwards[4]. For a Living Lab network, this means agreeing early who can access which data, under what conditions, and for what purpose.

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A "virtual Living Lab" extends this logic from data to participation itself. Alongside physical experimental sites, a digital layer of dashboards, virtual workspaces and, increasingly, digital twins of the monitored land lets stakeholders who cannot be on-site continue to take part in observation, discussion and decision-making, while giving the network a persistent, inspectable record of what has been tried, measured and learned[1]. Usability and inclusivity are decisive here: platforms that are difficult to navigate, or that assume constant high-speed connectivity, exclude precisely the actors whose knowledge and buy-in the Living Lab depends on[5].

The Nemesis virtual Living Lab platform puts this general case into practice through a set of purpose-built tools, rather than a single generic dashboard. A data cube brings together Earth observation layers, in-situ sensor readings and site-level measurements into one structured, queryable resource, so that a soil health indicator is computed the same way whether the underlying data came from a satellite pass over Cyprus or a field sensor in Tunisia. A digital twin of each experimental site lets Living Lab members and researchers simulate how a given practice – a cover crop, a change in tillage, a restoration intervention – is likely to affect soil organic carbon, erosion or biodiversity before it is trialled on the ground, shortening the loop between evidence and decision. A dynamic mapping tool, building on the stakeholder-registration functions already built into the platform, lets each Living Lab see who is involved, where activity is concentrated, and where engagement gaps remain, turning stakeholder participation itself into something that can be tracked rather than assumed. Further tools will be added as the network matures including an e-learning hub with training material and valuable information for various stakeholders and audiences.

Governance questions are as central to this toolset as the technology itself. Who can see which layer of the data cube, how simulation outputs from the digital twin are validated before they inform real decisions, and how smaller or less digitally-resourced partners stay genuinely included in the mapping tool rather than nominally connected, all need to be settled alongside the tools, not after they are built. Designed this way, as infrastructure for evidence-sharing, simulation and participation together, these tools can let the platform outlast the project and keep connecting soil innovation across sites.

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References:

1. Demontis, R., Lorrai, E. B., Muscas, L., Palla, P., & Zucca, C. (2026). *A decentralized network of soil information systems for soil data management across the Mediterranean region*. Frontiers in Soil Science, 6. https://doi.org/10.3389/fsoil.2026.1857035
2. Lachmuth, S., Dönmez, C., Hoffmann, C., Specka, X., Svoboda, N., & Helming, K. (2025). *Facilitating effective reuse of soil research data: The BonaRes repository.* European Journal of Soil Science, 76(2). https://doi.org/10.1111/ejss.70103
3. Gil, R. M., Ryan, M., & García, R. (2025). *Sovereignty by design and human values in agriculture data spaces.* Agriculture and Human Values, 42(3), 1413–1438. https://doi.org/10.1007/s10460-024-10674-0
4. Sofronievska, A., Cheshmedjievska, E., Stojcheska, D., Taneska, M., Gjorgievski, V. Z., Kokolanski, Z., & Taskovski, D. (2026). *Understanding Living Labs: A framework for evaluating sustainable innovation*. Sustainability, 18(1), 117. https://doi.org/10.3390/su18010117
5. Loisel, Q. E. A., An, Q., Anand-Kumar, V., Balaskas, G., Papadopoulos, H., Pappa, D., Giné-Garriga, M., Longworth, G. R., & Chastin, S. F. M. (2025). *Scoping review of needs for digital technology in co-creation: a health CASCADE study.* Research Involvement and Engagement, 11(1), 121. https://doi.org/10.1186/s40900-025-00797-x

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